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Base Realignment and Closure
Program Management Office West
1230 Columbia Street, Suite 1100
San Diego, California 92101

CONTRACT NO. N68711-98-D-5713
CTO NO. 0084

FINAL

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Revision 0

May 17, 2005

PCB HOT SPOT SOIL EXCAVATION SITE
PARCELS E AND E-2, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: FWSD-RAC-05-1163

Prepared by:

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May 19, 2005
FWSD-RAC-05-1163
5.0

Mark Walden
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Program Management Office West
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SUBJECT: FINAL SITE-SPECIFIC HEALTH AND SAFETY PLAN, PCB HOT SPOT SOIL EXCAVATION SITE PARCELS E AND E-2, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Reference: Contract N68711-D-5713, Environmental Remedial Action Contract for Sites in Southern California, Arizona, New Mexico and Southern Nevada

Dear Mr. Walden,

Enclosed is the Final Site-Specific Health and Safety Plan for the PCB Hot Spot Soil Excavation Site, Parcels E and E-2, Hunters Point Shipyard, San Francisco, California, dated May 17, 2005. If you have any questions, please do not hesitate to contact me at (619) 471-3502 or Roger Margotto at (619) 471-3503.

Sincerely,

Luis Rivero
Project Manager

Enclosure: Final Site-Specific Health and Safety Plan, PCB Hot Spot Soil Excavation Site, Parcels E and E-2, Hunters Point Shipyard, San Francisco, California

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TRANSMITTAL/DELIVERABLE RECEIPT

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Southwest Division
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DATE: 05/20/05
CTO: 0084
LOCATION: Hunters Point Shipyard

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Neil Hart, Program Manager

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ABBREVIATIONS AND ACRONYMS

AL	action level
ALARA	as low as reasonably achievable
AM	Action Memorandum
AHA	Activity Hazard Analysis
bgs	below ground surface
Cal/EPA	California Environmental Protection Agency
Cal-OSHA	California Occupational Safety and Health Administration
^{137}Cs	cesium-137
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHP	Certified Health Physicist
CIH	Certified Industrial Hygienist
CMT	Construction Management Technician
CNS	central nervous system
COC	chemical of concern
CSO	Caretaker Site Office
CTO	Contract Task Order
DAC	derived airborne concentration
dBA	decibels, A-scale
DoD	Department of Defense
DON	Department of the Navy
DPH	Department of Public Health
DTSC	Department of Toxic Substances Control
EM	Engineer Manual
EMS	Emergency Medical System
EPA	U.S. Environmental Protection Agency
EZ	exclusion zone
FOPS	Falling Object Protective System
HEPA	high efficiency particulate air
HPS	Hunters Point Shipyard
hr	hour

ABBREVIATIONS AND ACRONYMS
(Continued)

HSP	Base-wide Health and Safety Plan
IR	Installation Restoration
LEL	lower explosive limit
LLRW	Low-Level Radioactive Waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mg/kg	milligram per kilogram
mg/m^3	milligrams per cubic meter
MSDS	Material Safety Data Sheet
msl	mean sea level
N/A	not applicable
NAVSEA	Naval Sea Systems Command
NFECSW	Southwest Division, Naval Facilities Engineering Command
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
NWT	New World Technology, Inc.
O_2	oxygen
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PESM	Project Environmental and Safety Manager
PM_{10}	particulate matter less than 10 microns in diameter
PjM	Project Manager
PPE	personal protective equipment
ppm	parts per million
PQCM	Project Quality Control Manager
QA	quality assurance
QC	quality control
^{226}Ra	radium-226

ABBREVIATIONS AND ACRONYMS
(Continued)

RASO	Radiological Affairs Support Office
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RRO	radiological remedial objective
ROC	radionuclide of concern
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RSO	Radiation Safety Officer
RSOR	Radiation Safety Office Representative
RTM	Radiological Task Manager
RWQCB	Regional Water Quality Control Board
RWP	Radiation Work Permit
SARA	Superfund Amendments and Reauthorization Act
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
SOP	Standard Operating Procedure
^{90}Sr	strontium-90
STEL	short-term exposure limit
SVOC	semivolatile organic compound
TCRA	time-critical removal action
TEDE	total effective dose equivalent
TLV	threshold limit value
TOG	total oil and grease
TPH	total petroleum hydrocarbons
TPH-d	total petroleum hydrocarbons quantified as diesel
TPH-extractable	total extractable petroleum hydrocarbons
TPH-g	total petroleum hydrocarbons quantified as gasoline
TPH-purgeable	total purgeable petroleum hydrocarbons
Triple A	Triple A Machine Shop, Inc.

ABBREVIATIONS AND ACRONYMS
(Continued)

TSP	total suspended particulate
TtEMI	Tetra Tech EM, Inc.
TtFW	Tetra Tech FW, Inc.
TWA	time weighted average
USACE	United States Army Corps of Engineers
VOC	volatile organic compound

1.0 INTRODUCTION

This Site-Specific Health and Safety Plan (SHSP) establishes the procedures and methods to be employed for the implementation of a time-critical removal action (TCRA) for the polychlorinated biphenyl (PCB) hot spot soil excavation site (PCB hot spot), located primarily within Parcel E-2, with a small section of the excavation in Parcel E, at Hunters Point Shipyard (HPS), San Francisco, California (Figure 1-1). The Department of the Navy (DON), Southwest Division, Naval Facilities Engineering Command (NFECSW), including the Radiological Affairs Support Office (RASO), are directing this removal action. The removal action is being performed under Contract No. N68711-93-D-5713 and Contract Task Order (CTO) No. 0084. The Contract Health and Safety Program for this work consists of the *Base-Wide Health and Safety Plan* (HSP) [Tetra Tech FW, Inc. (TtFW), 2004], which provides the overall framework and basic criteria for the implementation of health and safety measures for HPS, and the TtFW Corporate Health and Safety Program Manual.

1.1 PROJECT OBJECTIVES AND SCOPE

The DON has initiated a TCRA for the extraction of soils containing PCB concentrations greater than 1 milligram per kilogram (mg/kg), petroleum hydrocarbons concentrations greater than 3,500 mg/kg, or radioactive contaminants in excess of the radiological remedial objectives (RROs) within the proposed lateral excavation boundary of the PCB hot spot to a depth of 3 feet below ground surface (bgs). In addition, excavation of the excavation bottom will be done to an estimated maximum depth of 10 feet bgs if post-excavation samples indicate PCB concentrations greater than 100 mg/kg, total petroleum hydrocarbons (TPH) concentrations greater than 3,500 mg/kg or radiological screening identifies an area with radioactive materials above the RROs. The excavation boundary sidewalls will also be excavated if post-excavation samples indicate PCB concentrations greater than 1 mg/kg, TPH concentrations greater than 3,500 mg/kg or radiological screening identifies and area with radioactive materials above the RROs. The TCRA will limit human and ecological (terrestrial and aquatic) receptor exposure to PCB contamination that poses a potential risk by breaking the potential pathway from contaminants in the soil to the receptor.

The cleanup goals and RROs for this TCRA have been established to protect public health and the environment by setting standards for the physical removal and disposition of chemical and radioactive contaminants. The planned removal action at the PCB hot spot incorporates in situ radiological surveys, identification and removal of radioactive material, pre-excavation characterization sampling, protection or removal of existing site features, soil and debris excavation, ex situ screening of excavated soils, segregation of contaminated soil and debris, stockpiling of excavated soil and debris, post-excavation sampling of the excavated area, backfill

placement, compaction with import materials, site restoration, and waste management/classification, storage and disposal. Any sandblast grit encountered during excavation activities will be sampled in accordance with the *Final Base-wide Radiological Work Plan Sampling and Analysis Plan* (TtFW, 2005a). Any firebricks encountered during excavation activities will be segregated because they contain naturally occurring radioactive materials and will require special disposal. The proposed excavation boundaries for the PCB hot spot will be further delineated following pre-excavation characterization sampling.

1.2 APPLICATION

This SHSP will be used in conjunction with the HSP (TtFW, 2004) and is applicable to all work conducted under the basic contract and this CTO. Refer to the HSP (TtFW, 2004) for additional details common to all work performed at HPS. Equivalent or additional health and safety procedures and practices may be approved by TtFW and implemented where necessary. All project personnel are required to follow the health and safety programs and procedures discussed herein, unless changes are approved by the Project Environmental and Safety Manager (PESM), who is a Certified Industrial Hygienist (CIH), and the DON Contracting Officer. The PESM will review the SHSP prior to initiation of field activities.

1.3 SUMMARY OF MAJOR RISKS

The potential project hazards associated with the site characterization and excavation activities consist of physical, chemical, and radiological hazards. Physical hazards include:

- Use of and working around heavy equipment.
- Hazards associated with drilling and excavation activities.
- Handling soil samples, wastewater, and excavated materials.
- Slip, trip, and fall hazards associated with working on uneven and sloped terrain.

The chemical hazards include exposure to contaminated soil, sediments, and groundwater. During a previous site investigation, concentrations of PCBs greater than 1 mg/kg were found in borings drilled within or near the PCB hot spot. A total of 219 samples were collected and analyzed for PCBs at various depths from 90 borings drilled. Of the 219 samples, 101 had PCB concentrations (specifically, Aroclor 1260) greater than 1 mg/kg. Other investigations within Parcel E have revealed concentrations of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) chemicals of concern (COCs), including metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and PCBs. Petroleum hydrocarbons were also found in soil at concentrations exceeding their screening criteria. COCs found in groundwater included metals and pesticides [Tetra Tech EM, Inc. (TtEMI) et al., 1997; TtEMI, 1998]. Anyone that enters the work area must be trained on the

Material Safety Data Sheets (MSDSs), provided in Attachment 1, and become familiar with the precautions that are associated with the known or suspect chemicals.

The *Final Historical Radiological Assessment Volume II* [Naval Sea Systems Command (NAVSEA), 2004] listed cesium-137 (^{137}Cs), radium-226 (^{226}Ra), and strontium-90 (^{90}Sr) as radionuclides of concern (ROCs) for these sites. Radioactive contamination was introduced to the site through the inadvertent disposition of radioluminescent devices containing ^{226}Ra and ^{90}Sr with other shipyard fill material. This was a common practice throughout the military and private industry from the 1940s to the 1960s. The radionuclides ^{137}Cs and ^{90}Sr may be encountered in contaminated sandblast grit, as well as other media besides sandblast grit. HPS used sandblast grit to decontaminate ships that were involved in atomic weapons testing and may have disposed of some of the grit at the PCB hot spot area (NAVSEA, 2004).

Previous radiological investigations have identified radioactive materials in Parcels E and E-2. Examples of radioactive materials expected to be encountered in the project area are radioluminescent devices, such as gauges and dials that contain paint mixed with ^{226}Ra and ship's deck markers containing ^{226}Ra or ^{90}Sr that were disposed of in the project area by the DON.

In addition, HPS was formerly used to facilitate activities associated with shipbuilding and repair, maintenance, storage, and transportation. Although a security fence surrounds the entire facility, HPS has had trespassers, vagrants, and scavengers. There is also a Defense Department Police Force on the facility.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The following list identifies the key contacts for those agencies and individuals that are responsible for the oversight and/or implementation of the site activities. A project organization chart showing the relationship among select team members is provided as Figure 2-1.

Agency	Contact	Project Title
NFECSW BPMOW.MW 1230 Columbia Street, Suite 1100 San Diego, CA 92101	Mark Walden (619) 532-0931	DON Remedial Project Manager (RPM)
RASO P.O. Drawer 260 Yorktown, VA 23691-0260	Laurie Lowman (757) 887-4692	Radiological Site Manager
Resident Officer in Charge of Construction (ROICC) San Francisco Bay Area 2450 Saratoga Ave., Suite 200 Alameda, CA 94501	Peter Stroganoff (510) 749-5941	ROICC
ROICC San Francisco Bay Area 2450 Saratoga Ave., Suite 200 Alameda, CA 94501	Andy Uehisa (510) 749-5946	ROICC Construction Management Technician
Caretaker Site Office (CSO) Hunters Point Shipyard 410 – Palm Avenue, Building 1, Suite 161 San Francisco, CA 94130	Mike Mentink (415) 743-4729	CSO
CSO Hunters Point Shipyard 410 – Palm Avenue, Building 1, Suite 161 San Francisco, CA 94130	Doug Delong (415) 743-4713	CSO
U.S. Environmental Protection Agency (EPA), Region IX 75 Hawthorne Street (SFD-8-3) San Francisco, CA 94105	Michael Work (415) 972-3024	EPA RPM
California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) Office of Military Facilities 700 Heinz Ave., Bldg. F, Suite 200 Berkeley, CA 94710	Tom Lamphar (510) 540-3776	Cal/EPA DTSC RPM
California Regional Water Quality Control Board (RWQCB) 1515 Clay Street, Suite 1400 Oakland, CA 94612	James Ponton (510) 662-2492	RWQCB RPM

Agency	Contact	Project Title
City and County of San Francisco Department of Public Health (DPH) 1390 Market St., Suite 210 San Francisco, CA 94102	Amy Brownell (415) 252-3967	San Francisco DPH RPM
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Gerard Slattery (415) 671-1990	HPS Project Manager (PjM)
TtFW 1230 Columbia Street, Suite 500 San Diego, CA 92101	Luis Rivero (619) 471-3502	PCB Hot Spot PjM
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Bill Williams (415) 671-1990	Construction Manager
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Mary Schneider (949) 756-7586	QC Program Manager
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Carl Jones (415) 671-1990	Project Quality Control Manager (PQCM)
TtFW	To be determined	Field Engineer
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Daryl DeLong (415) 671-1990	Radiation Safety Officer (RSO)
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Richard Quinn, CSP (415) 671-1990	Senior Site Health and Safety Specialist (SHSS)
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Carl Walker, (415) 671-1990	Alternate SHSS

Agency	Contact	Project Title
TtFW 1230 Columbia Street, Suite 500 San Diego, CA 92101	Roger Margotto, CIH, CSP, CHMM (619) 471-3503	PESM, Certified Industrial Hygienist
TtFW 1050 NE Hostmark Street, Suite 202 Poulsbo, WA 98370	Keli McKay-Means (360) 598-8108	Regulatory Compliance Manager
TtFW 3200 George Washington Way, Suite G Richland, WA 99352	Cliff Stephan (509) 371-0140	Project Certified health Physicist (CHP)
New World Technology, Inc. (NWT) Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Bert Bowers (415) 216-2742	NWT Radiological Task Manager (RTM)

3.0 SITE HISTORY AND PROJECT DESCRIPTION

The HSP (TtFW, 2004) details the description, history, and physical characteristics of HPS. A description of this specific site and duration of the project are described below. Additional details are contained in the Project Work Plan (TtFW, 2005b).

3.1 SITE DESCRIPTION AND HISTORY

HPS is located in the City and County of San Francisco, California, on a long promontory in the southeastern part of San Francisco that extends east into San Francisco Bay (Bay). HPS encompasses 848 acres, including 416 acres on land. The land portion of HPS was purchased by the DON in 1939 and leased to Bethlehem Steel Corporation. At the start of World War II in 1941, the DON took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974. The DON deactivated HPS in 1974. From 1976 to 1986, the DON leased HPS to Triple A Machine Shop, Inc. (Triple A), a private ship repair company. In 1986, Triple A ceased operations at HPS and the DON resumed occupancy through 1989.

Because previous shipyard operations left hazardous materials on site, HPS was placed on the National Priorities List in 1989 as a Superfund site pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. HPS then came under the administrative jurisdiction of the Treasure Island Naval Station in April 1990.

In 1991, HPS was placed on the Navy's Base Realignment and Closure list and its mission as a Navy shipyard ended in April 1994. Closure activities at HPS involve environmental remediation activities and making the property available for non-defense use. On March 31, 1994, control of HPS was transferred from the Treasure Island Naval Station to the Naval Facilities Engineering Command, Western Division (now Engineering Field Activity West) in San Bruno, California. In October 1999, NFECSW assumed management of HPS.

HPS was divided into six parcels, Parcels A through F. In November 2004, Parcel A was transferred to the City and County of San Francisco. In 2004, the DON subdivided Parcel E, creating Parcel E-2 in order to move the Industrial Landfill forward under the CERCLA process. Parcel E-2, 47 acres in size encompasses former portions of Parcel E, Including IR-01/21, the Panhandle Area, parts of IR-02 Northwest and the area east of IR-01/21 that does not have an Installation Restoration (IR) site designation. Parcels E, a majority of which is unpaved and formerly used for industrial support, now occupies 138 acres along the upland shoreline in the southwestern portion of HPS.

The activities governed by this TCRA deal specifically with the PCB hot spot, located primarily within Parcel E-2, with a small section of the excavation in Parcel E. The PCB hot spot covers approximately 3.5 acres along the shoreline. The DON created this land area by filling in the bay margin, largely with soils derived from serpentinite bedrock quarried from the Hunters Point peninsula. After the area was filled, the area to the north of the PCB hot spot was used as an industrial waste landfill. The suspected source of the PCB contamination is disposal of waste oils that contained PCBs.

Radioactive contamination was introduced to the site through the inadvertent disposition of radioluminescent devices containing ^{226}Ra and ^{90}Sr with other shipyard fill material. This was a common practice throughout the military and private industry from the 1940s to the 1960s. In addition, ^{137}Cs and ^{90}Sr may be encountered in contaminated sandblast grit. HPS used sandblast grit to decontaminate ships that were involved in atomic weapons testing and may have disposed of some of the grit at the PCB hot spot area (NAVSEA, 2004).

Along the western portion of the PCB hot spot, an 800-foot-long sheet pile barrier was constructed between the landfill area and the shoreline of the Bay in 1996. This wall, along with a groundwater extraction system installed approximately 20 feet to the east of the sheet pile barrier, is designed to intercept Bay Mud and control the movement of groundwater, thereby limiting the amount of hazardous substances that would otherwise migrate toward the Bay.

3.2 SITE PHYSICAL CHARACTERISTICS

The topography of the PCB hot spot is relatively bare and flat, with surface elevations of generally less than 10 feet above mean sea level (msl). The shoreline area generally consists of riprap containing rock, concrete, and other debris, with relatively sharp slopes to the bay as well as mudflats and sandy beaches. Groundwater is located at approximately zero to 2 feet above msl (8 to 11 feet bgs), with a gradient generally to the west toward the Bay.

3.3 PROJECT DESCRIPTION

A TCRA has been initiated for the PCB hot spot and is being conducted pursuant to the *Draft Action Memorandum, Time-Critical Removal Action for the PCB Hot-spot Area at Parcels E and E-2* (DON, 2005) (referred to hereafter as the Draft Action Memorandum (AM) for the PCB Hot Spot) and the *Final Basewide Radiological Removal Action, Action Memoradum for Hunters Point Shipyard* (DON, 2001) [referred to hereafter as the Final Basewide AM], and will document for the Administrative Record, the DON's decision to undertake a TCRA at this site due to PCBs, TPH and radioactive contamination in soils and debris. The Project Work Plan (TtFW, 2005b) has been prepared to outline the various field activities associated with implementing the TRCA, which consists of removing PCBs and radioactive materials from the site. The radiological surveying (surveying, screening, sampling, and post-excavation sampling)

of the excavated areas will be conducted in accordance with the *Base-wide Radiological Work Plan* (Base-wide Plan) (TtFW, 2005a) following guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) *NUREG-1575* [Department of Defense (DoD) et al., 2000].

Specifically, the planned project activities for the PCB hot spot will include the following:

- Permitting and notifications
- Preparatory activities and meetings
- Environmental resources surveying
- Clearing of vegetation
- Topographic surveying
- Geophysical surveying
- Radiological surface surveying
- Identification and removal of radioactive materials
- Mobilization
- Pre-excavation and PCB characterization sampling
- Protection or removal of existing site features, such as utilities, structures, groundwater extraction wells, and piezometers
- PCB and/or petroleum hydrocarbon-contaminated soil excavation and removal of additional radioactive materials
- Dewatering of excavated materials
- Secondary screening of excavated materials (ex situ)
- Segregation and stockpiling of the screened materials (soil, radioactive materials, and construction debris)
- Post-excavation sampling
- Backfill placement and compaction
- Site restoration
- Decontamination of equipment and tools and free-release surveying
- Waste classification, on-site storage of radioactive wastes, and transportation and off-site disposal of non-radiological wastes
- Demobilization

3.4 PROJECT DURATION

Field activities of the removal action, including site restoration, required in order to address PCB and petroleum hydrocarbon contamination and potential radiological impacts within the PCB hot spot, are expected to be completed within 120 days following approval of the Project Work Plan (TtFW, 2005b). Upon completion of the TCRA, TtFW will proceed with the preparation of the Removal Action Completion Report.

4.0 POTENTIAL HAZARDS

The HSP (TtFW, 2004) identifies hazards that are common to all projects within HPS. Site-specific hazards associated with this project, including chemical, environmental, and physical hazards, are summarized below.

4.1 CHEMICAL HAZARDS

During a previous site investigation, 219 samples were collected from 90 borings installed within or near the PCB hot spots excavation limits for PCB analysis. Of the 219 samples, 101 had PCB concentrations that exceeded the project cleanup goal of 1 mg/kg. Pre-excavation characterization sampling will be conducted as detailed in the Project Work Plan (TtFW, 2005b) to further delineate the lateral extents of the PCB hot spot excavation boundaries. During project activities within the identified areas of PCB contamination, a water truck equipped with a hose will be used to mist the soil and debris during excavation and segregation to minimize the potential for dust. In addition, personal protective equipment (PPE) will be specified/used to control exposure to potential PCB contamination.

Other chemicals that have been found within Parcel E include metals (antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc), VOCs (vinyl chloride), SVOCs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene), pesticides (aldrin), PCBs (Aroclors 1254 and 1260) and petroleum hydrocarbons TPH quantified as gasoline (TPH-g), TPH quantified as diesel (TPH-d), total oil and grease (TOG), total purgeable petroleum hydrocarbons (TPH-purgeable), and total extractable petroleum hydrocarbons (TPH-extractable)]. These contaminants may also be encountered at the PCB hot spot. The PESM and SHSS will specify the levels of protection and air monitoring requirements, if needed, based on the contaminant data provided or obtained during initial TCRA activities. These requirements may change as site conditions are more fully evaluated. Table 4-1 summarizes the hazards associated with these chemicals.

MSDSs for these contaminants and for any additional chemicals found on site or brought onto the site will be acquired and reviewed with all personnel during daily safety meetings. A master file of MSDSs for use on this project will be kept in the HPS trailer, and a copy of the MSDSs will be maintained at the worksite and will be readily accessible at all times. Attachment 1 of this SHSP contains MSDSs of the primary contaminants (PCB and petroleum hydrocarbons). MSDSs for other contaminants that may be near the hot spot can be found in Attachment 1 of the SHSP for IR-02 Northwest and Central (TtFW, 2005c).

4.2 ENVIRONMENTAL HAZARDS

Projects at HPS have the potential for hazards related to temperature stresses, which are addressed in the Base-Wide Plan (TtFW, 2005a). Other environmental hazards may include excessive noise levels during excavation operations and high winds. Hearing protection will be made available to all employees exposed to noise levels above a time-weighted average (TWA) of 84 decibels, A-scale (dBA). If wind speeds are 25 miles per hour or higher, the SHSS will stop all work and assess what, if any, work activities can continue to be performed in a safe manner.

Biological hazards may include animal bites, insect stings, and contact with poison oak, animal and bird droppings, mice, rats, and snakes. Personnel will use extreme caution when working in the vicinity of potential animal habitat, such as pickleweed, wetlands, riprap, crevices, and under or behind objects.

The SHSS or Superintendent will discuss project-related environmental hazards with site personnel at the orientation meeting prior to startup of remediation activities and during the daily safety meetings as the various environmental hazards require attention.

4.3 PHYSICAL HAZARDS

There are numerous physical hazards associated with this project that could present accidents and personal injury to the workforce, as well as operational problems. In order to minimize the physical hazards, TtFW has developed standard safety protocols, which will be followed at all times. The health and safety rules and guidelines are presented in the TtFW Project Rules Handbook, and the physical hazards associated with most project activities at HPS are identified in the HSP (TtFW, 2004). In addition to the hazards in the HSP (TtFW, 2004), the following precautions should be applied when performing site activities.

4.3.1 Heavy Equipment

Equipment operators must become thoroughly knowledgeable of the hazards associated with their equipment in addition to reviewing the Activity Hazard Analyses (AHAs). Excavation equipment, as well as associated hand and power tools, will only be operated by competent workers trained on the specific equipment.

Prior to using heavy equipment, the operator will visually inspect and walk around the vehicle to ensure that the equipment is in good condition and that there are no personnel or objects nearby that could be damaged by vehicle movement. Operators will use handrails and footholds for mounting and dismounting equipment and maintain three points of contact. Operators will follow equipment startup procedures described in the equipment's operating manual and keep hauling equipment under positive control at all times. Heavy equipment must have booms, forks,

buckets, blades, belly pans, and other similar type parts lowered to the ground when the equipment is shut off. All cranes, booms, or hoists used in this project will be inspected and used as required by Engineer Manual (EM) 385-1-1 [United States Army Corps of Engineers (USACE), 2003]. Wire ropes, chains, and slings used for lifting will be inspected prior to use and must be rated for the weight to be lifted and meet the requirements of EM 385-1-1, Section 16. A lift plan will be required for all lifts using any wire ropes, chains, or slings.

During work with heavy equipment, safe work practices, such as maintaining eye contact with the operator, will be followed at all times. Heavy equipment will have the right-of-way over other traffic. Truck drivers transporting soil will remain in the cabs of their vehicles while the soil is being loaded or unloaded if the trucks have a Falling Object Protective System (FOPS). If the trucks do not have a FOPS, the operator of the truck will get out of the cab of the truck and stand in an area designated by the SHSS during loading and unloading activities.

Those personnel directly involved with spotting for an operator will typically be the only personnel allowed on the ground in the vicinity of operating heavy equipment. Other personnel will remain a safe distance away from operations. Personnel needing to approach heavy equipment while the equipment is operating will observe the following protocols:

- Make eye contact with the operator (and spotter)
- Signal the operator to cease heavy equipment activity, if applicable
- Approach the equipment operator and inform the operator of intentions

Operators, drivers, and passengers of equipment and vehicles will wear seat belts at all times. Drivers and operators will have a valid driver's license and comply with federal, state, county, and local regulations governing the safe and legal operation of vehicles. Drivers are responsible for ensuring that passengers are seated and properly secured before moving the vehicle. Under no circumstance will personnel ride on fenders, running boards, tops of vehicles, buckets, lift forks of a forklift, beds of dump trucks or pickup trucks, or any other area where a passenger cannot be secured by a properly installed seat belt. Operators of heavy equipment must follow the regulations specific for the type of equipment they are operating.

When temporarily parked in excavation areas, vehicle and equipment keys are to remain in the ignition switch, except when the vehicle is being used as a fall protection anchor. When the vehicle is used as a fall protection anchor, the keys are to be removed and placed in the possession of the person using the fall protection. Operators are required to use vehicle chocks, positioned to reduce the potential for rolling when parked, for wheeled vehicles and other equipment as specified by the Construction Manager. Vehicles or equipment with tall booms will not be parked in the vicinity of any overhead power lines.

4.3.2 Slip, Trip, and Fall Hazards

The topography of the PCB hot spot is relatively bare and flat, and most of the area is currently covered with grass and brush. The shoreline area is marked by riprap containing rock, concrete, metal debris, metal slag, and other debris, with relatively sharp slopes to the bay, as well as mudflat and sandy beaches. Care will be taken when walking around the site to avoid slip, trip, and fall hazards, especially during rainy or windy conditions. The SHSS will inspect each work area prior to commencement of work in each area and physically mark all trip hazards. Site-specific training will be provided for hazards that cannot be marked or removed. In order to minimize tripping hazards caused by debris, job supplies, and equipment, personnel will remove these materials from the work areas daily and stockpile the materials and place equipment in storage areas. The SHSS will enforce this "housekeeping" effort throughout the day.

4.3.3 Head and Back Injuries

At a minimum, workers will don hard hats, safety boots, and safety glasses prior to performing any site activities. This will reduce the likelihood of a severe injury from small falling objects and prevent minor injuries caused by bumping one's head while working around heavy equipment. Heavy lifting will be required when moving equipment and supplies, launching small boats, stowing gear, and handling testing equipment. To control this hazard, personnel will be instructed in proper lifting techniques and will not lift more than 50 pounds without the assistance from another person. Mechanical lifting equipment will be used whenever possible to minimize worker exposure to lifting hazards.

4.3.4 Stockpile Management

If stockpiles need to be maintained during excavation activities, they will be covered with a plastic liner to prevent wind and rain erosion. Sandbags will be used to prevent wind from removing the plastic covers from over the stockpiles. Sandbags are heavy and workers will be instructed to follow safe lifting procedures. Sandbags will weigh no more than 40 pounds each (wet). The plastic liner can be slippery and is a hazard, especially if the plastic is wet. When the stockpiles are to be either used for backfilling or disposed of, the plastic must be removed. Workers will handle the plastic carefully so that the wind does not pick up the plastic and whip the plastic around them.

4.4 RADIOLOGICAL HAZARDS

Radioactive materials may be present in the PCB hot spot. If radioactive materials are encountered during radiological surveying, the procedures outlined in the Radiological Controls section in Section 4.0 of the Project Work Plan (TtFW, 2005b) and the HSP (TtFW, 2004) will be followed. Specifically, following identification of a point source, the source will be removed with hand-digging tools or a small backhoe or equivalent, placed into an appropriately sized

clear plastic bag, logged, packaged for placement into metal storage containers, and stored in a designated and posted radioactive material storage area for subsequent disposal.

4.4.1 Radiological Health and Safety

Necessary controls for radiologically safe operations will be implemented in accordance with NWT's license, TtFW's Standard Operating Procedures (SOPs), and current health physics practices. Critical requirements include the presence of a:

- TtFW RSO and NWT's Radiation Safety Office Representative (RSOR) to ensure compliance with NWT's Nuclear Regulatory Commission (NRC) license.
- RTM to manage implementation of the radiological aspects of the Project Work Plan (TtFW, 2005b).
- Radiological Control Technician (RCT) at active work areas to ensure compliance with the Radiation Work Permit (RWP).

Dose rate, contamination, and air monitoring, including initial baseline sampling to determine radiological background conditions, will be performed in accordance with the requirements specified in the RWP and based on judgment of the RCT. PPE levels, dictated by radiological considerations and physical and chemical safety issues identified at each work location, will be assigned or modified, according to the approved RWP.

4.4.2 ALARA

The basic concept in radiation protection specifies that exposures to ionizing radiation and releases of radioactive materials should be managed to reduce collective doses to workers and the general public as low as reasonably achievable (ALARA). ALARA will be implemented during the course of the work specified in the Project Work Plan (TtFW, 2005b).

The basic methods used to control radiation exposure will include personnel training, personnel monitoring, evaluation of radiological conditions, use of RWPs, site control procedures, posting of potentially hazardous areas, implementation of engineering controls, and specification/use of PPE.

4.4.3 Radiation Work Permits

A RWP will be prepared that will specify the radiological safety requirements for activities performed at the PCB hot spot. Personnel assigned to site work will be required to understand the requirements and sign the RWP prior to beginning work.

5.0 ACTIVITY HAZARD ANALYSES

AHAs are the focal point for safe conduct of work on a project. An AHA has been developed for each planned work activity to identify the sequence of work, specific hazards anticipated, and the control measures to be implemented to minimize or eliminate each hazard. The AHAs will be covered during the preparatory phase meetings for all definable project tasks and will be used to augment daily safety meetings intended to heighten safety and hazard awareness on the job.

AHAs for this project are included in Attachment 2. These AHAs, having been prepared prior to the initiation of work activities, consider the anticipated hazards. Additional AHAs may be necessary to address tasks that were not identified at the time this SHSP was written. During the TCRA work, if changes to the existing AHAs are necessary due to changing site conditions or requirements, the SHSS will ensure that the affected AHAs are updated and that workers review the amended AHAs. The SHSS will forward new or modified AHAs to the PESM for review.

6.0 PERSONAL PROTECTIVE EQUIPMENT

PPE will be selected and used based upon the existing and potential hazards anticipated. Various levels of PPE will be provided to workers at the site depending on the specific work tasks to be performed. The selection of PPE requires an evaluation of chemical contaminants, radiological hazards, concentrations of the chemical and radiological contaminants, and physical hazards that may be encountered.

The initially established PPE and action levels for the site activities presume that the contaminants are non-volatile and that techniques used will not generate aerosols or dust. A PPE matrix is included as Table 6-1 to specify the minimum PPE requirements for each task, as known at the start of the project. As additional testing, monitoring, and background information becomes available, the SHSS and the RCT may adjust the action levels and PPE accordingly, as specified in the RWP. Any changes to PPE for protection from chemical or non-radiological hazards require approval by the PESM. Changes to the PPE based on radiological conditions require coordination with the SHSS and the approval of the RSO and PESM. The decision to upgrade or downgrade the level of protection required in the field will be communicated as appropriate to all site personnel. The decision and justification for the change in level of protection will be recorded in the health and safety logbook.

7.0 AIR AND RADIATION MONITORING

Air monitoring for chemical contaminants and personal air sampling will be performed during daily field activities per an industrial hygiene monitoring plan described in this section. During any activities that involve ground disturbances, visual observation of dust will be monitored to ensure that dust levels are not excessive. It is a goal of this project to have virtually no releases of visible dust. At a minimum, no visible dust will leave the perimeter of the worksite. The SHSS will contact the PESM if conditions change from those currently anticipated.

Site activities that involve ground disturbances will also require monitoring for radium-containing devices. Radiological screening is discussed in detail in the Project Work Plan (TtFW, 2005b) and the HSP (TtFW, 2004).

Additional monitoring required may include noise monitoring and heat stress monitoring. The SHSS shall have experience using all required monitoring or sampling equipment. The PESM shall ensure that the SHSS is qualified to operate all assigned instruments. The SHSS shall ensure that each piece of equipment is properly maintained and calibrated according to the manufacturers' recommendations. All equipment shall be calibrated before and after use. A calibration log shall be kept to record all calibrations.

7.1 DUST MONITORING

A MiniRAM® Monitor Model PDM-3 or equivalent will be used to measure respirable airborne particulates between 0.1 to 10 micrometers in size. The MiniRAM will be used as an indicator of total ambient dust in the work area and will serve to monitor when additional dust control is required. Worst-case scenarios will be assessed for the purpose of establishing a total dust action level by using half of the threshold limit values (TLVs) as the action level.

Instrument:	MiniRAM Aerosol Monitor Model PDM-3 or equivalent
Action Level:	1.5 milligrams per cubic meter (mg/m^3) for general site areas 0.5 mg/m^3 for perimeter (level chosen to minimize overall permissible dust release from site)
Action:	Implement dust control procedures

If dust cannot be reduced below the specified concentration, respiratory protection will be required, which will consist of a full-face air purifying respirator and combination organic vapor/acid gas/high-efficiency particulate air (HEPA) cartridges.

The dust meter will be used during any activity that involves ground disturbances, such as excavation. The meter will be set up on the perimeter downwind of the project area to document that dust is not affecting the environment outside of the project area.

7.2 LANDFILL GAS MONITORING

Since some of the excavations are near a landfill, the SHSS will monitor each excavation for landfill gas emissions by use of a combustible gas meter that measures lower explosive limit and oxygen concentration. The combustible gas meter measures all gases that are flammable but does not distinguish between methane and other flammable gases. This is acceptable, as the main concern is the release of any flammable gases from a landfill. Monitoring will be performed after each lift is completed and at the end of each day.

A Gastech Model 1314 or MSA Model 260 combustible gas meter or equivalent may be used to screen for the presence of flammable vapors, oxygen (O_2)-deficient atmosphere, and O_2-enriched atmosphere. If flammable vapors are at 10 percent lower explosive limit (LEL) or greater, work will cease and the area allowed to ventilate. If O_2 levels below 20.8 percent or above 22 percent are encountered, personnel will leave the area and the area will be ventilated. The instrument is used during excavating and hot work procedures such as welding, cutting, and grinding. Results of all monitoring will be logged in the health and safety logbook.

Instrument:	Gastech Model 1314 or MSA Model 260 or equivalent
Action Level:	10 percent $\geq$ LEL, <20.8 percent O_2 or >22 percent O_2
Action:	Stop work, allow area to ventilate and notify PESM and project contact person.

7.3 INDUSTRIAL HYGIENE AND PERIMETER AIR MONITORING

During the performance of fieldwork two air monitoring programs will be used to verify that workers and the nearby areas of the community are not being exposed to contaminants above established levels. Worker monitoring will be conducted by following an industrial hygiene monitoring plan. Area monitoring will use a subcontracted vendor to provide high-volume air sampling for various COCs, including metals such as manganese, cadmium, arsenic and lead. Organic contaminants will also be analyzed such as PCBs and polynuclear aromatic hydrocarbons (PAHs). Particulate matter less than 10 microns in diameter (PM_{10}) and total suspended particulates (TSP) will also be analyzed.

7.3.1 Industrial Hygiene Air Monitoring Plan

The industrial hygiene air monitoring plan follows the recommendations of the *Occupational Exposure Sampling Strategy Manual* [National Institute for Occupational Safety and Health (NIOSH), 1977]. The plan implements a random sampling strategy based on a homogenous group of workers. This strategy implements a statistical model in a selection of the number of samples and types of analyses based on the number of workers who have the potential for exposure. The strategy assumes that workers are not routinely exposed. In the case of this project, it is known that workers will not be exposed provided that dust control measures are effective. Tasks that have the potential to generate more dust will employ a higher sampling frequency. Each task will have initial sampling performed at the onset of the task. Table 7-1 identifies tasks, sampling frequency, number of samples to be collected, and analyses required by NIOSH methods.

7.4 RADIOLOGICAL MONITORING

To support the monitoring, tracking, and recording of occupational whole-body radiation exposure, personnel conducting fieldwork will be issued and required to wear dosimeters. The RSO will be responsible for ensuring that site personnel wear the specified dosimeters. Visitors will not wear dosimeters, as they will not be allowed to enter controlled areas. The wearing of dosimeters will be managed in accordance with the TtFW Health Physics Program, as specified by the CHP.

Consistent with the commitment to limiting radiation exposure to ALARA, administrative control limits will be established at levels below regulatory limits to prevent inadvertent overexposure and to serve as an action level and control point for exposures that should be investigated. The administrative exposure limit for the project is established at a total effective dose equivalent (TEDE) of 0.05 rem for the entire project. If an individual is suspected or known to have received an exposure in excess of the TEDE, the incident will be reported immediately to the RSO, who will notify the SHSS, CHP and PESM. Evaluation will be made by the CHP in coordination with the PESM, and an investigation will be conducted to determine the cause of such exposure and to determine if future exposures can be avoided.

To support the monitoring, tracking, and recording of occupational whole-body radiation exposure, any personnel working directly with impacted materials, including equipment operators, under the Work Plan will be issued and required to wear dosimeters. Only National Voluntary Laboratory Accreditation Program (NVLAP)-approved dosimeters from a NVLAP-certified provider will be used. Personnel issued dosimetry must complete an NRC Form 4. The original Form 4 will be maintained by the organization issuing the dosimetry with a copy or the original kept at the project field office at HPS.

To minimize the potential for an internal uptake of radioactive material, air sampling and required respiratory protection will be evaluated and provided as needed, as specified by the RWP and the CHP and coordinated with the PESM. Full-face air-purifying respirators with P-100 cartridges will be supplied for personnel protection will be used during the course of work. In order to control occupational exposures to radioactivity, establish PPE, and determine respiratory protection requirements, monitoring and trending for airborne radioactive material will be performed as necessary. Engineered controls, with concurrence from RASO, will be implemented if required to maintain airborne concentrations below 10 percent of the applicable derived airborne concentration (DAC) value for the radionuclides of concern, where airborne radioactivity exists. As specified in the RWP, airborne activity monitoring as specified in Table 4-4 of the Project Work Plan (TtFW, 2005b) will be implemented.

If, during the course of work, an airborne concentration exceeds 10 percent of the DAC, ongoing activities will cease and the affected location will be posted until the source of the airborne concentration is eliminated and levels are confirmed to be below 10 percent of the DAC.

Clean areas will be surveyed for radioactive surface contamination at a minimum of once per week. Clean areas will be promptly decontaminated if surface contamination levels exceed the exposure limit.

7.5 QUALITY ASSURANCE/QUALITY CONTROL

Adherence to a proper quality assurance/quality control (QA/QC) plan is essential for a meaningful monitoring effort. The major concerns of a QA/QC plan are calibration of equipment and document control.

7.5.1 Equipment Calibration and Maintenance Procedures

The MiniRAM Monitor Model PDM-3 will not require field calibration; however, factory calibration of the dust meter must have been performed within the last year, as documented in paperwork or on a tag that comes with the instrument. The operating instructions for the meter must be followed to ensure that the instrument is zeroed properly. Any zero reading of 3.5 mg/m^3 or greater requires that the instrument be cleaned and re-zeroed as specified in the manufacturer's operating manual.

Procedures for the use of air sampling pumps and samplers will follow manufacturers' directions for calibrations. Personal air sampling will follow criteria specified in the NIOSH Manual of Analytical Methods

Calibration procedures for radiation detection equipment are presented in the Base-wide Plan.

7.5.2 Documentation

Strict adherence to document and data control procedures is essential for good QA/QC. Data and calibration records must be accounted for and retrievable at all times. Types of documents that are essential include notes, logbooks, maps, data sheets, and reports. Forms required for this CTO are presented in the HSP (TtFW, 2004). Completed forms must be placed in the project files. Copies of all field data reports and sampling records will be sent to the PESM for review.

The SHSS will ensure that all data is documented in logs or logbooks including the calibrations performed, the types of calibrants used, the manufacturers and model numbers of instruments used, the dates and times of calibration and monitoring events, the areas and/or personnel monitored, the atmospheric conditions and weather, unique site conditions, equipment operating in the area, the initials of individuals performing the monitoring, and any other information that may affect the data or the actions taken based on the data.

8.0 SITE CONTROL

To minimize the transfer of potentially hazardous substances from the site, contamination control procedures will be employed. The establishment of regulated areas and designated site work zones will be one method of contamination control. Site control through access control points will reduce the possibility of:

- Personnel exposure to site contaminants
- Contaminant translocation by personnel or equipment from the site

Methods that will be used to facilitate site access control include:

- Scheduling operations to minimize the numbers of personnel at the site
- Establishing site work zones around each worksite location
- Establishing control points to regulate access to and egress from work zones
- Implementing appropriate decontamination procedures

The areas surrounding the proposed soil boring and sampling locations will be controlled by barricades, cones, and caution tape. The cordoned areas will be considered exclusion zones (EZs). Entries into these areas will require personnel to have the proper PPE and training. The Construction Manager and SHSS will implement control measures as necessary.

8.1 SITE SECURITY

HPS has a DoD police force. The San Francisco Redevelopment Agency provides guard services at the Innes Avenue entrance to HPS. All personnel entering HPS must have a badge and a parking permit. However, HPS has had significant scavenging and thefts. Project equipment will be stored in a fenced and secured area. The PjM may employ the use of a private security guard service to augment HPS security.

Workers should always ensure that their vehicles are in good operating condition and that they have sufficient fuel. When re-entering any area for the day's work, the entire work area is to be re-inspected by the SHSS and the assigned RCT to ensure that the work area is unchanged from the previous day's work. Personnel will verify that their equipment has not been altered or vandalized. Inspections of equipment must be performed each day. If workers discover syringes, needles, drugs, unknown containers, and so forth, they will inform the SHSS so that the items can be safely removed. Workers will not attempt to remove these items on their own.

8.2 EQUIPMENT DECONTAMINATION

Heavy equipment, PPE, monitoring equipment, and sampling equipment may require decontamination. To prevent the spread of contamination, preliminary radiological surveys, consisting of a 100 percent scan of accessible areas for alpha/beta contamination will be conducted on equipment, tools, and materials prior to chemical decontamination. As equipment is moved from one work area to the next work area, the parts of the equipment that may have been contaminated, but not yet washed off, can be covered with plastic to facilitate movement of the equipment to the next work area without performing a full decontamination wash. However, it is essential that all gross contamination be removed from the equipment before moving the equipment out of a work zone. Pressure washing of equipment contaminated with PCBs should be avoided to prevent aerosolization of the PCBs. Other contaminants may be scraped or brushed off.

All PPE waste generated will be bagged, labeled, and stored for off-site disposal or incorporation into other waste materials. In no case will storage exceed 90 days from the start date of accumulation of the waste.

8.3 PERSONNEL DECONTAMINATION

At a minimum, site workers will be provided with adequate restroom and hand washing facilities and will be required to wash exposed areas of the skin (that is, hands and face) upon exiting potentially contaminated areas. Personnel leaving an area controlled for radiological hazards will be surveyed by a RCT prior to leaving the area. Smoking, eating, or drinking will not be allowed in active work areas.

In case of an emergency, gross chemical decontamination procedures will be implemented and the person will be transported to the nearest medical facility immediately at the direction of the SHSS in accordance with the Emergency Response Plan (Section 12.0). The medical facility will be informed that the injured person is on the way and has not been fully decontaminated. The medical facilities will be notified of the potential chemicals present and of the exposure-prevention measures that can be used while treating the victim.

9.0 MEDICAL SURVEILLANCE PROCEDURES

The HSP (TtFW, 2004) describes medical surveillance procedures for all projects at HPS. Additional medical surveillance procedures may be required for this particular project, depending on the results gathered during personnel radiation monitoring or for any other reason that necessitates biological monitoring of site personnel.

10.0 SAFETY CONSIDERATIONS

For general safety considerations, refer to the HSP (TtFW, 2004). Additional guidelines that should be adhered to include the following:

- Telephone communications will be confirmed as functioning.
- Project personnel will work in sight of each other. If it is necessary for workers to work out of sight of each other, the buddy system will be used and each team will have a means of communicating via telephone (either each team has a telephone or at least one team has a telephone and the remaining teams can communicate by way of radio with the team that has the telephone).
- Work will only be performed during daylight hours (half an hour after sunrise to half an hour before sunset).
- Workers will park only in designated areas and will be reminded to follow traffic rules and regulations within and around the project site. In particular, workers are reminded to wear seatbelts in all vehicles at all times.
- Workers will wear reflective safety vests at all times when working at the site so that they are readily visible to other workers.
- Workers will avoid contact with potentially contaminated soil at all times. Equipment operators will exit their equipment near the access point to the EZ.
- Underground Services Alert [(800) 642-2444] will be called prior to intrusions into the ground. A geophysical survey and a review of existing site drawings will be performed to identify buried underground utilities in the work area. Also, any overhead power lines above the work area will be demarcated with ground warning tape that indicates the overhead lines, and the voltage of the lines will be posted.
- Safety equipment requirements, to be set up near the work area, include: 20-pound ABC dry chemical fire extinguisher, portable eyewash, first aid kit, hand-washing station, and air horn.
- Housekeeping is important to maintain a safe workplace. As work is performed, the work area will be kept clean to avoid creating hazards that may cause injuries. Hazards associated with poor housekeeping usually involve slips, trips, or falls. In addition, workers should avoid generating dust when they clean up a work area.

11.0 DISPOSAL PROCEDURES

The Waste Management Plan, contained in Section 7.0 of the Project Work Plan (TtFW, 2005b), describes the handling of wastes from the project site. Disposal of radiological wastes will be conducted by a certified Waste Broker under the DON Low-level Radioactive Waste (LLRW) disposal program and is not part of the scope covered by the Project Work Plan (TtFW, 2005b). The PCB Hot Spot PjM, the Construction Manager, the SHSS, and other project personnel conducting field activities must receive waste management and Department of Transportation training prior to performing tasks associated with waste management.

12.0 EMERGENCY RESPONSE PLAN

Refer to the HSP (TtFW, 2004) for emergency response activities. Personnel shall maintain verbal communication with each other, and telephone services must be available at all times during the project. Figure 12-1 shows the routes to the nearest hospital and clinic from the site. The location of the evacuation assembly point for the PCB hot spot is shown in Figure 1-1. Table 12-1 consists of a list of emergency contacts and telephone numbers. Figure 1-1, Figure 12-1, and Table 12-1 must be placed on the dashboard of each site vehicle and posted in the project area.

The following emergency equipment, at a minimum, will be present at the work area:

- Fire extinguisher, minimum one 20-pound dry chemical ABC type
- Industrial first aid kit
- Portable eye wash, capable of supplying 15 minutes of water and protected from direct sunlight
- Air horn
- Spill control material consisting of absorbent pillows or absorbent material and shovels, plastic sheeting, and 55-gallon drum(s)
- Means of communication (cell phone or radio)

13.0 TRAINING

All personnel will be required to receive training on this SHSP, the AHAs, and the HSP (TtFW, 2004). Included in this training will be a general site orientation, the location of all emergency equipment, the location of the emergency assembly point, and the routes to the nearest clinic and hospital. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding health and safety for their particular activity. All workers will also receive radiation awareness training. Additional training, if required for the completion of field activities, will be identified and provided for personnel as the work progresses.

Upon completion of this training and review, all project personnel will acknowledge this training by signing both the SHSP review form and the HSP review form (TtFW, 2004). A daily safety meeting form will be used to document training in the AHAs as they are reviewed and discussed with the employees.

14.0 LOGS, REPORTS, AND RECORDKEEPING

Logs, reporting, and recordkeeping requirements are included in the HSP (TtFW, 2004).

15.0 REFERENCES

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TtFW. 2005c. *Draft Site-specific Health and Safety Plan, IR-02 Northwest and Central Parcel E*, Hunters Point Shipyard, San Francisco, California. March.

United States Army Corps of Engineers (USACE). 2003. *Safety – Safety and Health Requirements*. EM 385-1-1. November 3.

Note:

Where no date is given in the references above, it is assumed that the reference used will be the most recent publication.

TABLES

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Aldrin	PEL - 0.25 mg/m^3 TLV - 0.25 mg/m^3	Inhalation, ingestion, skin contact	Acute: Difficult breathing, headache, nausea, dizziness, vomiting, malaise, convulsions, coma, kidney damage, irritation of eye or skin, blood in urine. Chronic: Dieldrin, a metabolite, is stored in liver, possibly causing liver damage.	CNS, blood, liver, and kidneys.
Antimony	PEL - 0.5 mg/m^3 TLV - 0.5 mg/m^3	Inhalation, ingestion, skin contact	Acute: Inhalation can cause sore throat, shortness of breath metallic taste, vomiting, nausea, and weight loss. Skin contact is irritating especially if skin is moist. Ingestion causes irritation of intestinal tract, vomiting, bloody stools, slow pulse and low blood pressure, coma, convulsions, and death. Chronic: Inflammation of respiratory tract. Skin papules and pustules especially in moist areas.	Eyes, skin, respiratory, and cardiovascular system.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Arsenic, inorganic	PEL - 0.01 mg/m^3 TLV - 0.01 mg/m^3	Inhalation, ingestion, skin contact	Human carcinogen. Acute: Nasal irritation, perforation of septum, chest pain, hoarseness, eyelid edema, pharyngitis, inflammation of mouth; metallic or garlic taste, nausea, vomiting, diarrhea, abdominal pain, and heartbeat irregularities. Acute poisoning may cause acute hemolysis of red blood cells. Chronic: Weight loss, hair loss, nausea, diarrhea, alternating with constipation, thickening of skin on palms of hands and soles of feet, skin eruptions, inflammation of nerves, leukemia, bone marrow depression, and aplastic anemia.	Liver, kidneys, skin, lungs, lymphatic system.
Barium	PEL - 0.5 mg/m^3 TLV - 0.5 mg/m^3	Inhalation, ingestion, skin contact	Acute: Gastroenteritis, slow pulse rate, muscle spasm, decreased potassium level in blood, coughing, bronchial irritation, dermatitis, and burns. Chronic: None	Skin, eyes, mucous membranes, lung, and heart.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Beryllium	PEL - 0.002 mg/m^3 TLV - 0.002 mg/m^3 STEL (30-min) - 0.005 mg/m^3 STEL (ceiling) - 0.025 mg/m^3	Inhalation, ingestion, skin contact	Carcinogen. Highly toxic by inhalation of fume or dust, may cause death. Acute: Symptoms may be delayed up to 72 hours after exposure. Pnemonitis, nasal congestion, nonproductive coughing, pulmonary edema, brain hemorrhage, liver inflammation, and spleen hemorrhaging. Chronic: Symptoms may be delayed up to 15 years. Granuloma formation in lungs, heart enlargement and failure, liver and spleen enlargement, and malignant tumors.	Lungs, mucous membranes, eyes and skin.
Cadmium	PEL - 0.005 mg/m^3 TLV - 0.01 mg/m^3 TLV (respirable fraction) - 0.002 mg/m^3	Inhalation, ingestion, skin contact	Human carcinogen. Acute: Metallic taste in mouth, nausea, vomiting, chills, weakness, leg pain, diarrhea, cough, headache, shortness of breath, chest pains, kidney damage, restlessness and irritability, pneumonitis, bronchitis, pulmonary edema, and eye and skin irritation. Ingestion causes severe nausea, salivation, choking, vomiting, diarrhea, abdominal pain, headache, muscular cramps, and vertigo. Chronic: Chronic bronchitis and rhinitis, loss of smell, gastrointestinal symptoms, pulmonary fibrosis, emphysema, kidney stones, changes in bone, and yellow discoloration of teeth.	Kidneys, respiratory and gastrointestinal tracts.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Chromium, hexavalent, water insoluble compounds	PEL - none TLV - 0.01 mg/m^3 TLV (ceiling) - 0.1 mg/m^3	Inhalation, ingestion contact	Human carcinogen. Acute: Headaches, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of conjunctiva, and dermatitis. Chronic: Asthmatic bronchitis.	Respiratory system.
Cobalt, inorganic compounds	PEL - 0.1 mg/m^3 TLV - 0.02 mg/m^3	Inhalation, ingestion, skin contact	Possible Carcinogen Acute: Contact dermatitis, breathing difficulties. Chronic: Allergic asthma, restricted pulmonary functions, and intestinal fibrosis.	Respiratory system, skin, bladder, kidneys, and eyes.
Copper	PEL - 1.0 mg/m^3, dust TLV - 1.0 mg/m^3, dust No established PEL or TLV for copper compounds	Inhalation, ingestion	Acute: Copper fumes and dust- allergic reactions, metallic taste, nausea, general weakness, and exhaustion. Greenish-black skin, irritation of skin, nose, mouth, and respiratory tract. Ingestion causes vomiting, nausea, abdominal pain, and diarrhea. Chronic: Mild dermatitis, degeneration of mucous membranes. Chronic respiratory disease of mucous membranes. Chronic respiratory disease.	Respiratory system, skin, eyes, liver, and kidneys.
Diesel fuel	PEL – none established TLV – 100 mg/m^3	Skin contact, inhalation, ingestion	Acute: Eye irritation, skin irritation, nose/throat/lung irritation, nausea, vomiting, diarrhea, restlessness, drowsiness, and loss of coordination. Chronic: Repeated contact with skin causes dermatitis.	CNS, skin, and respiratory system.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Gasoline	PEL – 300 ppm (Cal-OSHA) TLV – 300 ppm	Skin absorption, inhalation, ingestion	Acute: Nose/throat/lung irritation, headaches, blurred vision, vomiting, dizziness, fever, slurred speech, and unconsciousness. Chronic: Appetite loss, nausea, weight loss, insomnia, and sensitivity in digital extremities.	Skin, eye, respiratory, and CNS.
Lead	PEL - 0.05 mg/m^3 TLV - 0.05 mg/m^3 AL - 0.03 mg/m^3	Inhalation, ingestion, skin contact	Animal carcinogen. Acute: Seizures, coma, death (very high doses). Chronic: Appetite loss, nausea, metallic taste, constipation, anxiety, weakness, insomnia, muscle and joint pain, irritability, headache, numbness, and kidney damage.	Systemic poisoning: nervous system, kidneys, reproductive system, blood, and gastrointestinal system.
Manganese	PEL - none TLV - 0.2 mg/m^3 STEL - 5.0 mg/m^3	Inhalation, ingestion, skin contact	Acute: Metal fume fever, skin and eye irritant. Chronic: CNS damage, headache, sleepiness, personality changes, irritability, inappropriate laughing or crying, hallucinations, euphoria, excess salivation, trembling of extremities and head, and impaired walking.	CNS, respiratory system, kidneys, and blood.
Mercury, inorganic compounds	PEL (ceiling) - 0.1 mg/m^3 TLV - 0.025 mg/m^3	Inhalation, ingestion, skin contact	Acute: Respiratory damage, wakefulness, muscle weakness, weight loss, headache, diarrhea, liver changes, cough, bronchitis, pneumonitis, acrodynia. Chronic: CNS damage, weakness, fatigue, nausea, weight loss, gastrointestinal disturbances, tremors, memory loss, insomnia, depressions.	CNS, eyes, skin, respiratory system, liver, and kidneys.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Molybdenum	PEL - none TLV - 10 mg/m^3 insoluble - 3 mg/m^3 respirable - 0.5 mg/m^3 soluble and respirable	Inhalation, ingestion, skin contact	Acute: Mild, transient irritation of eyes, nose and throat. Elevated serum uric acid levels (potential gout). Chronic: None reported.	None reported.
Nickel, elemental	PEL - 1.0 mg/m^3 TLV - 1.5 mg/m^3 inhalation	Inhalation, ingestion, skin contact	Human carcinogen. Acute: Nickel fume causes respiratory tract irritation, metal fume fever, asthma, lung inflammation, eye irritation, nausea, vomiting, abdominal pain. Dermal contact causes nickel "itch". Sensitization with eczema.	Skin, lungs, and nasal cavities.
Nickel, insoluble and soluble compounds	PEL - 1.0 mg/m^3 TLV - 0.2 mg/m^3 insoluble, inhalation - 0.1 mg/m^3 soluble, inhalation	Inhalation, ingestion, skin contact	Chronic: Nickel sensitization, eczema, hardened and leathery skin, Chronic pulmonary irritation, chronic thickening of mucous membranes, impairment or loss of smell, perforation of nasal septum. Chronic dust exposure can cause cancer of sinuses, larynx, and lungs.	Skin, mucous membranes, and respiratory tract.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
PAHs, coal tar pitch volatiles (Chrysene, Pyrenes, Phenanthrene, etc.) from residuals of diesel fuel	PEL - 0.2 mg/m^3 TLV - 0.2 mg/m^3	Inhalation ingestion contact	Acute: Skin contact may cause irritation, redness, burning, itching, dermatitis, and burns. Photosensitization may occur (rash worsens with exposure to sunlight). Inhalation irritating to respiratory tract. Eye contact may cause conjunctivitis, keratitis, or corneal burns. Ingestion may result in nausea, vomiting, abdominal pain, respiratory distress, and shock. Exposure to large doses, especially by ingestion, may be fatal. Chronic: Dermatitis, skin cancer, and lung cancer.	Respiratory system, skin, bladder, kidneys (lung, kidney and skin cancer).
PCBs	PEL - 0.05 mg/m^3 TLV - 0.05 mg/m^3	Inhalation, ingestion, skin contact	Acute: Irritation to eyes, skin, nose, throat, and respiratory tract. Intense acute exposure may cause damage to eyes, liver, or lungs. Systemic effects include nausea, vomiting, high blood pressure, fatigue, weight loss, jaundice, edema, and abdominal pain. Neurological impairment is possible. Chronic: Chloracne, neurological symptoms, and liver enlargement. Cancer, primarily of the liver.	Skin, liver, eyes, mucous membranes, and respiratory tract.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Selenium	PEL - 0.2 mg/m^3 TLV - 0.2 mg/m^3	Inhalation ingestion contact	Acute: Skin and eye burns, contact dermatitis, intense irritation of the upper respiratory tract, headache. Flu-like symptoms resembling metal-fume fever (delayed onset). Chronic: Odor of garlic on breath, fatigue, irritability, upper respiratory tract irritation, pallor, gastrointestinal distress, metallic taste, allergic eye reactions.	Upper respiratory tract, skin, and eyes.
Silver, soluble compounds	PEL - 0.01 mg/m^3 TLV - 0.01 mg/m^3	Inhalation, ingestion, skin contact	Acute: Silver fumes cause lung damage and pulmonary edema. Some compounds in contact with skin are corrosive and cause dark pigmentation of skin (photosensitization). Chronic: Deposition of silver in skin tissues causes argyria - a condition causing blue-gray pigmentation.	Skin, eyes, and mucous membranes.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Vanadium	PEL - 0.05 mg/m^3 TLV - 0.05 mg/m^3 (as vanadium pentoxide)	Inhalation, ingestion, skin contact	Elemental vanadium is relatively non-toxic. Acute: Skin: Eczema-like reaction with intense itching. Green discoloration of hands and groin area. Eyes: Severe irritation with burning and tearing. Airway: Nasal congestion, throat irritation, dry mouth, green tongue, metallic taste, coughing chest pain, pulmonary edema. Cardiovascular: Constriction of blood supply; CNS: Headaches; Gastrointestinal: diarrhea, black stool, cramping. Chronic: Lung effects last 2 weeks after exposure. Skin and tongue discoloration may occur gradually.	Respiratory system, skin, and eyes.
Vinyl chloride	PEL - 1 mg/m^3 TLV - 1 mg/m^3	Skin absorption, inhalation, ingestion	Carcinogen. Acute: CNS effects including fatigue, headaches, vertigo, ataxia, euphoria, numbing and tingling in extremities, narcosis, unconsciousness, and death. Chronic: Liver cancer, tumors, pain in joints, and blood changes.	Liver, CNS, respiratory and lymphatic systems, bone, and connective tissue of the skin.
Zinc	PEL - 5.0 mg/m^3 TLV - 2.0 mg/m^3 (respirable as zinc oxide)	Inhalation, ingestion, skin contact	Elemental zinc relatively non-toxic. Compounds have various effects. Acute: metal fume fever, gastroenteric irritation, irritation to skin. Chronic: Compounds of zinc may have other residual effects.	Respiratory system.

TABLE 4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Zinc	PEL - 5.0 mg/m^3 TLV - 2.0 mg/m^3 (respirable as zinc oxide)	Inhalation, ingestion, skin contact	Elemental zinc relatively non-toxic. Compounds have various effects. Acute: metal-fume fever, gastroenteric irritation, and irritation to skin. Chronic: Compounds of zinc may have other residual effects.	Respiratory system.

Notes:

AL – action level
Cal-OSHA – California Occupational Safety and Health Administration
CNS – central nervous system
mg/m^3 – milligrams per cubic meter
PAH – polynuclear aromatic hydrocarbon
PCB – polychlorinated biphenyl
PEL – permissible exposure level
ppm – parts per million
STEL – short-term exposure limit
TLV – threshold limit value

TABLE 6-1

PERSONAL PROTECTIVE EQUIPMENT

Task	EPA Level	Respiratory Protection	Head	Hand	Clothing	Boots	Face	Eye	Hearing	Additional
Site setup, surveys (non-intrusive)	D	None required, unless dust exceeds action level	Hard hat	Leather work gloves, as needed	Work uniform or Tyvek® coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Clearing of vegetation	D	None required, unless dust exceeds action level	Hard hat	Leather work gloves, as needed	Work uniform or Tyvek coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Radioactive point source identification and removal	D mod	None required, unless dust exceeds action level	Hard hat	Nitrile gloves	Tyvek coveralls	Steel-toe, Tyvek booties	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Sampling	D mod	None required, unless dust exceeds action level	Hard hat	Nitrile gloves, two layers	Tyvek coveralls, poly-coated Tyvek coveralls or PVC rainsuit for liquids	Steel-toe, Tyvek, booties, water-esistant or PVC rainsuit	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Well abandonment	D mod	None required, unless dust exceeds action level	Hard hat	Nitrile gloves	Tyvek coveralls	Steel-toe, Tyvek booties	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.

TABLE 6-1

PERSONAL PROTECTIVE EQUIPMENT

Task	EPA Level	Respiratory Protection	Head	Hand	Clothing	Boots	Face	Eye	Hearing	Additional
Excavation, dewatering, screening, and stockpiling	D mod	None required, unless dust exceeds action level	Hard hat	Nitrile gloves, two layers	Tyvek coveralls, poly-coated Tyvek coveralls or PVC rainsuit for liquids	Steel-toe, Tyvek, booties, water-resistant or PVC rainsuit	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Backfilling	D	None required, unless dust exceeds action level	Hard hat	Leather work gloves, as needed	Work uniform or Tyvek coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Decontamination	D mod	None required, unless dust exceeds action level	Hard hat	Nitrile gloves, two layers	Tyvek coveralls, poly-coated Tyvek coveralls or PVC rainsuit for liquids	Steel-toe, Tyvek, booties, water-resistant or PVC rainsuit	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.
Waste management	D	None required, unless dust exceeds action level	Hard hat	Leather work gloves, as needed	Work uniform or Tyvek coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 84 dBA	Fall protection for work above 6-foot level. Reflective safety vests.

Notes:

DBA – decibels, A-scale
EPA – U.S. Environmental Protection Agency
N/A – not applicable

TABLE 7-1

INDUSTRIAL HYGIENE MONITORING PLAN*

Job Task	Number of People Performing Task	Sample to be Collected	Frequency	Duration	# of Samples
Excavator or backhoe, open cab	2 or less 3-4 >4	Metals**, PCBs	1 x per wk	8 hr	1 2 3
Ground worker in vicinity of excavation	3 or less 4-8 9-12 >12	Metals, PCBs	2 x per wk 1 x per wk 1 x per wk 1 x per wk	8 hr	1 2 3 4
Stockpile workers	3 or less 4 or greater	Metals, PCBs	2 x per wk 2 x per week	4 hr	1 2
Workers near or at conveyor	2 or less 3-4 >4	Metals, PCBs	Every day first week, 2 x per week after	8 hr	1 2 3
General ground workers during excavation activities	3 or less >4	Metals, PCBs	1 x per wk	8 hr	1 2

Notes:

*This table is used to establish the type of sample to be collected and the frequency of the collection based upon the job category of the person performing a specific task. Where more than one person is performing the task, more than one person in the same function may be sampled as outlined in the chart. In all cases, when a task is initiated, all persons performing the task will be sampled on the first day of the task. Thereafter, the chart establishes frequency. This table applies only to activities involved with excavation and the management of potentially contaminated soil. No monitoring is required for backfilling activities. After evaluation by the CIH, frequency of collection may be modified.

Example on use of table: Workers at conveyors 3-4 for first week collect a total of two samples every day for first week (10 samples for metals and 10 for PCBs). For subsequent weeks, workers will collect two samples (random days) for a total of four samples each for metals and PCBs for the week.

**Metals analysis includes arsenic, lead, cadmium, chromium (VI) and manganese.

TABLE 12-1

EMERGENCY INFORMATION

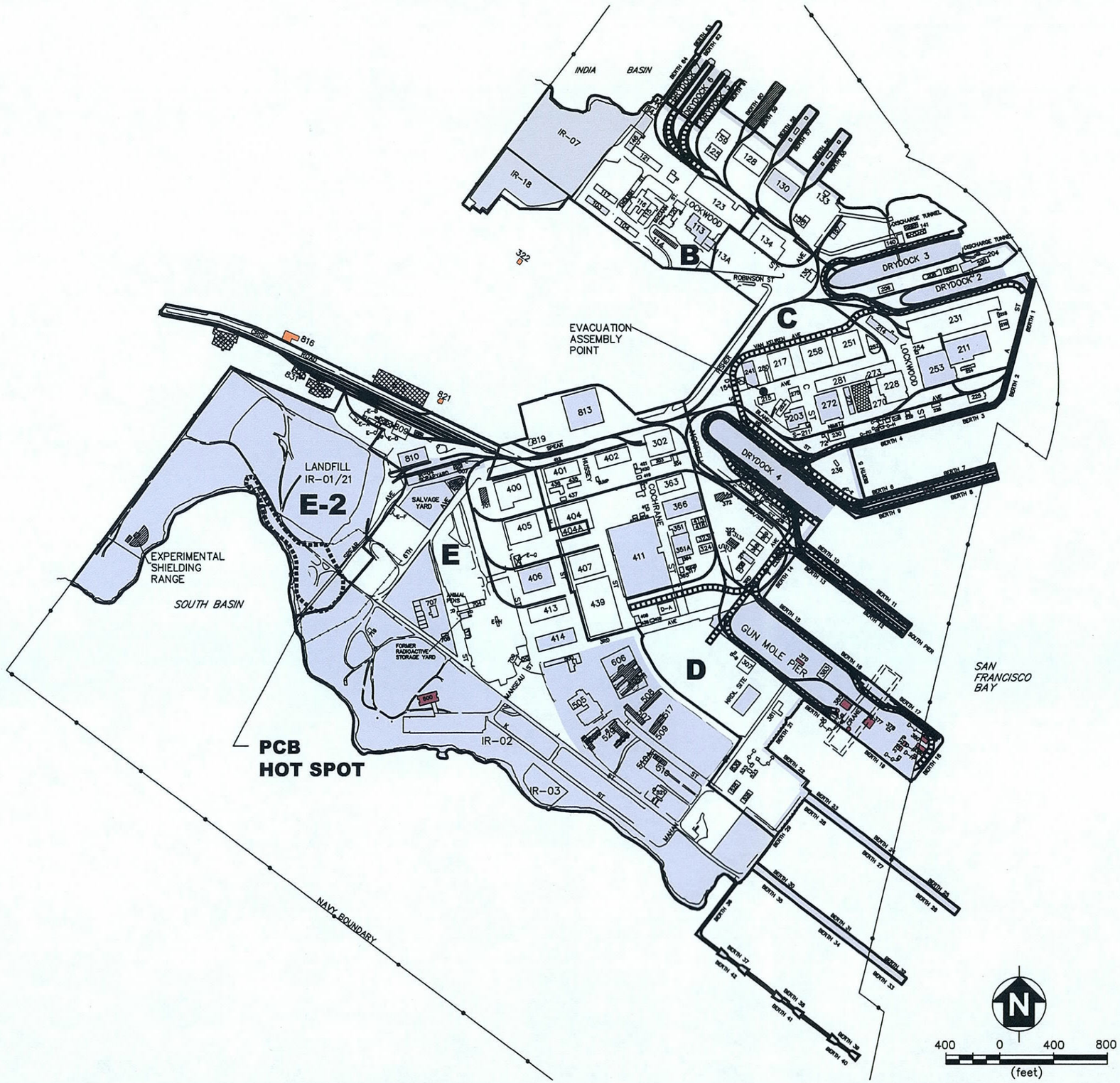
REPORT ALL FIRES, SERIOUS INJURY, OR UNCONTROLLED SPILLS IMMEDIATELY: 911

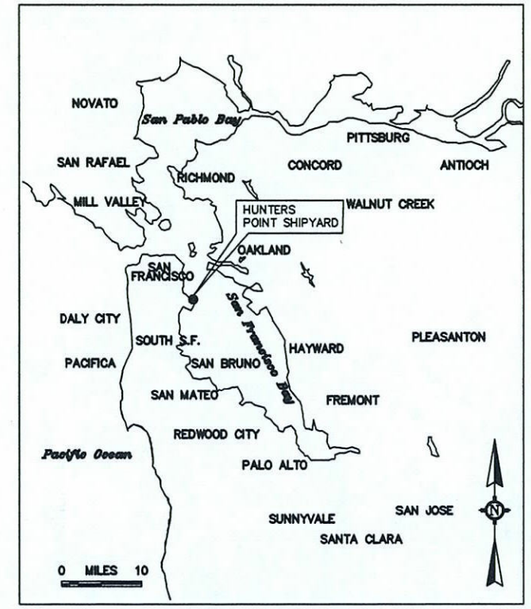
Hospital:	San Francisco General Hospital (415) 206-8000 1001 Potrero Avenue San Francisco, CA 94110		
Directions:	From main gate on Innes Avenue, travel northwest on Innes Avenue and turn right onto Hunters Point Boulevard. Continue on Hunters Point Boulevard, which becomes Evans. Continue on Evans under Interstate 280, bear right at Napoleon, and continue to Cesar Chavez. Turn left onto Cesar Chavez. Continue west on under 101 Freeway, and turn right on Potrero. Hospital will be on right side of Potrero.		
Fire/Police/EMS:	911 There is a federal fire department and Department of Defense Police on HPS, but they should be contacted through the 911 number. ***911 calls from a cell phone do not go directly to HPS emergency services, but through the California State Highway Patrol.***		
TtFW Contacts:	PjM Luis Rivero (619) 471-3502	PESM (CIH) Roger Margotto (619) 471-3503 pager: (714) 810-3742	SHSS Rich Quinn (415) 671-1990
RPM:	Mark Walden (619) 532-0931		
ROICC:	Peter Stroganoff (510) 749-5941 Project Engineer Andrew Uehisa (510) 749-5946 (510) 915-5041 (cell) CMT		
CSO:	Michael Mentink (415) 743-4729 (415) 559-9851 (cell) Doug Delong (415) 743-4713		
Poison Control Center:	California Poison Control System, Central Office Emergency Phone: (800) 876-4766		
CHEMTREC:	(800) 424-9300		
National Response Center:	(800) 424-8802		
RCRA Hotline:	(800) 424-9346		

Notes:

CIH – Certified Industrial Hygienist
CMT – Construction Management Technician
CSO – Caretaker Site Office
EMS – Emergency Medical System
HPS – Hunters Point Shipyard
PESM – Project Environmental and Safety Manager
PjM – Project Manager
RCRA – Resource Conservation and Recovery Act
ROICC – Resident Officer in Charge of Construction
RPM – Remedial Project Manager
SHSS – Site Health and Safety Specialist
TtFW – Tetra Tech FW, Inc.

FIGURES





KEY MAP

- NAVY PROPERTY BOUNDARY (OFFSHORE)
- 6-FOOT TEMPORARY FENCE
- PCB HOT SPOT EXCAVATION BOUNDARY
- PARCEL BOUNDARY
- IMPACTED BUILDINGS OR SITES
- DEMOLISHED IMPACTED BUILDINGS/STRUCTURES
- DEMOLISHED BUILDINGS/STRUCTURES
- IMPACTED SITES THAT HAVE OBTAINED REGULATORY RELEASE
- IMPACTED FUDS SITES
- NON-IMPACTED BUILDINGS WITHIN AN IMPACTED SITE, RADIOLOGICAL PRECAUTIONS MAY BE REQUIRED

NOTE
IMPACTED SITES ARE SITES THAT HAVE KNOWN RADIOLOGICAL CONTAMINATION OR WHERE SITE HISTORY INDICATES THAT RADIOLOGICAL CONTAMINATION MAY BE PRESENT.

FIGURE 1-1
HUNTERS POINT SHIPYARD AND PCB HOT SPOT SOIL EXCAVATION SITE-LOCATION MAP

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CA

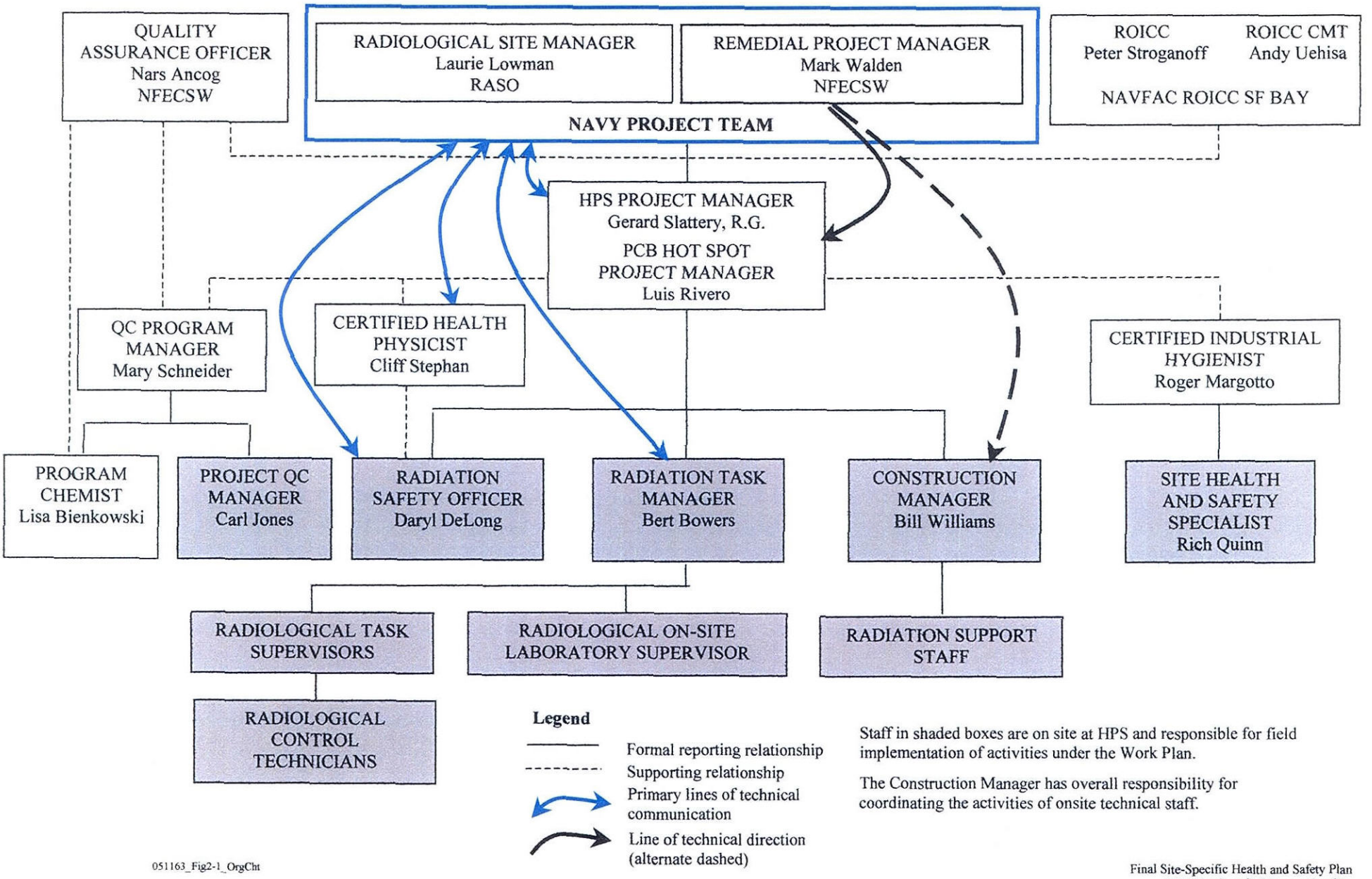
TETRA TECH FW, INC.

DRAWING NO: 05116311.DWG
DCN: FWSD-RAC-05-1163
CTO: 0084
APPROVED BY: LR
CHECKED BY: LB
REV: 0
DRAWN BY: KLD
DATE: 05/17/05

I:\1990-RAC\CTO-0084\DWG\051163\05116311.DWG
PLOT/UPDATE: MAY 17 2005 09:27:43

FIGURE 2-1

PROJECT ORGANIZATION CHART



Staff in shaded boxes are on site at HPS and responsible for field implementation of activities under the Work Plan.

The Construction Manager has overall responsibility for coordinating the activities of onsite technical staff.

051163_Fig2-1_OrgCht

LEGEND

- TTFWI SITE OFFICES
- CONCENTRA MEDICAL CENTER OCCUPATIONAL HEALTH CLINIC
- SAN FRANCISCO GENERAL HOSPITAL
- ROUTE TO CLINIC
- ROUTE TO HOSPITAL

Concentra Medical Center ..... (415) 648-9501
Occupational Health Clinic
728 20th Street
San Francisco, CA 94107

Hours of Operation: 7:30 A.M. - 5:00 P.M. (Mon. – Fri)

From the TTFW offices at HPS, use Nimitz to go towards the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on *Hunters Point Boulevard which becomes Evans.* Continue on Evans and turn right at 3rd Street. Continue on 3rd Street past Cesar Chavez until 20th Street. Tun left, clinics are on right.

San Francisco General Hospital ..... (415) 206-8000
1001 Potrero Avenue
San Francisco, CA 94110

From the TTFW offices at HPS, use Nimitz to go towards the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on *Hunters Point Boulevard which becomes Evans. Continue on Evans and turn* right at 3rd Street. Continue to Cesar Chavez. Turn left onto Cesar Chavez. Continue west on under the 280 Freeway and continue to under the 101 Freeway, turn right on Potrero. Continue on Potrero, hospital will be on the right on 23rd Street.

N

NOT TO SCALE

FIGURE 12-1
ROUTE TO CLINIC AND HOSPITAL

HUNTERS POINT SHIPYARD, SAN FRANCISCO

TETRA TECH FW, INC.

DRAWING NO: 051163121.DWG
DCN: FWSD-RAC-05-1163
CTO: 0084
APPROVED BY: LR
CHECKED BY: LB
DRAWN BY: KLD
DATE: 05/17/05
REV: 0

I:\1990-RAC\CTO-0084\DWG\051163\051163121.DWG
PLOT/UPDATE: MAY 17 2005 09:27:07

ATTACHMENT 1

MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

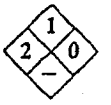
Section 1. Material Identification

Antimony Trioxide (Sb_2O_3) Description: Derived by heating antimony ore and recondensing the fumes, adding ammonium hydroxide to antimony chloride, or direct extraction from low-grade ores. Used in fire retarding of textiles, paper, and plastics (chiefly PVC); paint pigments; high stability specialty lubricants; phosphors; as a ceramic opacifier; catalyst; mordant; glass decolorizer; and chemical intermediate.
Other Designations: CAS No. 1309-64-4, antimonious oxide, antimony peroxide, antimony sesquioxide, antimony white, Antox, C.I. Pigment White II, Dechlorane-A-O, diantimony trioxide, Exitelite, flowers of antimony, Senarmontite, Valentinite, White Star.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Antimony trioxide is an eye, skin, and mucous membrane irritant and is considered a suspected human carcinogen. The powder form will ignite and burn in air when heated.

powder

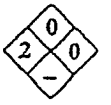
R	1	HMIS	
I	3	H	2*
S	2	F	1
K	2	R	0



Genium

cubes

R	1	HMIS	
I	3	H	2*
S	2	F	0
K	0	R	0



* Chronic effects

PPE†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Antimony trioxide, < 100%. Impurities include arsenic.

1992 OSHA PEL
Transitional & Final Rule Limits
8-hr TWA: 0.5 mg/m³ (as Sb)

1990 IDLH Level
80 mg/m³ (as Sb)

1992 NIOSH REL
TWA: 0.5 mg/m³ (as Sb)

1993-94 ACGIH TLV
TWA: 0.5 mg/m³ (handling and use, as Sb)

1991 DFG (Germany) MAK
TWA: 0.5 mg/m³ (as Sb)
Category III: Substances with systemic effects
Onset of effects; > 2 hr
Half life: > shift length (strongly cumulative)
Peak Exposure limit: 5 mg/m³, 30 min. average value, 1/shift

1992 Toxicity Data*
Rat, inhalation, TC_{Lo}: 4200 µg/m³ given intermittently for 52 weeks caused liver and lung tumors.
Rat, oral, LD_{50}: > 20 g/kg
Rat, inhalation, TC_{Lo}: 270 µg/m³ from 1 to 21 days of pregnancy caused post-implantation mortality or fetal death.

* See NIOSH, *RTECS* (CC5650000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 843.3 °F (1550 °C), *sublimes**
Melting Point: 346.1 °F (655 °C)
Vapor Pressure: 1 mm Hg at 574 °F (1065.2 °C)
pH: Amphoteric (can react as an acid or a base)
Molecular Weight: 291.5

Density: 5.2
Water Solubility: Insoluble; 0.000029 mole/1000 g water at 77 °F (25 °C).
Other Solubilities: Soluble in sulfuric, hydrochloric, and nitric acids; potassium hydroxide; warm tartaric acid; bitartrates; alkali hydroxides and sulfides.

Appearance and Odor: White, odorless, crystalline powder or cubes.
* Sublimes in high vacuum at 752 °F (400 °C)

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: The powder ignites and burns when heated; the cubes don't. Use dry chemical, carbon dioxide, water, or regular foam.
Unusual Fire or Explosion Hazards: The more finely divided the powder, the more readily it burns.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Antimony trioxide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include chlorinated rubber (at 420.8 °F/216 °C), bromine trifluoride, acids, oxidizers, and halogenated agents.
Conditions to Avoid: Excessive dust generation, exposure to heat or ignition sources, and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony trioxide can produce toxic antimony fumes.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, TLV-A2 (suspected human carcinogen for Sb_2O_3 *production*)[183] and DFG, MAK-A2 (unmistakably carcinogenic animals only, Sb_2O_3 *handling and use*),[183] list antimony trioxide as a carcinogen.
Summary of Risks: Antimony trioxide is irritating to the eyes, skin, and respiratory tract. Chronic exposure appears to be more of a threat than acute exposure and is evident by heart disease, "antimony measles", and possible carcinogenicity. Liver and kidney damage is seen in animals but it is not clear if the same damage could occur in humans. Due to its insolubility in water, antimony trioxide is less toxic than soluble antimony salts. In addition, it is three times less toxic than the metal.
Medical Conditions Aggravated by Long-Term Exposure: Skin, heart, and lung disorders.
Target Organs: Eyes, skin, and the respiratory and cardiovascular systems.
Primary Entry Routes: Inhalation, skin and eye contact, ingestion.

Continue on next page

Section 6. Health Hazard Data, *continued*

Acute Effects: Inhalation can cause sore throat, headache, chest pain, shortness of breath, metallic taste, nausea and vomiting, diarrhea, and weight loss. Skin contact is irritating. Eye contact is irritating and can cause conjunctivitis. Ingestion causes irritation of the gastrointestinal tract, vomiting, bloody stools, slow pulse and low blood pressure, shallow breathing, and possibly, coma and convulsions resulting in death.
Chronic Effects: Chronic inhalation can cause inflammation of the respiratory tract resembling simple pneumoconiosis and is shown by radiographic lung changes (studied individuals were exposed up to 10 X the TLV). Lung cancer is possible based on an English epidemiologic study but at present, Sb_2O_3 only has status as a suspected carcinogen. There is also evidence of chronic heart disease due to effects on the heart muscle. Repeated or prolonged skin contact may cause "antimony measles", consisting of itchy papules and pustules around the sweat and fat glands. This is particularly seen in moist areas (elbows, underarms, groin area, etc.). The condition appears to be more prevalent when temperatures are high.
FIRST AID
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water to remove any loose material, then wash with soap and water. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Support respiratory and cardiovascular function. A urine test can be used to confirm exposure-1 mg/L is indicative of potentially harmful exposure. Chelators such as BAL and unithiol have been used in some countries.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation and skin/eye contact. Avoid dust generation; do not sweep. Carefully scoop spills into suitable containers for disposal. Damp mop any residue. Vacuuming (with an appropriate filter) may also be used. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: Antimony trioxide is not expected to volatilize from water because of its low vapor pressure.
Ecotoxicity Values: *Lepomis macrochirus* (bluegill sunfish), LD_{50} = > 530 mg/L/96 hr; *Pimephales promelas* (fathead minnow), LD_{50} = > 833 mg/L/96 hr.
Disposal: Consider returning large amounts to a smelter for reprocessing. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed (as Sb) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Consider the NIOSH respirator recommendations for antimony dust because there are no specific recommendations for antimony trioxide. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Butyl rubber and polycarbonate are suitable materials. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove Sb_2O_3 from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Sb_2O_3, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from incompatibles.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, lungs, and heart.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Antimony compounds, inorganic, solid, n.o.s.
DOT Hazard Class: 6.1
ID No.: UN1549
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102):—

Packaging Authorizations
a) **Exceptions:** 173.153
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 100 kg
b) **Cargo Aircraft Only:** 200 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:**—

MSDS Collection References: 1, 26, 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 159, 167, 168, 176, 183, 186
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** T Thoburn, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.
Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

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HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensi to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.
Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M4

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Section 1. Material Identification

Asbestos and Asbestos-containing Materials Description: Asbestos is a generic term applied to many naturally occurring, hydrated silicates (minerals) found in rock which separate into flexible fibers when crushed or processed. Commercially important forms are amosite, anthrophyllite (mined and used only in Finland), chrysotile, and crocidolite. Other types include tremolite and actinolite. Most widely used in US industry is chrysotile, a fibrous form of serpentine. Since asbestos is insensitive to chemical attack and incombustible, there are over 2000 uses as processed fiber. It is added to such diverse materials as cement, vinyl, plaster, asphalt, and cotton, although due to its health hazards other materials are now replacing it wherever possible. Its use is now limited to products that bind fibers within the product. The largest use of asbestos is in asbestos cement for pipes in water supply, sewage disposal, and irrigation systems; ducts; and flat and corrugated sheets for a wide variety of construction applications. Other uses include fire-resistant textiles, floor tiles, underlayment and roofing papers, friction materials (brake linings), reinforcing filler in elastomers for packing and gaskets, reinforcing pigment in surface coatings and sealants, thermal and electrical insulation media, as a component of taping compound and industrial talcs, and as filler in industrial greases. About 98% of crocidolite is used in production of asbestos cement pipe. Between 1950 and 1972 asbestos was used as spray insulation in buildings, but OSHA now prohibits spray application of actinolite, anthophyllite, asbestos, or tremolite (29 CFR 1910.1001).

Other Designations: CAS No. 12172-73-5, amosite, brown asbestos; CAS No. 1332-21-4, asbestos; CAS No. 12001-29-5, chrysotile, white asbestos; CAS No. 12001-28-4, crocidolite, blue asbestos; Ascarite; earth flax; mountain cork; stone flax.

Molecular Formulas: Amosite, $(FeMg)SiO_3$; anthophyllite, $(MgFe)_7Si_8O_{22}(OH)_2$; chrysotile, $3MgO \cdot 2SiO_2 \cdot H_2O$; crocidolite, $NaFe(SiO_3)_2 \cdot FeSiO_3 \cdot H_2O$; tremolite, $Ca_2Mg_5Si_8O_{22}(OH)_2$.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Asbestos causes three specific diseases: asbestosis (fibrous lung scarring), lung cancer, and mesothelioma (cancer of the chest lining and abdominal cavities). Prevent or maintain exposures at the lowest feasible level.

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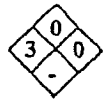

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Section 2. Ingredients and Occupational Exposure Limits

	1989 OSHA PELs*			1990-91 ACGIH TLVs	1988 NIOSH REL
Asbestos	TWA: 0.2 f/cc†	Action Level TWA: 0.1 f/cc	Excursion Limit: 1.0 f/cc‡	TWA: 2.0 f/cc§	0.1 f/cc
Amosite	0.2 f/cc	0.1 f/cc	1.0 f/cc	0.5 f/cc	0.1 f/cc
Chrysotile	0.2 f/cc	0.1 f/cc	1.0 f/cc	2.0 f/cc	0.1 f/cc
Crocidolite	0.2 f/cc	0.1 f/cc	1.0 f/cc	0.2 f/cc	0.1 f/cc

1985-86 Toxicity Data for Asbestos (CAS No. 1332-21-4)**
Human, inhalation, TC_{Lo}: 1.2 fb/cc, continuous exposure over 19 years. Toxic to lungs.

* OSHA has proposed a lower asbestos exposure limit of 0.1 f/cc as an 8-hr TWA (*Industrial Safety and Hygiene News*, 8/90).
† Fiber/cm³
‡ Average over a 30-min sampling period.
§ As determined by membrane filter method at 400 to 450X magnification (4-mm objective) phase contrast illumination. Fibers longer than 5 µg and with an aspect ratio ≥ 3:1 (ACGIH).
** See NIOSH, *RTECS* (CI6475000), for additional toxicity data.

Section 3. Physical Data

Melting Point: Decomposes
Water Solubility: Insoluble (breaks down slowly in hot water)
Molecular Weight: Varies with asbestos form (Sec. 1)
Appearance and Odor: White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None rpeorted	UEL: None reported

Extinguishing Media: Asbestos is nonflammable. Use dry chemcial, CO_2, water spray, or regular foam. Do not scatter spilled material with high-pressure water streams. **Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since there may be airborne asbestos fibers, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode; structural firefighter's protective clothing provides limited protection. If feasible, remove containers from fire area. Avoid dust generation. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Develop decontamination procedures for protective clothing and equipment.

Section 5. Reactivity Data

Stability/Polymerization: Asbestos is inert under ordinary room temperature and heated use conditions. It is heat resistant, but decomposes and alters its microscopic fiber structure above 600 °C (1112 °F). Chrysotile dehydroxylates at 1112 to 1436 °F (600 to 780 °C); the "asbestos anhydride" in turn breaks down to a mixture of silica (SiO_2) and fosterite (Mg_2SiO_4) at 1472 to 1562 °F (800 to 850 °C). Above 1832 °F (1000 °C) magnesium pyroxenes form and melt at ~2642 °F (1450 °C). **Chemical Incompatibilities:** Strong acids can attack chrysotile and rapidly extract its MgO and H_2O content; glacial acetic acid can decompose it. Hot water slowly breaks down chrysotile. Like other asbestos forms, it resists strong alkali (5M NaOH at least up to 100 °C).

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, OSHA, and ACGIH list asbestos as a human carcinogen. **Summary of Risks:** Asbestos may cause 1) asbestosis, 2) lung cancer, 3) mesothelioma, 4) pleural plaques, and 5) several other forms of cancer. *Asbestosis* is fibrosis (scarring) of lung tissue after many years of high-level occupational exposure. Scarring may be progressive even after exposure ceases. Even though detectable in lungs of a high proportion of adults in industrialized areas, asbestosis does not result from lower level environmental exposure. Its symptoms range from mild shortness of breath and dry cough to severe disabling breathlessness, heart failure, and ultimately death. Lung scarring can be seen on X-ray and alterations in lung function can be detected with spirometry (a medical test). Examination typically detects rales (crackling sounds in lungs). Severe cases may have cyanosis (bluish skin discoloration) and clubbing of fingertips. *Lung cancer* can result from lower exposure levels than asbestosis, but also takes many years to develop. Smokers exposed to asbestos are at 5 to 10X higher risk than exposed nonsmokers. *Mesothelioma* is a very aggressive cancer of the pleura (lining around the lungs) or peritoneum (lining of the abdomen), and develops after decades of (sometimes low level) exposure. Symptoms may include chest and abdominal pain, weight loss, and/or shortness of breath, with death within 2 years of diagnosis. *Pleural plaques* are thickenings, sometimes with calcium deposits, of the lungs's lining and may be seen on X-ray. While not associated specifically with health effects, they indicate significant exposure. *Other sites of cancer* include larnyx (vocal cords), portions of digestive tract, and possibly the kidney. Asbestos's toxicity depends on fiber type (crocidolite > amosite > chrysotile), size (longer > shorter), shape (long, thin needle-like > curly), and solubility. Health effects depend on dose (exposure concentration and duration), smoking habits, and individual susceptibility. Prevent or maintain exposures at lowest feasible level.

Continue on next page

Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Long-term, high-level exposure may aggravate any chronic lung (asthma, emphysema, bronchitis) or heart condition. **Target Organs:** Respiratory system; possibly digestive system. **Primary Entry Routes:** Inhalation, ingestion, dermal contact. **Acute Effects:** Nose, throat, skin and eye irritation are possible with high exposure. **Chronic Effects:** Asbestosis, lung cancer, and mesothelioma typically develop decades (20 to 40 years) after exposure begins, but may occur sooner. **FIRST AID** *Emergency personnel should protect against asbestos exposure.* Eyes: Do not rub. Gently lift eyelids and flush with flooding amounts of water. **Skin:** Shower with water and soap. Wet contaminated clothing prior to removal and seal in a plastic bag for disposal as hazardous waste. If rash develops, consult physician. **Inhalation:** Remove to fresh air. Clean any fibers from nose and mouth. Encourage victim to cough, spit, and blow nose to remove fibers. **Ingestion:** Induce vomiting *only* if awake and alert. Consult a physician. **After first aid, consult medical care provider. Note to Physicians:** Asbestos diagnosis is based on chest X-ray with an abnormal ILO "B" reading (small irregular opacities), rales, restrictive pattern spirometry, adequate exposure history, and symptoms. Consider pneumovax, annual flu shot, and other supportive treatment as needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and skin or eye contact. Avoid dust generation, blowing, dry brushing, and dry mopping. Provide HEPA-filtered (high-efficiency particulate air) portable ventilation systems. Use wet cleaning methods or approved HEPA vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into air. Place waste in *properly labeled* dust-tight containers or sealed, heavy-gauge, impervious plastic bags for disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a); Clean Air Act, Sec. 112]
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA Extremeley Hazardous Substance (40 CFR 355): Not listed
OSHA Designations
Listed as Air Contaminant (29 CFR 1910.1000, Table Z-1-A, Z-3)

Section 8. Special Protection Data

Note: *Do not substitute personal protective clothing or equipment for proper handling and engineering controls.* **Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For airborne concentration of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals not in excess of 2 f/cc (10 X PEL), use a half-mask air-purifying respirator, other than a disposable respirator, equipped with high-efficiency filters; not in excess of 10 f/cc (50 X PEL), a full facepiece air-purifying respirator equipped with high-efficiency filters; not in excess of 20 f/cc (100 X PEL), any powered air-purifying respirator equipped with high-efficiency filters or any supplied-air respirator operated in continuous flow mode; not in excess of 200 f/cc (1000 X PEL), a full facepiece supplied-air respirator operated in pressure-demand mode; greater than 200 f/cc (>1,000 X PEL) or unknown concentration, a full facepiece supplied-air respirator operated in pressure-demand mode and equipped with an auxillary positive-pressure self-contained breathing apparatus (29 CFR 1910.1001). *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation and dust collection systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103] **Safety Stations:** Make available in work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Never enter lunchroom facilities or leave workplace wearing clothing or equipment worn during workshift. Separate contaminated work clothes from street clothes. *If proper hygiene is not rigorously followed, family members can be exposed to asbestos fibers.* Place contaminated protective devices or work clothing in labeled, impermeable, and sealed containers or bags. Do not remove asbestos from clothing by blowing or shaking. Launder contaminated clothing before wearing. Inform laundering service of asbestos-contaminated clothing and of asbestos' potential harmful effects (29 CFR 1910.1001). **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using asbestos, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed (dust-tight) containers or heavy-gauge impervious plastic bags in a clean, secure area protected from physical damage. Do not open containers that can release asbestos dust without providing proper enclosure or control measure. **Engineering Controls:** Educate workers about asbestos's and asbestos-containing materials' hazards. Inform employees of asbestos standard (29 CFR 1910.1001). Exposure to asbestos, tremolite, anthophyllite, and actinolite in construction work is covered by 29 CFR 1926.58. ["OSHA is proposing an expanded requirement for a trained 'competent person' to ensure compliance with the standard on all construction operations involving asbestos, and requiring more stringent housekeeping to remove asbestos in general industry." (*Industrial Safety and Hygiene News*, 8/90).] Instruct employees in proper practices for handling asbestos-containing materials and correct use of protective equipment. Prevent or minimize asbestos exposure. Regulate areas where exposure in excess of the PEL is likely. Post warning signs in all regulated areas (see legend below). Work with asbestos only in a sufficient wet state to prevent emission of airborne fibers. Practice good personal hygiene and housekeeping procedures. Do not substitute personal protective equipment for proper handling and engineering controls. If exposures exceed the PEL, ensure employees wear appropriate protective clothing. Inhaling or ingesting asbestos fibers from contamined clothing or skin can be hazardous. Do not allow dusts and asbestos-containing wastes to accumulate. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Monitor work areas that expose employees to airborne concentrations at or above the action level (Sec. 2). Whenever production, process, control equipment, personnel, or work practices change, institute new monitoring. **Other Precautions:** Medical surveillance is required for all employees possibly exposed at or above the action level. Provide preplacement medical examination that includes complete medical and work history, complete physical examination that emphasizes respiratory and cardiovascular systems and digestive tract, the respiratory disease standardized questionnaire, a posterior-anterior 14" x 17" chest roentgenogram, and pulmonary function tests [FVC and FEV(1)]. Annual periodic medical examinations shall include all these elements and an abbreviated questionnaire. If it is 10+ years since first asbestos exposure, an individual should have a chest roentogram: every 5 years (ages 15 to 35), every 2 years (ages 35 to 45), every year (age 45+). Within 30 days of employment termination, an individual should receive a periodic medical examination with the elements listed above. Keep medical surveillance records for duration of employment, plus 30 years.

Transportation Data (49 CFR 172.101, .102)
DOT Shipping Name: Asbestos
DOT Hazard Class: ORM-C
ID No.: -
DOT Label: None
DOT Packaging Exceptions: 173.1090
DOT Packaging Requirements: 173.1090
Other Requirements: Stow and handle to avoid airborne particle
IMO Shipping Name: Asbestos, blue; asbestos, white
IMO Hazard Class: 9
ID No.: UN2212, UN2590
IMO Label: None
IMDG Packaging Group: II, III

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

MSDS Collection References: 2-4, 6, 12, 14, 20, 26, 32, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 142, 143, 146, 148, 152, 153, 156-158
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 59
Beryllium Metal/Powder

Issued: 4/80 Revision: A, 11/89

Section 1. Material Identification

30

Beryllium Metal/Powder Description: A naturally occurring ore found in chrysoberyl (Be_2SiO_4) or produced industrially from beryl ($3Be.OAl_2O_3.6SiO_2$). The ore is converted to the oxide or hydroxide, then to the fluoride or chloride. The halide may be reduced in a furnace by magnesium metal or by electrolysis. An alternative purification process is a liquid-liquid extraction with an organophosphate chelating agent. Used in aerospace structures, radio tube parts, inertial guidance systems, computer parts, Be-Cu alloys, gyroscopes; used as an additive in solid propellant rocket fuels, as a neutron source when bombarded with alpha particles, and as a neutron moderator and reflector in nuclear reactors.
Other Designations: Glucinium; Be; CAS No. 7440-41-7.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 2
K 1

Genium

HMIS
H 4
F 1
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Beryllium and compounds, ca 100%

OSHA PELs
8-hr TWA: 0.002 ppm
30-min STEL: 0.005 ppm
Ceiling level: 0.025 ppm

ACGIH TLV, 1989-90*
TLV-TWA: 0.002 mg/m³

NIOSH REL, 1987*
Not to exceed 0.5 µg/m³

Toxicity Data†
Human, inhalation, TC_{Lo}: 300 mg/m³, pulmonary effects
Rabbit, intravenous, TD_{Lo}: 20 mg/kg, neoplastic effects

* These values are for beryllium and its compounds.
† See NIOSH, *RTECS* (DS1750000), for additional data with references to mutagenic and tumorigenic effects.

Section 3. Physical Data

Boiling Point: 5378 °F (2970 °C)
Melting Point: 2332 °F (1278 °C)
Vapor Pressure: 7.6 mm Hg at 3470 °F (1910 °C)
Atomic Weight: 9.01 g/mol

Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 1.848 at 68 °F (20 °C)
Water Solubility, hot water: Slight
cold water: Insoluble

Appearance and Odor: A grayish-white metal with a hexagonal and aniostropic crystal structure (i.e., their index of refraction varies with incident light direction), and a powdered metal, no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Powder, ca 1200 °F (649 °C) **LEL:** None reported **UEL:** None reported

Extinguishing Media: *Never* use water or CO_2. Instead, smother the fire with an approved dry-powder extinguisher. Sand, graphite powder, and sodium chloride are also recommended.
Unusual Fire or Explosion Hazards: Beryllium can be a moderate fire hazard if exposed to flame. The hazards increase as particulate size decreases. A beryllium dust cloud can be explosive (areas where dusting may occur require Class 2, Group E electrical services, 29 CFR 1910.309). This material's combustion products are *highly toxic.*
Special Fire-fighting Procedures: Fire fighters should use full protective clothing, eye protection, and a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. After exposure to a beryllium fire, they should clean equipment and bathe carefully.

Section 5. Reactivity Data

Stability/Polymerization: Beryllium is stable at room temperature in closed containers.* Hazardous polymerization cannot occur.
Chemical Incompatibilities: Acid and alkali soluble, it reacts with strong bases to evolve hydrogen.† Warm beryllium reacts incandescently with phosphorus, fluorine, or chlorine. Molten lithium metal at 356 °F (180 °C) severely attacks beryllium metal.
Conditions to Avoid: When heated in air or in mixed CO_2 and nitrogen, beryllium is ignitable. Mixtures of the powdered metal with CCl_4 or trichloroethylene flash on heavy impact.
Hazardous Products of Decomposition: Thermal oxidative decomposition of beryllium emits very toxic oxide of beryllium fumes.

* When moist, beryllium forms thin, acid-resistant oxide films on solid surfaces.
† A simple asphyxiant gas, hydrogen is extremely flammable.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and ACGIH list beryllium as a carcinogen. Animal studies also indicate that beryllium produces lung and bone tumors.
Summary of Risks: Beryllium is highly toxic by inhalation of fume or dust and exposure to this element and its salts may cause death. Inhaled beryllium is partially deposited in the lungs, the blood system, and finally the bones, thus affecting all organ systems. Since the human body does not quickly eliminate beryllium, trace amounts in urine are detectable as long as 10 years after exposure. Prolonged or repeated skin contact can cause skin irritation or dermatitis. Eye contact can produce conjuctivitis and eye ulcers. If introduced through the skin via cuts or punctures, nonhealing ulcers may develop.

Continue on next page

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Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure: Increased risk of lung, liver, gall bladder, and bile duct cancers. **Target Organs:** Lungs, mucous membranes, eyes, skin. **Primary Entry:** Inhalation. **Acute Effects:** Symptoms may occur up to 72 hr after a massive exposure. Acute inhalation can produce pneumonitis with inflammation of the upper and lower respiratory tracts, nasal congestion, nonproductive coughi and pulmonary edema. High dose exposures may cause acute respiratory distress, brain hemorrhaging, liver inflammation, and spleen hemorrha ing. **Chronic Effects:** Symptoms may be delayed up to 15 years. Chronic exposures result from long-term exposure to small (microgram) quantities and can produce berylliosis. Berylliosis is a progressive granuloma formation in the lungs which eventually causes increasing shortness of breath and, in some cases, death. Since it also circulates among other organs, beryllium causes eventual heart enlargement and failure, liver and spleen enlargement, kidney stones, various malignant tumors, and damaging cell death in any organ in which it accumulates.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min. **Skin:** After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. Present studies indicate that beryllium is so poorly absorbed through the intestinal tract, that ingestion is not an important hazard (*Industrial Toxicology*, 3rd Edition, Hamilton).

After first aid, get appropriate in-plant, paramedic, or community medical attention and support. Watch for signs of respiratory deterioration, and use oxygen as needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: If powdered metal is spilled, notify safety personnel. Evacuate area except for cleanup personnel with protective equipment against contact or inhalation hazards. Provide ventilation and remove heat and ignition sources. To prevent dusting conditions, vacuum or wet mop powder spills. Collect particulate scrap, absorb on paper, and transfer to a sealed recovery or disposal container. **Disposal:** Dissolve beryllium in a small amount of 6M-HCl, filter it, and add a slight excess of 6M-NH_4OH to the filtrate using litmus as an indicator (blue at pH 8-3). Heat and coagulate the precipitate. After 12 hr, filter and dry it. Handle beryllium waste unsuitable for recycling in accordance with Federal, state, and local regulations. Dispose of scrap or waste material by arranging its return to the supplier in a mutually acceptable form. Contact your supplier or a licensed contractor for detailed recommendations.

OSHA Designations

Listed as Air Contaminant (29 CFR 1910.1000, Table Z-2)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001; per Clean Water Act, Sec. 307(a), 112]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator for emergency and nonroutine use in concentrations above the 8-hr, 2-µg/m³ TWA. For any time period, a half-mask, air-purifying respirator with a high-efficiency filter is suitable for concentrations as high as 25-µg Be/m³ (see NIOSH, *A Recommended Standard for Occupational Exposure to Beryllium*, Sec. 4). A powered, air-purifying respirator equipped with a "fume filter" is suitable for concentrations up to 40 µg Be/m³. A full facepiece, air-purifying respirator with a high-efficiency filter is suitable for concentrations up to 100 µg Be/m³. A powered, air-purifying respirator equipped with a high-efficiency filter, operating in the positive-pressure mode, is suitable for concentrations up to 1000 µg Be/m³. An SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode is suitable for concentrations above 1000 µg Be/m³. Follow OSHA respirator regulations (29 CFR 1910.134). **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. When exposure levels exceed the TLV, change into clean protective clothing and shower at the end of your shift. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standards (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Clearly label and store beryllium away from incompatible materials (Sec. 5) in a clean, dry, low fire-hazard area. Protect containers from physical damage. **Engineering Controls:** Provide adequate ventilation in areas where beryllium can become airborne. Monitor these areas with personal samplers to limit and control exposure levels. Teach workers about beryllium's potential hazards. Practice good housekeeping to prevent accumulation of beryllium-containing deposits. Give preplacement and annual medical exams (chest x-rays, baseline pulmonary function tests [FVC_1 (functional vital capacity) and FEV_1 (the amount of air exhaled in the first second after maximum inhalation)] and body weight measurements to workers possibly exposed to concentrations above the TLV. Prevent exposing those with pulmonary disease, chronic skin, liver, heart, or kidney conditions; abnormal chest x-ray or blood count; or vital capacity depression greater than 10%. Ensure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Beryllium compound, n.o.s.
DOT Hazard Class: Poison B
DOT ID No.: UN1567

IMO Shipping Name: Beryllium, metal powder
IMO Hazard Class: 6.1
IMO Label: Poison, flammable solid

MSDS Collection References: 1-12, 18-20, 24-26, 81, 84, 85, 88-91, 100, 116, 117

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

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Section 1. Material Identification

Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.

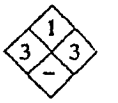
Other Designations: CAS No. 7440-43-9, colloidal cadmium.

Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*[73] for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

Powder

HMIS			
H	3*	R	3
F	1	I	4
R	3	S	2
		K	3



Genium

Solid

HMIS			
H	3*	R	1
F	0	I	4
R	0	S	2
		K	1

*Chronic effects PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL
8-hr TWA: 5 $\mu g/m^3$

1992 OSHA SECAL*
TWA: 15 or 50 $\mu g/m^3$

1990 IDLH Level
50 mg/m^3

1993-94 ACGIH TLVs
TWA: 0.01 mg/m^3 (total dust), Class A2 carcinogen
TWA: 0.002 mg/m^3 (respirable fraction)

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
Carcinogen, keep as low as possible

1992 Toxicity Data†
Human, inhalation, LC_{Lo}: 39 mg/m^3/20 min caused cardiac changes, thrombosis, and respiratory depression.
Rat, oral, LD_{50}: 225 mg/kg; details not reported.
Woman, inhalation, LC_{Lo}: 129 $\mu g/m^3$ for 20 continuous years produced lung tumors.
Man, TC_{Lo}: 88 $\mu g/m^3$/8.6 years caused kidney and ureter toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practices alone. The SECAL for Cd is 15 or 50 $\mu g/m^3$ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.
†See NIOSH, *RTECS* (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 1409 °F (765 °C)
Melting Point: 610 °F (321 °C)
Vapor Pressure: 0.095 mm Hg at 609.6 °F (320.9 °C)
Refraction Index: 1.13
Mohs Hardness: 2.0
Molecular Weight: 112.4

Density: 8.642
Water Solubility: Insoluble
Other Solubilities: Soluble in nitric (rapidly), hydrochloric (slowly), and other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.

Appearance and Odor: Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes that create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 °F (80 °C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, and oxidizing agents. **Conditions to Avoid:** Creation of Cd dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),[183] NTP Class 2 (reasonably anticipated to be a carcinogen),[169] and NIOSH Class X (carcinogen defined without further categorization),[183] ACGIH TLV-A2 (suspected human carcinogen),[183] EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).[183]
Summary of Risks: Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to metal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and may result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

Section 6. Health Hazard Data, *continued*

occurs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, healthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear to suppress Cd toxicity: Se binds up Cd, preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **Primary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, abdominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney damage may occur after acute exposures, but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several years after last exposure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, anorexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Wash exposed area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of cadmium's irritating nature.

Note to Physicians: ß-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 µg/g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. *Do not* disperse dust by sweeping. Remember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1027)

† No reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not have concentrations above 2.5 $\mu g/m^3$ at any time. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes; launder before reuse. Remove Cd from shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do not allow cadmium dust to build up in storage area.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means that disperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplacement and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Poisonous solids, n.o.s.*, Pyrophoric metals, n.o.s.†
DOT Hazard Class: 6.1*, 4.2†
ID No.: UN2811*, UN1383†
DOT Packing Group: III*, I†
DOT Label: Keep away from food*, Spontaneously Combustible†
Special Provisions (172.102): —*, B11†
* Solid metal, † Powder

Packaging Authorizations
a) **Exceptions:** 173.153*, None†
b) **Non-bulk Packaging:** 173.213*, .187†
c) **Bulk Packaging:** 173.240*, .242†

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 100 kg*, Forbidden†
b) **Cargo Aircraft Only:** 200 kg*, Forbidden†

Vessel Stowage Requirements
a) **Vessel Stowage:** A*, D†
b) **Other:** –

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

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Material Safety Data Sheet Collection

Cesium Hydroxide **MSDS No. 201**

Date of Preparation: 1/87 Revision: A, 4/96

Section 1 - Chemical Product and Company Identification 48

Product/Chemical Name: Cesium Hydroxide
Chemical Formula: CsOH
CAS Number: 21351-79-1
Synonyms: cesium hydrate
Derivation: Produced by electrolysis of cesium salts or by adding barium hydroxide to an aqueous solution of cesium sulfate.
General Use: Used in storage battery electrolytes for sub-zero temperatures, in color photography, and as a catalyst in the polymerization of cyclic siloxanes.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Cesium hydroxide, ca 100 %wt

OSHA PEL	ACGIH TLV	NIOSH REL	DFG (Germany) MAK
Vacated 1989 Final Rule Limit 8-hr TWA: 2 mg/m^3	TWA: 2 mg/m^3	10-hr TWA: 2 mg/m^3	None established

Section 3 - Hazards Identification

☆☆☆☆☆ **Emergency Overview** ☆☆☆☆☆

Cesium hydroxide exists as colorless, white, or yellowish crystals. It readily absorbs moisture from air and surfaces. It is the strongest known base and is highly corrosive to all body surfaces.

Wilson Risk Scale	
R	1
I	3
S	4
K	1

HMIS	
H	3
F	0
R	0

PPE*
*Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.
Target Organs: Eyes, skin, respiratory tract.
Acute Effects: Because cesium hydroxide is used in such small quantities, toxicity data for industrial exposures is little or non-existent. However, it is becoming more widely used which may result in future toxic exposures. Because cesium is similar to lithium, it is expected that overexposure may result in central nervous system effects.
Inhalation: Inhalation of dusts can cause severe irritation and possible burns of the respiratory tract. The severity is due to cesium hydroxide's ability to extract moisture from the mucous membranes.
Eye: Corrosive. May cause permanent damage.
Skin: Highly irritating and can be corrosive, especially if skin is moist.
Ingestion: Severe irritation and possible burns of the gastrointestinal tract.
Carcinogenicity: ACGIH, IARC, NTP, and OSHA do not list cesium hydroxide as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: None reported.
Other: Cesium hydroxide has been shown not to be a sensitizer in animal studies.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Gently wash exposed area with soap and water. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting due to the corrosive nature of cesium hydroxide. Vomiting can compound the damage to the gastrointestinal tract and pose additional respiratory damage if aspirated.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treat alkali burns as for thermal burns. Use copius irrigation.

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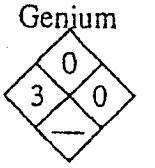
Section 5 - Fire-Fighting Measures



Flash Point: Noncombustible.
Autoignition Temperature: Noncombustible.
LEL: None reported.
UEL: None reported.
Flammability Classification: Noncombustible solid.
Extinguishing Media: Use agents suitable for surrounding fire. Be aware that water may be used, but that it can create a large amount of heat.
Unusual Fire or Explosion Hazards: Use agents suitable for surrounding fire. If water is used, flooding amounts are needed to minimize the exothermic reaction with cesium hydroxide. Material may become molten.
Hazardous Combustion Products: None reported.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel must protect against inhalation and skin/eye contact.
Small Spills: Carefully scoop up or vacuum (with appropriate filter) and place in suitable containers.
Large Spills
Containment: Flush spill to containment area with flooding quantities of water (enough to prevent exothermic reaction with cesium hydroxide) for later reclamation or disposal. Do not release into sewers or waterways.
Cleanup: Damp mop any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use only in a fume hood and with appropriate PPE.
Storage Requirements: Store in a cool, dry, well-ventilated area. Keep containers tightly closed to prevent absorption of moisture and exposure to carbon dioxide. It must be stored in platinum or silver containers. Glass containers are not suitable due to reaction with glass. Store away from water sources and incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose processes where possible to prevent dust dispersion into work areas.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic medical exams (including lung function tests) of exposed workers, especially those exposed to the action level (1 mg/m^3) or above.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. High-efficiency particulate respirators may be necessary for protection. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Polyvinyl chloride is considered appropriate PPE material. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove cesium hydroxide from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using cesium hydroxide, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless, white, or yellowish crystals.
Vapor Pressure: ~0 mm Hg at 68 °F (20 °C)
Formula Weight: 149.92
Density (H_2O=1, at 4 °C): 3.68 g/mL
Water Solubility: Highly soluble; 395% at 59 °F (15 °C)
Other Solubilities: Soluble in alcohol.
Melting Point: 521.6 °F (272 °C)

Section 10 - Stability and Reactivity

Stability: Cesium hydroxide is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Glass, carbon dioxide, water, strong acids (hydrochloric, sulfuric, nitric), and metals (aluminum, lead, zinc, tin). Contact with wet metals can evolve highly flammable and explosive hydrogen gas.
Conditions to Avoid: Exposure to water and other incompatibles.
Hazardous Decomposition Products: None reported.

Section 11 - Toxicological Information

Toxicity Data:*

Eye Effects:
Rabbit, eye: 5 mg/5 min rinse caused severe irritation.

Skin Effects:
Rabbit, skin: 5 mg/24 hr caused mild irritation.

Acute Oral Effects:
Rat, oral, LD_{50}: 570 mg/kg caused somnolence, muscle contraction or spasticity, and respiratory changes.
Mouse, oral, LD_{50}: 800 mg/kg caused tetany.

* See NIOSH, *RTECS* (FK9800000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Data not found.
Environmental Fate: Data not found.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Cesium hydroxide, solid*; Cesium hydroxide, solution†
Shipping Symbols: –
Hazard Class: 8
ID No.: UN2682*, UN2681†
Packing Group: II
Label: Corrosive
Special Provisions (172.102): –*; B2, T8†

Packaging Authorizations
a) **Exceptions:** 173.154
b) **Non-bulk Packaging:** 173.212*; 202†
c) **Bulk Packaging:** 173.240*; 242†

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 15 kg*; 1 L†
b) **Cargo Aircraft Only:** 50 kg*; 30 L†

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.22): Characteristic of Corrosivity, D002
Listed as a "Unlisted Hazardous Waste, Characteristic of Corrosivity" CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001
CERCLA Reportable Quantity (RQ), 100 lb (45.4kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 136, 176, 190, 197, 201, 203, 209

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... PA Roy, MPH, CIH
Medical Review ..... J Brent, MD, PhD

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Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 Revision: A, 11/89

Section 1. Material Identification

30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
Other Designations: Chrome; Cr; CAS No. 7440-47-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium

HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Lo}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m³. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).
† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.
‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79
Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C) **LEL:** Dust cloud explosion, 0.230 oz/ft³ **UEL:** None reported

Extinguishing Media: Use dry chemical or sand.
Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed.

MSDS Collection **References:** 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Material Safety Data Sheets Collection:

Sheet No. 757
Coal Tar Creosote

Issued: 7/91

Section 1. Material Identification

34

Coal Tar Creosote (molecular formula varies with purity) Description: Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.
Other Designations: CAS No. 8001-58-9, Awpa,® brick oil, Caswell No. 225,® coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote,® Sakresote,® tar oil, wash oil.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.
Cautions: Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP classify it as *a human carcinogen.*

R 1
I 4
S 4*
K 2
* Skin absorption

NFPA
2 / 2 / 0 / -

HMIS
H 2
F 2
R 0
PPG†
† Sec. 8

* Skin absorption can occur with phenol, a major component of coal tar creosote.

Section 2. Ingredients and Occupational Exposure Limits

Coal tar creosote, ca 100%

1990 OSHA PEL
8-hr TWA: 0.2 mg/m³*

1990-91 ACGIH TLV
TWA: 0.2 mg/m³*

1987 IDLH Level
700 mg/m³

1990 NIOSH REL
0.1 mg/m³ (cyclohexane extractable portion)

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed
Dog, oral, LD_{Lo}: 600 mg/kg; toxic effects not yet reviewed
Rat, TD_{Lo}: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries
Mouse, skin, TD_{Lo}: 99 g/kg produces tumors in skin and appendages

* As coal tar pitch volatiles.
† See NIOSH, *RTECS* (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

Section 3. Physical Data

Boiling Point: 381 to 752 °F (194 to 400 °C)
Distillation Range: 446 to 554 °F (230 to 290 °C)
Heat of Combustion: -12,500 Btu/lb
Heat of Vaporization: 107 Btu/lb
Molecular Weight: Varies with purity
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble

Appearance and Odor: Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

Section 4. Fire and Explosion Data

Flash Point: 165.2 °F (74 °C), CC	Autoignition Temperature: 637 °F (336 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

Section 5. Reactivity Data

Stability/Polymerization: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.
Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.
Summary of Risks: Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and phenol derivatives. The range of toxicity depends on the expo· concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.
Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory or skin diseases.
Target Organs: Eyes, skin, bladder, kidneys, and respiratory system.
Primary Entry Routes: Inhalation, ingestion, and skin contact.
Acute Effects: Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.
Chronic Effects: Dermatitis, skin cancer, and lung cancer.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub eyes or keep them tightly closed. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of milk or water. *Do not induce vomiting!*
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Cresol may be detected in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources–no flares, smoking, or flames in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water spray may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL_{50}, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD_{50}, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil ointment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.
Ventilation: Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.
Engineering Controls: Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a vertical ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.
Other Precautions: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.
Other Comments: Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Creosote
DOT Hazard Class: Flammable liquid
ID No.: UN1136
DOT Label: Flammable liquid

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159
Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: Mark Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheet

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No. 82

COBALT METAL/POWDER
(Revision A)
Issued: March 1981
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: COBALT METAL/POWDER

Description (Origin/Uses): Used in alloys and in nuclear weapons.

Other Designations: Co; NIOSH *RTECS* No. GF8750000; CAS No. 7440-48-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: The hazards of working with cobalt metal/powder are associated with cutting, grinding, welding, etc., that produce dust, fumes, powders, and gases.

HMIS		Not Found
H	1	
F	1	R 1
R	1	I 4
PPG*		S 1
*See sect. 8		K -

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Cobalt Metal/Powder, CAS No. 7440-48-4	Ca 100	IDLH* Level: 20 mg/m³ OSHA PEL 8-Hr TWA: 0.1 mg/m³ ACGIH TLVs, 1987-88 TLV-TWA: 0.05 mg/m³ TLV-STEL: 0.1 mg/m³ Toxicity Data** Rat, Oral, LD_{Lo}: 1500 mg/kg

All the exposure limits above are defined for cobalt metal, dust, and fume as Co.
*Immediately dangerous to life and health.
**See NIOSH, *RTECS*, for additional data with references to tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 5792°F (3200°C)
Melting Point: 2719°F (1493°C)
Specific Gravity (H_2O = 1): 8.92
Water Solubility (%): Insoluble
Molecular Weight: 59 Grams/Mole

Appearance and Odor: A gray, hard, magnetic, ductile, and somewhat malleable metal or black powder; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Do not use water. Recommended extinguishing agents include dry sand, dry dolomite, dry graphite powder, or sodium chloride. Solid cobalt does not burn; however, its dust can burn and it may form explosive mixtures with air.
Unusual Fire or Explosion Hazards: Cobalt dust particles suspended in the air can explode. If a cobalt dust cloud does form, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and take appropriate precautions (e.g., spray the affected area with a water mist or fog). Pyrophoric cobalt, which appears as a black powder, burns brilliantly when exposed to air. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workplace.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Cobalt metal/powder is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Pyrophoric cobalt decomposes cold acetylene and becomes incandescent. Fused ammonium nitrate can sometimes react explosively with powdered cobalt.

Conditions to Avoid: Prevent contact with incompatible chemicals. Powdered cobalt is more reactive than the solid metal; do not allow the powder to accumulate or form a potentially explosive dust cloud.

Hazardous Products of Decomposition: Only powdered cobalt can burn; various oxides of cobalt may be produced during fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Cobalt metal/powder is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Inhalation of cobalt dust can cause pulmonary symptoms such as wheezing, irritation of the upper respiratory tract (URT), and hypersensitivity reactions (asthma). Skin contact with powdered cobalt may cause dermatitis, especially in the creases of the elbows, knees, ankles, and neck. Contact with eyes may cause conjunctivitis. Ingestion may produce a hot sensation along with vomiting, diarrhea, and nausea. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the skin and the URT may be worsened by exposure to cobalt; administer preplacement and periodic medical exams emphasizing these functions.

Target Organs: Respiratory system, skin, bladder, kidneys, and eyes. **Primary Entry:** Skin contact, inhalation.

Acute Effects: Contact dermatitis and breathing difficulties. **Chronic Effects:** Allergic asthma, restricted pulmonary functions, and interstitial fibrosis may be caused by long-term occupational exposure to cobalt or its compounds.

FIRST AID

Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.

Skin: Immediately wash the affected area with soap and water.

Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.

Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. If cobalt salts are ingested, give 1 to 2 glasses of water and induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, remove all sources of heat and ignition, and provide adequate ventilation. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Prevent skin contact. Scoop up spilled cobalt into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Consider recycling. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for cobalt metal, dust, and fume)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Not Listed

CERCLA Hazardous Substance: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves; boots; aprons; and clean, impervious body-covering clothing to prevent any possibility of skin contact. Barrier creams may be useful to limit the effects of skin contact. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of cobalt metal, dust, or fume below the OSHA PEL standard cited in section 2.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale dust or create dusty working conditions.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cobalt metal/powder in a cool, dry, well-ventilated area in closed containers away from oxidizing agents, incompatible chemicals (see sect. 5), and sources of heat or ignition.

Special Handling/Storage: Practice good housekeeping techniques that minimize accumulation of dust; cleaning procedures should not create dusty conditions.

Transportation Data (49 CFR 172.101-2): Not Listed

References: 1, 2, 12, 73, 84-94, 100, 103. PJI

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Material Safety Data Sheets Collection:

Sheet No. 162
Copper

Issued: 12/85 Revision: A, 8/90

Section 1. Material Identification

Copper (Cu) Description: Widely distributed in nature in elemental state, arsenites, sulfides, chlorides, and carbonates. Prepared by crushing, grinding, and concentrating copper ores by flotation and leaching or by smelting copper ore concentrates to yield a blister (96 to 98%) copper which is electrolytically refined to yield 99.9+% copper. Copper is the most widely used structural metal, next to iron and aluminum. Used in electric wiring; switches, heating, plumbing, roofing, and building construction; alloys (brass, bronze, Monel metal, beryllium-copper); coins; chemical and pharmaceutical machinery; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc., cooking utensils; insecticides; antifouling paints; and as a catalyst. Copper whiskers are used in thermal and electrical composites. Copper flakes are used as insulation for liquid fuels.

Other Designations: CAS No. 7440-50-8, bronze powder, copper slag-airborne, copper slag-milled.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: *Copper may be toxic through contact, inhalation, and ingestion.* It may cause skin and eye irritation and metal fume fever. Copper is not considered a fire hazard, but fine particles may burn in air.

R	0
I	4
S	1
K	0

Genium

HMIS
H 2
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

1989 OSHA PELs	1989-90 ACGIH TLVs	1988 NIOSH REL	1985-86 Toxicity Data‡
8-hr TWA: 1 mg/m³*	TLV-TWA: 1 mg/m³*	None established	Human, oral, TD_{Lo}: 120 µg/kg affects the gastrointestinal tract (nausea or vomiting)
8-hr TWA: 0.1 mg/m³†	TLV-TWA: 0.2 mg/m³†		Rat, oral, TD_{Lo}: 1210 µg/kg (35 weeks prior to mating) affects fertility (pre- and post-implantation mortality)

* Copper dusts and mists, as Cu.
† Copper fume.
‡ See NIOSH, *RTECS* (GL5325000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4703 °F (2595 °C)
Melting Point: 1981 °F (1083 °C)
Vapor Pressure: 1 mm Hg at 2962 °F (1628 °C)
Molecular Weight: 63.546
Density/Specific Gravity: 8.94
Water Solubility: Insoluble

Appearance and Odor: Solid, various shapes, odorless, red/brown-colored metal or powder. Copper is ductile, tough, and easily worked. It is very resistant to corrosion, but readily attacked by alkalies.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire since copper does not burn. Finely divided copper burns in air, and in extreme cases ignites spontaneously.

Unusual Fire or Explosion Hazards: Liquid copper explodes on contact with water. High concentrations of fine copper particles in the air may present an explosion hazard.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit.

Section 5. Reactivity Data

Stability/Polymerization: Copper is stable at room temperature in closed containers under normal storage and handling conditions. However, on long standing, a white, highly explosive peroxide deposit may form. Copper's vapors are uninhibited and may form polymers in vents and flame arresters.

Chemical Incompatibilities: Copper reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. A potentially explosive reaction occurs with actylenic compounds. Copper ignites on contact with chlorine, fluorine [above 250 °F (121 °C)], chlorine trifluoride, and hydrazinium nitrate [above 158 °F (70 °C)]. It is also incompatible with 1-bromo-2-propyne; an incandescent reaction occurs with potassium dioxide.

Conditions to Avoid: Avoid prolonged exposure to air and moisture. On exposure to moist air, copper slowly converts to the carbonate.

Hazardous Products of Decomposition: Thermal oxidative decomposition of copper can produce metallic oxides (copper fumes).

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list copper as a carcinogen. Experimental studies show tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Copper is a necessary human nutrient, excessive intake levels of which the kidneys normally eliminate. In individuals with kidney disease or, rarely, Wilson's disease (abnormal retention and storage of copper in the body that damages the liver, kidneys, brain, blood, bones, and endocrine glands), copper levels may accumulate. Significant industrial exposure to copper occurs mainly through inhalation of fumes during welding, smelting, or refining operations; or through exposure to copper dusts and mists during mining, extracting, refining, or manufacturing processes. Copper particles may irritate, discolor, and damage eyes. Exposure to copper salts in many applications is potentially toxic. Copper dusts, fumes, and salts may irritate the upper respiratory tract. Long-term exposure may irritate the skin and discolor the skin or hair.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with impaired pulmonary or renal function should avoid exposure.
Target Organs: Respiratory system, skin, eyes, liver, kidneys.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Inhalation of copper fumes may give rise to metal fume fever (after an incubation period of about 5 hr), an allergic reaction with flu-like symptoms—high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion. These symptoms usually disappear within 24 hr. Direct contact with copper causes skin and (less often) eye irritation, and itching of the linings of the nose, mouth, and respiratory tract. Exposure to copper dust may cause a greenish-black skin discoloration. Copper ingestion causes nausea, vomiting, abdominal pain, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.
Chronic Effects: Continued exposure to copper may cause mild dermatitis and degeneration of the mucous membranes. Repeated or prolonged exposure to copper dusts and mists can discolor skin and hair and irritate the skin. Repeated inhalation can cause chronic respiratory disease. Individuals with Wilson's disease (1 in 200,000 individuals) are more susceptible to chronic copper poisoning. If undetected and untreated, this progressive condition is eventually fatal.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing with artificial respiration.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: A blood count shows leucocytosis if an individual has metal fume fever. Consider chellation with penicillamine or BAL (British Anti-Lewisite or dimercaprol) for chronic intoxication.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, remove all heat and ignition sources, and provide adequate ventilation. Avoid creating dusty conditions. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Cleanup methods such as vacuuming (with the appropriate filter) or wet mopping minimizes dust dispersion. Absorb liquid containing copper with vermiculite, dry sand, or other inert materials. Place in appropriate containers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Some recommendations follow. For copper dust and mists greater than 50 mg/m^3, wear a high-efficiency particulate respirator, a supplied-air respirator, or an SCBA, all with a full facepiece. For copper dust and mists greater than 2000 mg/m^3, wear a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. For copper fumes over 100 mg/m^3, wear either a powered air-purifying respirator with a high-efficiency filter, or a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode.
Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Eye and face protection is required when grinding, welding, cutting, or remelting. Protect skin from molten metal and radiant heat when melting scrap. Machine turnings may also present a laceration hazard. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store copper in tightly closed containers in a cool, dry, well-ventilated area. Avoid exposure to air and moisture.
Engineering Controls: Avoid dust and fume inhalation and direct contact with skin and eyes. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Maintain exposures below the PEL/TLV. Monitor copper dust and mist levels in the air.
Other Precautions: Provide placement and periodic examinations that emphasize the skin, eyes, and respiratory system. Prevent exposing individuals with chronic respiratory disease or Wilson's disease.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144
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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

33

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

R	1
I	-
S	2
K	2

NFPA

HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m³† STEL: 10 mg/m³	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.	Autoignition Temperature: >500 °F (932 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).
Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additiv such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.
Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet Collection

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin (TCDD)

MSDS No. 906

Date of Preparation: 6/94

Section 1 - Chemical Product and Company Identification

44

Product/Chemical Name: 2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
Chemical Formula: $C_{12}H_4Cl_4O_2$
CAS No.: 1746-01-6
Synonyms: dioxin; dioxine; NCI-C03714; tetrachlorodibenzodioxin; 2, 3, 7, 8-tetrachlorodibenzo(b, e)(1, 4)dioxin; 2, 3, 7, 8-tetrachlorodibenzo-1, 4-dioxin; TCDBD; TCDD; 2, 3, 7, 8-TCDD; tetradioxin
Derivation: TCDD is not manufactured, but is formed as a by-product of chlorobenzenes, chlorophenols, and the herbicides 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2-(2, 4, 5-trichlorophenoxy)propionic acid (Silvex) which are produced from 2, 4, 5-trichlorophenol (TCP). 2, 4, 5-T, commonly known as Agent Orange, was the defoliant used during the Vietnam War. TCP, 2, 4, 5-T and Silvex are no longer commercially produced in the U.S. As a chemical and toxicological standard, TCDD can be prepared by catalytic condensation of potassium 2, 4, 5-trichlorophenate. TCDD has been released to the environment during the incineration of chemical wastes including chlorinated benzenes, chlorophenols, and biphenyl ethers, from the improper disposal of certain chlorinated chemical wastes, in emissions from wood burning in the presence of chlorine, in accidental fires involving transformers containing PCBs, and from the use of the herbicides 2, 4, 5-T and Silvex.
General Use: TCDD is an extremely toxic, unwanted by-product and essentially has no beneficial uses. It may be used as a research chemical.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin, ca 100 %wt. TCDD normally persists as a contaminant in TCP in variable amounts (0.07-6.2 mg/kg). Consequently, the concentrations of TCDD in different batches of Agent Orange varied greatly with an average concentration of about 2 ppm.

OSHA PEL*	NIOSH REL	DFG (Germany) MAK
None established	Carcinogen, lowest feasible concentration.	None established
ACGIH TLV		
None established		

* A preliminary occupational exposure limit of 0.2 ng/m^3 (200 pg/m^3) is recommended. It provides an ample margin of safety to prevent chloracne and takes into consideration the chronic effects of animal studies and accidental human exposure. [Leung HW et al; *American Industrial Hygiene Association Journal*, 49 (9): 466-74 b(1988)]

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

TCDD is a colorless, crystalline solid at room temperature. It is highly toxic and a potential human carcinogen. Exposure to TCDD-contaminated materials may cause a severe and disabling acne-like rash that may persist for years (chloracne), metabolic disorders, and nervous system and liver damage. In animals, TCDD causes teratogenesis, tumorigenesis, and immunological dysfunction. Findings in humans are inconclusive, but human toxicology is under continuing investigation. Workers may be exposed to TCDD from residues from prior production or use of 2, 4, 5-T or Silvex, waste materials contaminated by TCDD, or contamination resulting from transformer fires. Take every precaution to avoid any exposure to TCDD.

Wilson Risk Scale	
R	1
I	4
S	4*
K	1

*Skin absorption

HMIS	
H	4†
F	1
R	0

†Chronic Effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation (dust),* skin contact, ingestion.
Target Organs: Skin, liver, and nervous system.
Acute Effects
Inhalation: Shortness of breath, headaches, fatigue, severe muscle pains, weakness, and digestive disturbance. Most symptoms develop slowly, over many days.
Eye: Conjunctivitis and chemical burns.
Skin: Chemical burns. In most cases, chloracne appears within 2 to 4 weeks after initial exposure. It consists of blackheads with small, pale-yellow cysts. In severe cases, there may be papules (red spots) or even pustules (pus-filled spots). This acne-like rash appears on the cheekbones under the eyes and behind the ears in very mild cases. With increasing severity, the rest of the face and neck are affected and the outer upper arms, chest, back, abdomen, outer thighs and genitalia may be involved in varying degrees in the worst cases. In the worst cases, lesions may be active 15 or more years after the contact has ceased. Chloracne may also appear after ingestion or inhalation. Skin fragility, hirsutism (excessive growth of hair of normal or abnormal distribution), and photosensitivity may also occur.
Ingestion: Nausea, vomiting, and possible pancreatitis.

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Carcinogenicity: The IARC, NTP, MAK, and NIOSH list TCDD as an IARC-2B (possibly carcinogenic to humans: inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), an MAK-A2 (unmistakably carcinogenic in animal experimentation only), and a NIOSH-X (carcinogen defined with no further categorization). OSHA does not list TCDD as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Skin, liver, nervous and endocrine system disorders.

Chronic Effects: Lack of energy, loss of sex drive, personality and mood changes, numbness, weakness and pain in the legs, liver damage, chloracne, and elevated blood lipids. TCDD increased the incidence of a variety of tumors in animals, but human data is inconclusive. Little is known of the human health effects (if any) as a result of long-term exposures to low concentrations.

Comments: The observed health effects from clinical or epidemiological studies of populations who were occupationally and non-occupationally exposed cannot be solely attributed to TCDD because of the concurrent exposure to 2, 4, 5-T and TCP and to other herbicides as well. There is no report of human exposure to TCDD alone.

* Vapor inhalation is unlikely because TCDD has a low vapor pressure.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Flush with water to remove solid particles; follow with a soap and water wash of exposed areas. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For an acute exposure, obtain liver function tests, CBC, prothrombin time, serum lipids, and uroporphyrins. EMG may be useful in detecting subclinical neuropathy. Current analytical techniques to detect dioxins in human tissue specimens involve gas chromatography and mass spectrometry. Chloracne may respond to topical retinoic acid, and oral tetracyclines may help secondary pustular follicles. Resistant cases may require dermabrasion or acne surgery. Isotretinoin may be tried.

Special Precautions/Procedures: Emergency personnel should protect against contamination.

Section 5 - Fire-Fighting Measures

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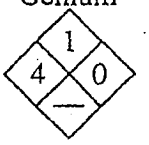

Flash Point: None reported.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam extinguisher.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic fumes of chlorine.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of spill, evacuate all unnecessary personnel, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against skin and eye contact and dust inhalation.

Small Spills: Carefully collect and place in sealed containers for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Avoid generating dust. *Do not* sweep! Provide an organized procedure of containment, collection, and disposal of contaminated solutions and residues generated during cleanup. Provide separate facilities for decontamination of large equipment. Conduct repetitive wash/rinse cycles separately, either by using different locations or by spacing in time.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120). For specific recommendations, contact your Department of Environmental Protection or your regional EPA office.

Section 7 - Handling and Storage

Handling Precautions: Handle with extreme caution. Take all the necessary precautions to avoid any exposure.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Isolate work areas involving TCDD or TCDD-contaminated materials.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical examinations with emphasis on the skin, liver, nervous and endocrine systems. Regularly monitor glassware, bench tops, instruments, and tools with wipe tests (wipe with filter paper and measure amount of TCDD). **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For situations where TCDD contamination is low (e.g., exposure to dust contaminated with low levels of TCDD), wear an air-purifying respirator until the extent and characterization of the exposure can be determined. For materials highly contaminated with TCDD, wear respirators that consist of self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive pressure mode. An alternate method utilizes a combination Type C supplied-air respirator, with full facepiece, operated in a pressure-demand mode and equipped with auxiliary positive pressure self-contained air supply. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Consider disposable clothing due to the uncertainty of adequate decontamination. Wear protective clothing consisting of both outer (zippered coverall with attached hood and draw string or elastic sleeves, gloves and closure boots) and inner (cotton overalls, undershirts, undershorts, gloves, and socks) garments. For dust or particulate exposure, wear coveralls of a non-woven fabric such as Tyvek or spun bonded polyethylene. For exposure to liquids, wear coveralls, gloves, and boots made of chemically resistant materials such as Saranax coated Tyvek or butyl, nitrile, or neoprene rubber. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Shower and change clothes after potential exposures or at the end of the work day. Separate contaminated work clothes from street clothes. Launder before reuse. Place disposable clothing in marked and approved containers for disposal. Remove this material from your shoes and clean personal protective equipment. To prevent cross-contact, provide segregated decontamination locations with separate, controlled, and well-marked entry/exit routes and locations. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless needles
Water Solubility: 19.3 ng/L
Other Solubilities: *o*-dichlorobenzene (1.4 g/L); chlorobenzene (0.72 g/L); benzene (0.57 g/L); chloroform (0.37 g/L); acetone (0.11 g/L); *n*-octanol (0.05 g/L); methanol (0.01 g/L); lard oil (0.04 g/L)

Vapor Pressure: 7.4×10^{-10} mm Hg at 77 °F (25 °C)
Formula Weight: 322
Melting Point: 581-583 °F (305-306 °C)
Octanol/Water Partition Coefficient: log Kow=7.02
Henry's Law Constant: 1.62×10^{-5} atm m^3/mole at 25 °C (estimated)

Section 10 - Stability and Reactivity

Stability: TCDD is relatively stable toward heat, acids, and alkalis. It is changed chemically when exposed in isooctane or *n*-octanol to UV light. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** None reported. **Conditions to Avoid:** Avoid heat and ignition sources. **Hazardous Decomposition Products:** Thermal oxidative decomposition of TCDD can produce toxic fumes of chlorine. Decomposition begins at 932 °F (500 °C) and complete decomposition occurs within 21 sec at 1472 °F (800 °C).

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects:
Rabbit, eye: 2 mg caused moderate irritation.
Acute Effects:
Human, skin, TD_{Lo}: 107 µg/kg produced dermatitis and allergic reaction.
Mammal, oral, LD_{50}: 4200 ng/kg produced changes of the liver, kidney, ureter, bladder, and spleen.
Rat, oral, LD_{50}: 20 µg/kg
Reproductive Effects:
Monkey, oral, TD_{Lo}: 92 ng/kg (46 weeks prior to mating, on each day during gestation, and for 17 weeks following birth) caused effects on the newborn (behavioral; delayed effects).

Genetic Effects *(continued)*:

Human cell: 100 pmol/L caused unscheduled DNA synthesis.

Human cell: 10 nmol/L caused DNA inhibition.

Tumorigenic Effects:

Rat, oral: 52 µg/kg/2 yr (intermittent) caused liver and thyroid tumors.

Rat, oral: 27 µg/kg/65 weeks (continuous) caused liver and kidney tumors.

Multiple Dose:

Rat, oral: 6500 ng/kg/13 weeks (intermittent) caused changes in liver and thymus weight and pigmented or nucleated red blood cells.

Mouse, skin: 97 µg/kg/13 weeks (intermittent) caused diffuse hepatitis (hepatocellular necrosis); changes in spleen; and death.

* See NIOSH, *RTECS* (HP3500000), for additional toxicity data.

Section 12 - Ecological Information

Environmental Transport: Bioconcentration will occur in aquatic organisms. Due to TCDD's low solubility in water and lipids as well as its low partition coefficient in lipids, TCDD is not likely to accumulate in as many biological systems as DDT.

Environmental Degradation: When released to the atmosphere, gas-phase TCDD is degraded by reaction with hydroxyl radicals and direct photolysis (half-life = 8.3 days). Particulate-phase TCDD may be physically removed from air by wet and dry deposition. TCDD may be transported long distances through the atmosphere with surface water sediments being an ultimate environmental sink of airborne particulates. TCDD will absorb to sediment and limit the overall rate by which TCDD is removed from water. TCDD near the water's surface may experience significant photodegradation. 1.5 yr is the persistence half-life of TCDD in lakes. TCDD is generally resistant to biodegradation. Photodegradation on terrestrial surfaces may be an important transformation process. During warm conditions, volatilization from soil surfaces may be a major removal mechanism. Volatilization of TCDD from dry soil surfaces is likely to be faster than from wet soil surfaces. TCDD that has been mixed into soil depths beneath the upper surface boundary will volatilize extremely slowly. On soil surfaces, persistence half-life of TCDD on soil surfaces varies from less than 1 yr to 3 yr. Half-lives in soil interiors may be as long as 12 yr.

Soil Absorption/Mobility: TCDD is immobile in soil and is not expected to leach. Lateral movement due to surface erosion may occur.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54, N50

Packaging Authorizations
a) **Exceptions:** 173.155
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** None
b) **Cargo Aircraft Only:** None

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** —

* If it is in a quantity, in one package which equals or exceeds the RQ of 1 lb (0.454 kg).

Section 15 - Regulatory Information

EPA Regulations: RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations: Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 139, 184, 187, 189, 190, 193

Prepared By MJ Wurth, BS **Industrial Hygiene Review** PA Roy, MPH, CIH **Medical Review** T Thoburn, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA

HMIS
H 2
F 3
R 1
PPG†
† Sec. 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0
Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	Autoignition Temperature: 536 to 853 °F (280 to 456 °C)	LEL: 1.3% v/v	UEL: 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.

Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. Note: Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

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* Sec. 8

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{L_o}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{L_o}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{L_o}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4); Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 148
Manganese Metal/Powder

Issued: 9/85 Revision: A, 11/89

Section 1. Material Identification

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Manganese Metal/Powder Description: A metallic element associated with iron ores such as pyrolusite, manganite, psilomelane, and rhodochrosite found mainly in open-hearth slags. Manganese is obtained from the reduction of the oxide with aluminum or carbon. Pure manganese is obtained electrically from chloride or sulfate solution. Used in ferroalloys (steel manufacture); for wagon buffers, rock crushers, railway points and crossings; as a purifying and scavenging agent in metal production; in the manufacture of aluminum by Toth process, dry-cell batteries, glass, welding rods, inks, rubber and wood preservatives, paints, and ceramics; high-purity salt for various chemical uses.
Other Designations: Manganese; colloidal manganese; magnacat; Mn; CAS No. 7439-96-5.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

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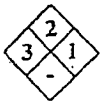

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Section 2. Ingredients and Occupational Exposure Limits

Manganese, ca 100%

OSHA PEL
Ceiling limit: 5 mg/m³ (manganese compounds, as Mn)

ACGIH TLVs, 1988-89
TLV-TWA: 5 mg/m³ (dust and compounds)
TLV-TWA: 1 mg/m³ (fume)
STEL: 3 mg/m³ (fume)

NIOSH REL, 1987
Ceiling limit: 5 mg/m³ (manganese and compounds, as Mn)
Toxicity Data*
Human, inhalation, TC_{Lo}: 2300 µg/m³

* See NIOSH, *RTECS* (OO9275000), for additional data with references to mutagenic and tumorigenic effects.

Section 3. Physical Data

Boiling Point: 3803 °F (2095 °C)*
Melting Point: 2300 °F (1260 °C)
Vapor Pressure: 1 mm Hg at 2358 °F (1292 °C)
Atomic Weight: 54.94
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.20
Water Solubility: Impure Mn decomposes slowly

Appearance and Odor: Reddish-grey or silvery powder or metal. No odor.

* Other sources (Genium refs. 7, 89, and 126) give 3807 °F (2097 °C), 3564 °F (1962 °C), and 3452 °F (1900 °C) boiling points, respectively.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** * **LEL:** * **UEL:** None reported

Extinguishing Media: Use dry chemical extinguishing agent designed for metal fires.
Unusual Fire or Explosion Hazards: Manganese dust or powder is flammable and moderately explosive when exposed to flame or heated in carbon dioxide. Mixtures of manganese dust and aluminum dust may explode in air. Ammonium nitrate and manganese may explode when heated. Flammable hydrogen gas is generated under certain conditions (Sec. 5).
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Manganese metal/powder can present a dust explosion hazard under favoring conditions of particle size and airborne dust dispersion. The minimum explosive concentration of Mn is 0.125 oz/ft³, with a minimum ignition temperature of 842 °F (450 °C). Oxygen concentrations of less than 15% prevent ignition.

Section 5. Reactivity Data

Stability/Polymerization: Manganese is stable at room temperature in closed containers. Hazardous polymerization cannot occur.
Chemical Incompatibilities: The powdered metal ignites on contact with hydrogen peroxide, bromine pentafluoride, fluorine, chlorine and heat, and sulfur dioxide and heat. It reacts violently with oxidants and nitrogen dioxide (NO_2), and incandescently with nitric acid, phosphorus, and nitryl fluoride. Manganese reacts slowly with water at 21°F (100 °C), forming hydrogen gas (flammable). Contact with acids (including dilute acids) readily dissolves Mn, with the evolution of hydrogen. Hot, concentrated potassium and sodium hydroxides also dissolve Mn, forming hydrogen and manganese hydroxide.
Hazardous Products of Decomposition: Thermal oxidative decomposition of manganese can produce manganese oxides.

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists manganese as a carcinogen.

Summary of Risks: Although an essential element for man, manganese is also toxic to humans in several ways. Acute or chronic manganese poisoning can result from excessive inhalation or ingestion. The immune system reacts to acute exposures with "metal fume fever," characterize by: fever, chills, nausea, weakness, body aches, frontal headache, occasional blurred vision, low back pain, muscle cramping, shallow respiratio throat dryness and irritation, a dry cough, a sweet or metallic taste, and chest tightness occurring over several hours. Progressive and permanent injury can result from chronic, untreated Mn poisoning. Its most notable effects are the neurological disorders caused by its ability to inhibit the chemical transmission of electrical impulses in the central nervous system. The lungs may become inflammed (manganese pneumonititis), as reported in workers exposed to manganese ores and compounds. Sufficient evidence proves that in several species, manganese is embryolethal at toxic doses. Impotence is a common symptom in grossly contaminated men.

Medical Conditions Aggravated by Long-Term Exposure: Degenerative brain changes, muscle weakness, change in motor activity.

Target Organs: Central nervous system (CNS), respiratory system, kidneys, blood.

Primary Entry: Inhalation, ingestion.

Acute Effects: High-concentration exposures may cause metal fume fever, with its onset occurring over several hours. Inhalation of large concentrations may cause managanese pneumonitis. This material is a skin and eye irritant leading to dermatitis, conjunctivitis, and corneal damage.

Chronic Effects: Exposure to manganese fume over 6 months to 2 years may harm the central nervous system, with symptoms progressing from headache, restless sleep or sleepiness, personality changes, irritability and inappropriate laughing or crying to visual hallucinations, double vision, uncontrolled impulse behavior, euphoria, and to abnormal reaction to painful stimuli, excess salivation, trembling in the extremities and head, impaired walking, and other signs similar to Parkinson's disease.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Remove heat and ignition sources. Ventilate spill area. Cleanup personnel should wear appropriate respiratory protective equipment. Carefully scoop spilled material, avoiding dust generation, into a suitable salvage container.

Disposal: Return scrap material to supplier or processor for recovery. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator where airborne concentrations exceed the ceiling limit. Fume or high-efficiency particulate filter respirators are acceptable for concentrations up to 50 mg/m^3 (250 mg/m^3 with full facepiece). Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA, ACGIH, and NIOSH standards. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). Consider the dust explosion potential of finely divided Mn powder when designing exhaust ventilation systems and other process equipment to contain heavily dust-laden air.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from ignition sources, acids, alkali, and other incompatible materials. Protect containers from physical damage.

Engineering Controls: Use with adequate ventilation. Avoid breathing dust and fumes. Maintain good housekeeping practices to prevent dust accumulation. Use cleanup procedures that minimize dust generation. Practice good personal hygiene. Examine exposed personnel at regular intervals with emphasis on the respiratory and central nervous systems.

Transportation Data (49 CFR 172.101, .102): Not listed

***MSDS Collection* References:** 2, 4, 7, 8, 9, 12, 14, 20, 25, 27, 38, 44, 47, 55, 58, 81, 89, 90, 100, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

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Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1mg/m^3 (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m^3 (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m^3 (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m^3), 30 min. average value, 1/shift

IDLH Level
28 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Wilson Risk Scale	
R	1
I	4
S	2*
K	1

*Skin absorption

HMIS	
H	4*
F	0
R	0

*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.
Acute Effects
Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.
Eye: Irritation and corrosion.
Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.
Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.
Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism.* Chronic symptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. *Mutation:* Aneuploidy and other chromosomal aberrations

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have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals.

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with soap. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, mercury will pass through the digestive tract uneventfully.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI: *blood* (15 µg/L), *urine*: (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

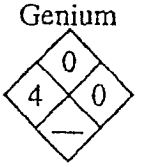
Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported.

UEL: None reported.

Genium



Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Administrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 0.5 mg/m^3, use any chemical cartridge respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m^3, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m^3, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical

cartridges providing protection against mercury, and equipped with an ESLI. For ≤28 mg/m^3, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid metal
Appearance and Odor: Silvery-white, odorless
Vapor Pressure: 0.0018 mm Hg at 77 °F (25 °C)
Formula Weight: 200.59
Density (H_2O=1): 13.534 g/cm^3 at 77 °F (25 °C)
Boiling Point: 674.09 °F (356.72 °C)
Freezing Point: -37.97 °F (-38.87 °C)
Viscosity: 15.5 mP at 77 °F (25 °C)
Electrical Resistivity: 95.76 µohm at 68 °F (20 °C)
Water Solubility: 0.28 µmol/L at 77 °F (25 °C)
Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.
Surface Tension: 484 dyne/cm at 77 °F (25 °C)
Critical Temperature: 2664 °F (1462 °C)
Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:
Rat, inhalation: 890 ng/m^3/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:
Man, skin, TD_{Lo}: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:
Man, oral, TD_{Lo}: 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:
Woman, inhalation, TC_{Lo}: 150 µg/m^3/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, TC_{Lo}: 44300 µg/m^3/8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:
Rat, inhalation: 1 mg/m^3/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, *RTECS* (OV4550000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Catfish, LC_{50} = 0.35 mg/L/96 hr; mollusk (*Modiolus carvalhoi*), LC_{50} = 0.19 ppm/96 hr; tadpole (*Rana hexadactyla*), LC_{50} = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas putida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Mercury
Shipping Symbols: A, W
Hazard Class: 8
ID No.: UN2809
Packing Group: III
Label: Corrosive
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: 173.164
b) Non-bulk Packaging: 173.164
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 35 kg
b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 334C
Mineral Spirits, Type IV

Issued: 4/90

Section 1. Material Identification

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Mineral Spirits, Type IV, Description: A low dry point mineral spirit. Used as a solvent and paint thinner; in the coatings and dry cleaning industries.
Other Designations: CAS No. 8052-41-3; Texsolve S-2; Varsol 3; stoddard solvent; white spirits.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.
Comments: All mineral spirits are refined petroleum distillates that Genium divides into types I, II, III, and IV (*MSDS Collection*, No. 334, 334A, 334B, and 334C, respectively). Types I and II have a standard aromatic content and 100 °F/37.78 °C and 140 °F/60 °C minimum flash points, respectively. Type III has a high aliphatic content (low or reduced aromatic content), little odor, and a 100 °F/37.78 °C minimum flash point; and type IV has a low dry point and a 100 °F/37.78 °C minimum flash point. These different types have different applications. Consult your manufacturer or supplier to ascertain the exact information applicable to your purchased mineral spirits.

R 1
I 3
S 1
K 2

Genium

HMIS
H 1
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Mineral spirits, type IV, ca 100%*

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
TWA: 100 ppm, 525 mg/m³	TLV-TWA: 100 ppm, 525 mg/m³	10-hr TWA: 350 mg/m³ 15-min ceiling: 1800 mg/m³	Cat, inhalation, LC_{Lo}: 10 g/m³/2.5 hr Human, eye: 470 ppm/15 min

* All mineral spirits are mixtures that typically consist of both straight and branched hydrocarbons, paraffins, naphthenes (cycloparaffins), and aromatic hydrocarbons. However, their physical properties divide them into types I, II, III, and IV. Since these parameters vary among suppliers, the purchaser must determine the mineral spirits' composition based on the supplier's information. Note that the mineral spirits' exact composition can affect disposal, shipping, approved uses, insurance policies, and regulatory liabilities.
† See NIOSH, *RTECS* (WJ8925000), for additional irritative data.

Section 3. Physical Data

Boiling Point: 300 °F/149 °C to 365 °F/185 °C*
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 0.754 to 0.800
Molecular Weight: Not applicable (mixture)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless liquid; a kerosene-like odor usually perceptible to humans at about 1-ppm concentration.

* This 300 °F/149 °C to 365 °F/185 °C distillation range describes a specific cut of petroleum distillates, as well as defines and distinguishes these mineral spirits from many petroleum distillates (petroleum naptha, petroleum ether, rubber solvent, kerosene, mineral seal oil, and others).

Section 4. Fire and Explosion Data

Flash Point: 100 °F/38.78 °C	Autoignition Temperature: >450 °F/232 °C	LEL: None reported	UEL: None reported

Extinguishing Media: Use water fog, dry chemical, carbon dioxide (CO_2), or foams to put out fires involving this material. Never direct solid streams of water into burning pools of this liquid since this can scatter and spread the flames.
Unusual Fire or Explosion Hazards: During fires, or if heated or misted, this liquid is an explosive, flammable hazard. Finely dispersed mists are a dangerous explosion hazard.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Type IV is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: As a hydrocarbon mixture, type IV can react dangerously with strong oxidizing agents like chlorine and oxygen, as well as with nitric, sulfuric, and phosphoric acids.
Conditions to Avoid: Prevent exposures to heat and ignition sources and incompatible chemicals. Perform processing operations that heat or mist type IV in a careful, controlled manner that minimizes exposure of vapors or mists to possible heat or ignition sources such as lighted tobacco products, open flames, or uninsulated heating elements.
Hazardous Products of Decomposition: Thermal oxidative decomposition of type IV mineral spirits can produce carbon dioxide (CO_2) and carbon monoxide (CO). Depending on your material's exact composition and its unreported contaminants (benzene, toluene, or other aromatics or aliphatics), degradation products could include unidentified aromatic compounds and organics. When heated to decomposition, this material may explode.

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists mineral spirits as a carcinogen.
Summary of Risks: Millions of industrial workers in chemical process and allied industries have been exposed to mineral spirits with minimal serious health effects, aside from the drying, defatting (stripping away of your skin's protective fats and emolients), and irritant skin effects. However, overexposure can depress the central nervous system (CNS) with these symptoms: headache, dizziness, drowsiness, intoxication with euphoria, and possibly unconsciousness. Prolonged or repeated skin contact can cause dermatitis due to this mineral spirits' defatting effect or by sensitization.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, nose, throat, respiratory system, and CNS.
Primary Entry Routes: Skin or eye contact with the liquid or inhalation of vapors.
Acute Effects: Irritation, redness of skin and eyes; narcotic effects like dizziness, slurred speech, or drunkeness. Ingestion may cause nausea, vomiting, diarrhea, and abdominal pain. After ingestion, the primary concern is aspiration into the lungs. Signs of aspiration pneumonitis include: fever, shortness of breath, increased rate of respiration, and rales (an abnormal rattling sound in the throat). Inhalaing this material may cause arrhythmias.
Chronic Effects: None reported in humans; animal testing indicates possible liver and kidney damage.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Inhalation may cause potentially lethal heart rhythm disturbances. Remove exposed person to fresh air and support breathing as needed.
Ingestion: Treat as an emergency. Potentially fatal aspiration hazard exists. To prevent aspiration, keep victim's head down between his knees. Never give anything by mouth to an unconscious or convulsing person. Never induce vomiting unless directed by qualified medical personnel. Even if aspiration into the lungs does not occur, ingestion of 3 to 4 oz can prove fatal in humans due to the CNS's depressed action.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: *Aspiration of even a few milliliters of mineral spirits can be fatal!* The resulting diffused chemical irritation of the lungs can progress to fatal pulmonary edema after aspiring liquid mineral spirits. To prevent their aspiration of freshly vomited solvent, carefully monitor persons who swallow mineral spirits. Consider intubation in treating any significant ingestion.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a mineral spirits spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, eliminate heat and ignition sources, provide optimum explosion-proof ventilation, and implement the SCCP. Cleanup crews must use nonsparking tools and equipment and protective clothing to prevent vapor inhalation or skin contact. Absorb the spilled material with vermiculite or a similar material and place in appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Never inhale its mists or vapors, especially when processing operations heat or mist this material.

Section 9. Special Precautions and Comments

Storage Requirements: Store this material in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and oxidizing agents. Protect these containers from physical damage. Store in properly labeled, closed metal drums or safety cans.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Use only nonsparking tools and equipment.
Comments: Shipping regulations vary with your particular mineral spirits' physical properties (flash point, boiling point). The data below represent one of several ways to classify mineral spirits, per the actual entries in the table of regulations. Before shipping mineral spirits, ascertain how the pertinent shipping rules apply to your product.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Petroleum distillate
DOT Hazard Class: Combustible liquid *or* Flammable liquid
ID No.: UN1268
DOT Label: None *or* Flammable liquid
DOT Packaging Requirements: None or 173.119
DOT Packaging Exceptions: 173.118a or 173.118

IMO Shipping Name: Petroleum distillates, n.o.s.
IMO Hazard Class: 3.1, 3.2, *or* 3.3
IMO Label: Flammable liquid
IMDG Packaging Group: II
ID No.: UN1268

***MSDS Collection* References:** 1, 6, 7, 38, 73, 84-94, 100, 103, 116, 117, 119, 120, 122, 123, 124, 126
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheet

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No. 84
MOLYBDENUM METAL/ POWDER
(Revision A)
Issued: March 1981
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: MOLYBDENUM METAL/POWDER

Description (Origin/Uses): Used to make specialty steels and nonferrous alloys; used in spark plugs and also as a lubricant additive.

Other Designations: Mo; NIOSH *RTECS* No. QA4680000; CAS No. 7439-98-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: The hazards of working with Molybdenum are associated with cutting, grinking, welding, etc., that produce dust, fumes, powders, and gases.

HMIS		Not Found
H	1	
F	1	R 1
R	0	I 2
PPG*		S 1
*See sect. 8		K -

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Molybdenum Metal/Powder; CAS No. 7439-98-7	Ca 100	**OSHA PEL** 8-Hr TWA:* 5 mg/m³ 8-Hr TWA:** 15 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA:* 5 mg/m³ TLV-TWA:** 10 mg/m³ **Toxicity Data***** Rat, Intraperitoneal, LD_{Lo}: 114 mg/kg

*Exposure limit defined for soluble molybdenum compounds as Mo.
**Exposure limit defined for insoluble molybdenum compounds as Mo.
***See NIOSH, *RTECS*, for additional data with references to reproductive and mutagenic effects.
Note: All exposure levels are defined for dust or fume.

SECTION 3. PHYSICAL DATA

Boiling Point: 10040°F (5560°C)
Melting Point: 4730°F (2610°C)
Specific Gravity (H_2O = 1): 10.28 at 68°F (20°C)
Water Solubility (%): Insoluble
Molecular Weight: 96 Grams/Mole

Appearance and Odor: A silver white metal or dark gray/black powder; odor not found.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Use dry chemical, "alcohol" foam, carbon dioxide, or water spray to put out molybdenum fires. Contact your supplier for further recommendations.

Unusual Fire or Explosion Hazards: Molybdenum dust particles suspended in the air can explode. If a molybdenum dust cloud forms, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and spray the affected area with a water mist or fog. When powdered molybdenum is exposed to heat or sources of ignition, it is a weak fire and explosion hazard; the solid metallic form of molybdenum is less reactive. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workpalce.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Molybdenum metal/powder is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions are reported for molybdenum and bromine trifluoride, chlorine trifluoride, fluorine, and lead dioxide.

Conditions to Avoid: Do not expose powdered molybdenum to sources of ignition; prevent dust clouds from forming.

Hazardous Products of Decomposition: During fires molybdenum can form oxides such as molybdenum trioxide (MoO_3), which is irritating to the eyes, nose, and throat.

SECTION 6. HEALTH HAZARD INFORMATION

Molybdenum metal/powder is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Limited data suggest that molybdenum compounds have a relatively low order of toxicity. The metal itself (Mo), the ore molybdenite, and the dioxide (MoO_2) are less toxic than the more active and soluble molybdenum compounds such as ammonium molybdate and the trioxide (MoO_3). Molybdenum itself is a necessary trace element in humans that is closely associated with copper; excessive intake of molybdenum may cause a copper deficiency.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** None reported.

Primary Entry: Skin contact, inhalation. **Acute Effects:** Mild, transient irritation of eyes, nose, and throat; elevated serum uric acid levels have been reported. **Chronic Effects:** None reported.

FIRST AID

Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.

Skin: Wash the affected area with soap and water.

Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.

Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. Give the exposed person 1 to 2 glasses of water, then induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, and provide adequate ventilation. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Scoop up spilled molybdenum into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Consider recycling. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for soluble and insoluble compounds as Mo)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Not Listed

CERCLA Hazardous Substance: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirators. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, and aprons, etc., as required by the work environment to prevent prolonged or repeated skin contact. Barrier creams may be useful to limit the effects of skin contact. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of molybdenum below the OSHA PEL standard cited in section 2.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale molybdenum dust.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store molybdenum metal/powder in a cool, dry, well-ventilated area in closed containers away from sources of ignition and incompatible chemicals (see sect. 5).

Special Handling/Storage: Practice good housekeeping techniques to minimize accumulation of dust; cleaning procedures should not create dusty conditions.

Transportation Data (49 CFR 172.101-2): Not Listed

References: 1, 2, 12, 73, 84-94, 100, 103. PJI

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Section 1. Material Identification

Nickel (Ni) Description: Found in ores in combination with sulphur, oxygen, antimony, arsenic, and/or silica. The Orford (sodium sulfide and electrolysis) and the Mond (nickel carbonyl) processes are used to refine nickel. Used in electroplating, casting operations for machine parts, manufacturing acid-resisting and magnetic alloys and tapes, synthesizing acrylic esters; in surgical and dental prostheses, coinage, catalytic gastrification of coal, paint pigments, Ni-Cd batteries, ceramics and glass; and as a catalyst in hydrogenation of fats and oils.

Other Designations: CAS No. 7440-02-0, Raney alloy, Raney nickel.*

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Nickel is an eye, skin, and respiratory tract irritant. *Chronic inhalation of nickel dust or fumes may cause cancer of the lungs and nasal passages. Nickel powder (Raney nickel) is a dangerous fire hazard.*

	NFPA	Genium
R	0	1
I	3	2
S	2	0
K	1	-
	catalyst	metal
	HMIS	HMIS
	H 2	H 2
	F 4	F 1
	R 0	R 0
	PPG†	PPG†
		† Sec. 8

* Raney nickel is prepared by leaching (with 25% caustic soda solution) aluminum from an alloy of 50% aluminum and 50% nickel. It is used as a catalyst for hydrogenation. Raney nickel, a silvery gray metal powder, is a dangerous fire risk and ignites spontaneously in air (Sec. 4). Nickel catalysts cause many industrial accidents.

Section 2. Ingredients and Occupational Exposure Limits

Nickel, ca 100%

1989 OSHA PEL	1989-90 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data*
8-hr TWA: 1 mg/m^3	TLV-TWA: 1 mg/m^3	0.015 mg/m^3	Dog, intravenous, LD_{Lo}: 10 mg/kg Guinea pig, oral, LD_{Lo}: 5 mg/kg Rat, implant, TD_{Lo}: 250 mg/kg

* See NIOSH, *RTECS* (QR5950000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4946 °F (2730 °C)
Melting Point: 2651 °F (1455 °C)
Vapor Pressure: 1 mm at 3290 °F (1810 °C)
Atomic Weight: 58.71
Density: 8.90 at 25 °C
Water Solubility: Insoluble

Appearance and Odor: A silvery-white, hard, malleable and ductile metal.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Smother with suitable dry powder or use large amounts of water.

Unusual Fire or Explosion Hazards: Nickel is combustible as dust or powder. Raney nickel ignites spontaneously in air. Nickel carbonyl (*MSDS Collection*, No. 226), a highly toxic substance, may form under fire conditions.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since nickel dust or powder is toxic if inhaled, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nickel is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Nickel can react violently with fluorine, ammonium nitrate, hydrogen + dioxane, performic acid, selenium, sulfur, ammonia, hydrazine, phosphorus, and titanium + potassium chlorate. Nickel is also incompatible with oxidants. Raney nickel catalysts may initiate hazardous reactions with sulfur compounds, *p*-dioxane, hydrogen, hydrogen + oxygen, ethylene + aluminum chloride, magnesium silicate, methanol, and organic solvents + heat.

Conditions to Avoid: Avoid incompatibilities.

Hazardous Products of Decomposition: Thermal oxidative decomposition of nickel can produce highly toxic nickel carbonyl.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP classify nickel as, respectively, a human carcinogen (Group 1) and an anticipated human carcinogen.
Summary of Risks: Nickel dust or fume is a respiratory irritant that with chronic exposure may cause nasal or lung cancer in humans. The average latency period for the induction of these cancers appears to be about 25 yr (within a 4- to 51-yr range). Experimental studies show nickel also has neoplastigenic, tumorigenic, and teratogenic effects in laboratory animals. Hypersensitivity to nickel is common and can cause conjunctivitis, allergic contact dermatitis, and asthma. The allergic contact dermatitis ("nickel-itch," a pink papular erythema with pustulation and ulceration) usually clears within one week, but sensitization is permanent.
Medical Conditions Aggravated by Long-Term Exposure: Chronic pulmonary, upper respiratory tract, and skin disorders. Carcinoma of the paranasal sinuses, larynx, and lung may also develop.
Target Organs: Nasal cavities, lungs, skin.
Primary Entry Routes: Inhalation, dermal contact, and ingestion.
Acute Effects: Exposure to nickel fumes can cause upper respiratory tract irritation (with nonproductive cough, rapid breathing, dyspnea, chest tightness), metal fume fever (chills, fever, flu-like symptoms), asthma, inflammation of the lungs (noninfectious pneumonia), eye (conjunctiva) irritation, nausea, vomiting, and abdominal pain. Dermal contact causes "nickel itch." Ingesting large doses causes nausea, vomiting, and diarrhea.
Chronic Effects: Prolonged or repeated contact can cause nickel sensitization. Symptoms of sensitization include nickel dermatitis with eczematous skin and lichenification (hardened and leathery skin). Chronic inhalation exposure can cause chronic pulmonary irritation, chronic thickening of the mucous membranes of the nose, nasal sinusitis, anosmia (loss or impairment of the sense of smell), and perforation of the nasal septum. Chronic exposure to dust and fumes may cause carcinoma of paranasal sinuses, larynx, and lung.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Since oral toxicity for elemental nickel is low, inducing vomiting is seldom necessary. In cases of severe vomiting or diarrhea, treat for fluid replacement.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Chronic exposure to nickel dust may cause *eosinophilic pneumonitis* (Loeffler's syndrome) which responds well to systemic cortico-steroids. There are cases of host rejection of nickel-containing prostheses after development of nickel sensitivity.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personal should protect against vapor inhalation and dermal contact. Avoid dust generation. Using nonsparking tools, carefully scoop spilled material into appropriate containers for reclamation or disposal. After completing material pickup, wash spill site. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from incompatible materials (Sec. 2). Protect against physical damage. Store Raney nickel under inert gas or water in tightly closed containers away from heat or ignition sources, acids, caustics, and oxidizing materials.
Engineering Controls: Minimize all possible exposures to potential carcinogens. Avoid vapor inhalation and dermal contact. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and periodic medical examinations that emphasize the skin, nasal cavities, and lungs, including a 14" x 17" chest roentgenogram and urine nickel determinations.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Nickel catalyst, wetted with not less than 40% water or other suitable liquid, by weight, finely divided, activated, or spent
IMO Hazard Class: 4.2
ID No.: UN1378
IMO Label: Spontaneously combustible
IMDG Packaging Group: II

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 140, 142, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD; Edited by: JR Stuart, MS

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MSDS No. 155

DDT (Dichlorodiphenyltrichloroethane)

Date of Preparation: 10/93

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: .... DDT (Dichlorodiphenyltrichloroethane)
Chemical Formula: ..... $(ClC_6H_4)_2CHCCl_3$
CAS No.: 50-29-3
Synonyms: Agritan; 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; chlorophenothan; Citox; dichlorodiphenyltrichloroethane; Dicophane; diphenyltrichloroethane; Genitox; Kopsol; NCI-C00464; Neocid; Pentech; trichlorobis (4-chlorophenyl) ethane; 1,1'-(2,2,2-trichloroethylidene)bis(4-chlorobenzene), Zerdane.
Derivation: Prepared by condensing chloral or chloral hydrate with chlorobenzene in presence of sulfuric acid.
General Use: One of the most widely used contact insecticides from 1945 until its ban in 1972. Although banned in the U.S. (except for such uses as emergency health situations and for controlling body lice), it is still widely used in the tropics for control of vector-carrying diseases such as malaria, yellow fever, dengue, filariasis, louse-borne typhus, and louse-borne relapsing fever.

Section 2 - Composition / Information on Ingredients

DDT: *p'p'*DDT 70% wt + *o'p'*DDT 30% wt (technical grade)
Trace Impurities: DDD, DDE

OSHA PELs
8-hr TWA: 1 mg/m^3 (skin)

ACGIH TLVs
TWA: 1 mg/m^3

NIOSH REL
10-hr TWA: 0.5 mg/m^3
Ca*: (Limit of quantitation: 0.1 mg/m^3)

IDLH Level
Ca*

DFG (Germany) MAK (skin)
TWA: 1 mg/m^3 (total dust)
Category III: Substances with systemic effects
Onset of effect: > 2 hr.
Peak Exposure Limit: 10 mg/m^3, 30 min. average value, 1/shift

* Ca = Carcinogen

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

DDT is a white to gray, crystalline solid. Although it has been banned in the U.S. because of its persistence in the environment and potential for bioaccumulation, DDT has not produced toxicity in workers who either manufactured or used it (even over many years). However, this lack of toxicity is based on inhalation and skin absorption. If DDT is ingested, especially in large amounts, central nervous system effects will occur with possible liver damage. DDT is considered a confirmed animal carcinogen and a suspected human carcinogen.

Wilson Risk Scale	
R	1
I	3
S	1*
K	2

*Skin absorption

HMIS	
H	2†
F	2
R	0

†chronic effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact.
Target Organs: Central nervous system, liver, skin, peripheral nervous system.
Acute Effects
Inhalation: Inhalation does not appear to cause toxicity beyond that of minor mechanical irritation.
Eye: Exposure to 423 mg/m^3/1 hr/day for 6 days caused eye irritation.
Skin: Skin absorption may occur from some DDT solutions, but degree of absorption will depend on the solvent involved. Aqueous solutions and the powder or crystals are not easily absorbed.
Ingestion: DDT can cause a variety of central nervous system effects if ingested. Large doses generally result in vomiting, while smaller doses cause symptoms within 2 to 3 hr post-ingestion. Symptoms include tingling of the lips, tongue, and face; malaise; headache; sore throat; fatigue; tremors of the head, neck, and eyelids; apprehension; ataxia; and confusion. Convulsions and paralysis of the hands is possible in severe exposures (if vomiting does not occur). Vital signs are usually normal, but in severe poisonings, the pulse may be irregular and abnormally slow. Based on animal studies, it is expected that ventricular fibrillation and sudden death can occur at any time during acute poisoning. Recovery from acute poisoning generally occurs within 24 hr except in the most serious cases.
Carcinogenicity: DDT is considered a suspected human carcinogen by several governmental agencies. IARC-2B (possibly carcinogenic to humans, limited evidence in humans in the absence of sufficient evidence in experimental animals), NTP-2 (reasonably anticipated to be a carcinogen: limited human evidence or sufficient animal evidence), EPA-B2 (sufficient animal evidence; inadequate human evidence), and NIOSH-X (carcinogen defined without further categorization)
Medical Conditions Aggravated by Long-Term Exposure: Possibly, disorders of the central nervous system and liver.

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Chronic Effects: There are conflicting reports on whether or not DDT produces chronic effects in humans. Although it is well established that chronic exposure in experimental animals produces effects including liver damage, CNS degeneration, dermatitis, weakness, convulsions, coma, and death, these effects are not confirmed in humans. Liver cancer is confirmed in animals, but has not been documented in humans. These conflicting reports appear due to the lack of documented chronic toxicity in workers and data showing that DDT and its metabolites are retained in the body fat for long time periods, thus providing a basis for the *possibility* of chronic toxicity.

Other: Solvents such as kerosine are added to DDT as a vehicle and, depending on the type involved, may be more toxic than DDT itself.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse away any loose material and wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting. Gastric lavage should be performed promptly.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Notes to Physicians: Effects may be delayed; keep under observation.

Special Precautions/Procedures: Amobarbital or pentobarbital is recommended for the relief of central neurological manifestations; tribromoethanol and paraldehyde are recommended for allaying prolonged convulsions.

Section 5 - Fire-Fighting Measures

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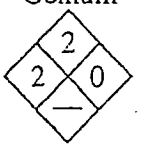

Flash Point: DDT itself is noncombustible but is dissolved in a variety of solvents. The average quoted Flash Point is 162 °F (72.2 °C) although the specific vehicle is not identified.

Flash Point Method: CC

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Flammability Classification: Class IIIA Combustible Liquid (varies depending on vehicle)

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire.

Hazardous Combustion Products: Chloride fumes and carbon oxide gases.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways. Fight fire from maximum distance. Stay away from ends of tanks.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural fire fighters' protective clothing is *not* effective.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against contamination.

Small Spills: For dry spills, carefully scoop up material or vacuum (with an approved filter). Damp mop any residue. For small solution spills, take up with earth, sand, vermiculite, or other absorbent material and place in suitable containers for disposal.

Large Spills

Containment: Dike far ahead of liquid spill for later reclamation or disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers. Keep dry chemical extinguishers on hand in case of fire.

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10). *Do not* store in aluminum or iron containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around DDT.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver and central nervous system.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA with a full facepiece and operated in pressure demand or other positive-pressure mode, or any supplied-air respirator with a full facepiece and operated in pressure demand or other positive-pressure mode with an auxiliary SCBA. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to gray crystals or powder which is odorless or has a slight aromatic odor.

Odor Threshold: 5.0725 mg/m^3

Vapor Pressure: 5.5 x 10^{-6} mm Hg at 68 °F (20 °C)

Formula Weight: 354.48

Specific Gravity (H_2O=1, at 4 °C): 0.98 to 0.99

Water Solubility: 0.0012 ppm

Other Solubilities (g DDT/100 mL): acetone 58, 95% alcohol 2, benzene 78, benzyl benzoate 42, carbon tetrachloride 45, chlorobenzene 74, cyclohexanone 116, dibutyl phthalate 33, o-dichlorobenzene 68, dichlorodifluoromethane 2, dioxane 100, ethyl ether 28, gasoline 10, isopropanol 3, kerosine 8 to 10, methylated naphthalenes 40 to 60, mineral oil 5, morpholine 75, peanut oil 11, pine oil 0 to 16, tetralin 61, tributyl phosphate 50, and xylene 60.

Boiling Point: 365 °F (185 °C)

Melting Point: 227 °F (108.3 °C)

Section 10 - Stability and Reactivity

Stability: DDT is stable at room temperature in closed containers under normal storage and handling conditions. It biodegrades very slowly.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong oxidizers, alkaline materials, iron and aluminum salts.

Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of DDT can produce carbon dioxide.

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects: None reported.

Skin Effects: None reported.

Acute Oral Effects:
Human, oral, LD_{Lo}: 500 mg/kg caused convulsions, cardiac arrhythmias, and respiratory changes.
Rat, oral, LD_{50}: 87 mg/kg; details not reported

Carcinogenicity: Rat, oral, TD_{Lo}: 1225 mg/kg given for 7 continuous weeks caused liver tumors.

Mutagenicity: *E. coli*: 15 µmol/L caused DNA damage.

Teratogenicity: Rat, oral, TD_{Lo}: 112 mg/kg given to a 56 day old male caused paternal effects (spermatogenesis, testes, epididymis, sperm duct).

* See NIOSH, *RTECS* (KJ3325000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Glass shrimp (*Palaemonestes kadiakensis*), LC_{50} = 2.3 mcg/L/96 hr at 69.8 °F (21 °C); Japanese quail, 2 month old male, (*Coturnix japonica*), LD_{50} = 841 mg/kg; bluegill (*Lepomis macrochirus*), LC_{50} = 28.7 mcg/L/36 hr.

Environmental Degradation: In water, DDT will adsorb strongly to sediments, significantly bioconcentrate in fish, and will be subject to considerable evaporation with an estimated half-life of several hr to almost 50 hr from certain waters. It may biodegrade when high concentrations of required microbes (*Escherichia*, *Hydrogenomonas*, and *Saccharomyces*) are present. On land, DDT will adsorb strongly and should not appreciably leach to groundwater. It may evaporate (half-life of 100 days) and is subject to photooxidation from soil. DDT may significantly biodegrade in flooded soils or under anaerobic conditions provided high populations of the required microbes are present. Half-life ranges from 2 to >15 yr. In the air, DDT is subject to direct photooxidation and reaction with photochemically produced hydroxyl radicals (est. half-life = 2 days). Wet and dry deposition are significant mechanisms for removal from air.

Section 13 - Disposal Considerations

Disposal: DDT is a good candidate for rotary kiln or liquid injection incineration (furnace with afterburner and alkali scrubber). 60 to 80% removal of DDT from contaminated soils has been achieved in 10 min. by super critical-carbon dioxide extraction. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Containers in good condition should be returned to the manufacturer and those that are not reusable should be punctured and transported to a scrap metal facility for recycling, disposal, or burial in a designated landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides, solid toxic, n.o.s.
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2761
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): —

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Number (40 CFR 261.33): U061
Listed as a RCRA Hazardous Waste Classification (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); and CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 167, 168, 169, 176, 180, 183

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Medical Review ..... T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Malathion
Chemical Formula: $(CH_3O)_2P(S)SCH(COOC_2H_5)CH_2COOC_2H_5$
CAS No.: 121-75-5
Synonyms: carbophos; Cythion; O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate; O,O-dimethyl-S-(1,2-dicarbethoxyethyl) phosphorodithioate; Maldison; mercaptothion
Derivation: Obtained from diethyl maleate and dimethyldithiophosphoric acid. **General Use:** As an insecticide for the control of mosquitoes, flies, spiders, animal ectoparasites, and human head and body lice. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Malathion, 99.6 % vol: technical grade; 25% and 50%: wettable powders
Trace Impurities: phosphorothioate and phosphorodithioate; malaoxon (crude grade impurity)

OSHA PELs, *Skin*	NIOSH REL, *Skin*	DFG (Germany) MAK
8-hr TWA :15 mg/m^3, total dust	10-hr TWA: 10 mg/m^3	Ceiling: 15 mg/m^3, total dust
Vacated 1989 Final Rule Limit: 8-hr TWA: 10 mg/m^3, total dust; 5 mg/m^3, respirable fraction	IDLH Level 5000 mg/m^3	ACGIH TLVs, *Skin* TWA: 10 mg/m^3*

* Biological Exposure Index for organophosphorus cholinesterase inhibitors: 70% of individual's baseline.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Malathion is a colorless (when pure) to light-amber liquid with a skunk-like or garlic odor. It is an anticholinesterase agent and severe intoxication causes profound pulmonary secretions and respiratory distress. Take the necessary precautions to prevent any exposure to malathion. It is absorbed through the skin and may produce systemic effects.

Wilson Risk Scale	
R	1
I	2
S	1*
K	1

* Skin absorption

HMIS	
H	2
F	1
R	1

PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin absorption.
Target Organs: Respiratory system, liver, blood cholinesterase, gastrointestinal tract, and central nervous and cardiovascular systems.
Acute Effects
Severe Intoxication by all Routes: Weakness, general twitching and paralysis, dizziness, confusion, staggering, slurred speech, sweating, irregular or slow heartbeat, convulsions, breathing may stop, and coma. **Inhalation:** Tightness of the chest, wheezing, increased pulmonary secretions, bluish discoloration of skin, small pupils, aching in and behind eyes, blurred vision, tearing, runny nose, headache, and watering of the mouth. **Eye:** Irritation.
Skin: Skin absorption causes sweating and twitching in area of absorption usually within 15 min to 4 hr. Weak skin sensitization and dermatitis may occur at high exposures.
Ingestion: Loss of appetite, nausea, vomiting, abdominal cramps, diarrhea within 2 hr.
Carcinogenicity: IARC, NTP, and OSHA do not list malathion as a carcinogen. IARC designates malathion as Group 3 (not classifiable as to carcinogenicity to humans).
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Repeated exposure to malathion may make a person more susceptible to the effects of organophosphates.
Comments: Malathion is an anticholinesterase agent which causes the inactivation of the enzyme cholinesterase resulting in the accumulation of acetylcholine at synapses in the neuromuscular system and secretory glands. It is less toxic to humans than most anticholinesterase agents because malathion and its metabolite, malaoxon, are metabolized in the liver to an inactive form. The acute lethal dose is estimated to be somewhat below 1.0 g/kg.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

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Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Thoroughly wash exposed area with soap and water. Do repeat soap washings. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting because of possible early onset of respiratory depression and seizures. Consider gastric lavage after control of any seizures.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Give 5 mg of atropine intravenously. Atropine may induce ventricular fibrillation in the presence of cyanosis. Repeat the dose of atropine at 5- to 10-minute intervals until signs of atropinization appear (dry, flushed skin, tachycardia as high as 140 beats/min, and pupillary dilatation). Repeat the dose of atropine if muscarinic symptoms appear. Maintain a mild degree of atropinization for at least 48 hr. Pralidoxime (2-PAM, Protopam) chloride is a cholinesterase reactivator that complements the action of atropine. For moderate-to-severe cases, give adults 1 to 2 g intravenously at a rate not in excess of 500 mg/min. A second dose of 1 g is indicated if muscle weakness has not been relieved, or if it recurs within 20 min. Pralidoxime chloride is ineffective after aging has occurred. Morphine, aminophyline, and phenothiazines are contraindicated. Depression in red blood cell cholinesterase in excess of 50% activity is generally associated with severe symptoms. Correlation between cholinesterase levels and clinical effects in milder poisonings may be poor. Individuals homozygous for the CHE gene display a defective serum butyrylcholinesterase and are particularly vulnerable to poisoning by organophosphorus insecticides.

Special Precautions/Procedures: Emergency personnel should protect against exposure when rescuing victims.

Section 5 - Fire-Fighting Measures

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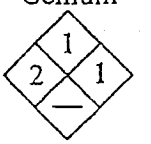

Flash Point: >325 °F (>163 °C)
Flash Point Method: OC
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Flammability Classification: Class IIIB Combustible Liquid, but may be difficult to ignite.
Extinguishing Media: Small fires: use dry chemical or carbon dioxide. Large fires: use water spray or foam.
Unusual Fire or Explosion Hazards: Containers may explode in the heat of fire.
Hazardous Combustion Products: Sulfur dioxide, phosphoric acid, phosphorus oxides, and carbon monoxide.
Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective. Wear chemically protective clothing specifically recommended by the manufacturer. Decontaminate equipment and clothing with a chlorine bleach solution.

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel of large spills, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel should protect against exposure. Fully-encapsulating, vapor-protective clothing (polycarbonate, butyl rubber, PVC, nitrile, Neoprene) is recommended.

Small Spills: Take up with sand or noncombustible absorbent material and place into containers for later disposal. For dry spills, scoop up with a clean shovel and place into a clean, dry container for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Decontaminate equipment and surfaces with an alkaline solution (5% sodium hydroxide).

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any contact with skin or vapor inhalation. Use only with adequate personal protective equipment and proper ventilation.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area. Outdoor or detached storage is preferred. *Do not* store in iron, steel, tin plate, lead, or copper containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Provide preplacement and periodic medical exam with emphasis on the respiratory system, liver, and blood cholinesterase levels. Biological Exposure Index (BEI): cholinesterase activity in red blood cells (timing is discretionary) is 70% of individual's baseline. Background levels are included in the BEI value. Consider precluding from exposure those

individuals whose red blood cell cholinesterase falls to or below 40% of the preexposure baseline until the activity returns to within 70% of the preexposure baseline. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations ≤ 100 mg/m^3, wear any supplied-air respirator, any SCBA, or any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations ≤ 250 mg/m^3, wear any supplied-air respirator operated in a continuous-flow mode; or any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations ≤ 500 mg/m^3, wear any self-contained breathing apparatus with a full facepiece or any supplied-air respirator with a full facepiece or any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter; or any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode. For concentrations ≤ 5000 mg/m^3, wear any supplied-air respirator operated in a pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Whole-body coveralls and chemically protective footwear are recommended. Wear protective eyeglasses or chemical safety, splash-proof goggles and face shields (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Colorless (when pure) to light amber with a skunk-like or garlic odor
Odor Threshold: 13.5 mg/m^3
Vapor Pressure: 1.25 x 10^{-4} mm Hg at 68 °F (20 °C); 4 x 10^{-5} at 86° F (30 °C)
Formula Weight: 330.36
Density (H_2O=1, at 4 °C): 1.23 at 77 °F (25 °C)
Water Solubility: Slightly soluble; 145 ppm at 20 °C
Other Solubilities: Alcohols, esters, ketones, ethers, vegetable oils, benzene, hexane, aromatic and alkylated aromatic hydrocarbons; limited solubility in paraffin hydrocarbons
Boiling Point: 140 °F (60 °C); decomposes
Freezing/Melting Point: 37.2 °F (2.9 °C)
Refraction Index: 1.4960 at 20 °C/D
Surface Tension: 37.1 dynes/cm at 75 °F (24 °C)
Octanol/Water Partition Coefficient: Log Kow=2.36

Section 10 - Stability and Reactivity

Stability: Malathion is stable in an aqueous solution buffered to pH 5.26. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Corrodes iron, steel, tin plate, lead and copper; will attack some forms of plastics, rubber, and coatings; and is also incompatible with strong oxidizers, magnesium, and alkaline pesticides. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Decomposition Products:** Thermal oxidative decomposition of malathion can produce sulfur dioxide, phosphoric acid, carbon monoxide, and phosphorus oxides. Malathion may isomerise at high temperatures and form the more toxic isomalathion. It starts to decompose at 140 °F (60 °C) and at > 212 °F (> 100 °C) it decomposes explosively.

Section 11- Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:
Rat, inhalation, LC_{50}: 84600 µg/m^3/4 hr

Acute Effects:
Woman, oral, LD_{Lo}: 246 mg/kg caused blood pressure lowering not characteristic in autonomic section, chronic pulmonary edema, and dermatitis.
Man, oral, LD_{Lo}: 471 mg/kg caused coma, blood pressure lowering not characteristic in autonomic section, and shortness of breath.
Rat, oral, LD_{50}: 290 mg/kg
Rat, skin, LD_{50}: > 4444 mg/kg

Reproductive Effects:
Rat, oral, 283 mg/kg administered to the female during 9 days of pregnancy caused specific developmental abnormalities of the urogenital system.

Genetic Effects:
Human, lymphocyte: 70 mg/L caused DNA inhibition.
Human, fibroblast: 5 mg/L caused sister chromatid exchange.

* See NIOSH, *RTECS* (WM8400000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Bluegill, fresh water, TLm, 96 hr: 0.09 ppm; Marine crustaceae, 96 hr: 0.033-0.083 ppm. Waterfowl, LD_{50}: 1485 mg/kg. **Environmental Fate:** A Koc of 280 has been estimated on the reported solubility of 145 ppm at 20 °C, vapor pressure of 4×10^{-5} mm Hg at 30 °C, and a Henry's law constant of 1.2×10^{-7} atm m^3/mol. **Environmental Degradation:** If released to water, malathion is subject to biodegradation and photodegradation at the surface and it may moderately absorb to sediment, but will not be expected to bioconcentrate in aquatic organisms. Volatilization from water should not be an important fate process. Hydrolysis in water may be an important fate process based on reported half-life range of 0.2 weeks at pH 8.0 to 21 weeks at pH 6.0. Products of hydrolysis include malaoxon; malathion, alpha and beta monoacid; O,O-dimethyl phosphorodithionic acid; diethyl fumarate; diethyl thiomalate; and O,O-dimethyl phosphorothionic acid. Iron catalyzes hydrolysis and humic substances accelerate photolysis. Persistence of malathion in water from 4 rivers ranged from 52% still present after 11 days to 21% after 14 days. Biodegradation may be an important fate process, especially in soils at pH <7 where the rate of hydrolysis may be slow relative to the rate of biodegradation. The major metabolite in soil is malathion beta monoacid. **Soil Absorption/Mobility:** Malathion will moderately bind to the soil and it will be subject to significant biodegradation and hydrolysis. Leaching is a viable route of transport in soil. Absorption is the best in high organic content, enhanced by the presence of metallic clays. The half-life in soil: 4 to average 6 days. **Analytical Method:** EPA Method 8141 is a gas chromatographic method used to determine malathion in ground water, soil, and non-water miscible waste.

Section 13 - Disposal Considerations

Disposal: Incinerate with flammable solvent in a furnace equipped with an afterburner and scrubber (permit-approved facility). Wastewater treatment technology: biological treatment and reverse osmosis. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. **Container Cleaning and Disposal:** Triple rinse containers and dispose of waste water as you would dispose of malathion unless it can be used for diluent.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organophosphorus pesticides, liquid, toxic, n.o.s.
Shipping Symbols:
Hazard Class: 6.1
ID No.: UN3018
Packing Group: I
Label: POISON
Special Provisions (172.102): N76, T42

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.201
c) Bulk Packaging: 173.243

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed*
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 311 (b)(4)
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

* Malathion may be classified as a RCRA Hazardous Waste, Characteristic of Corrosivity, because it corrodes steel. See 40 CFR 261.22 for specific criteria.

Section 16 - Other Information

References: 26, 73, 100, 101, 103, 124, 132, 136, 139, 140, 148, 153, 164, 167, 168, 174, 175, 176, 180, 183, 189, 190
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Section 1. Material Identification

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA
1 / 2 / 0 / –

HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift

TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5

Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	Autoignition Temperature: 464 °F (240 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] and NTP[169] list PCBs as an IARC probable carcinogen (overall evaluation is 2A: limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician. **Note to Physicians:** Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) **Exceptions:** 173.155
b) **Non-bulk Packaging:** 173.202
c) **Bulk Packaging:** 173.241

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 100 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** 34

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy MPH, CIH; **Medical Review:** AC Darlington, MD

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Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.
For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Strontium-90

Part 1 – Radioactive Material Identification

Common Names:	Strontium-90	**Chemical Symbol:**	Sr-90 or ^{90}Sr
Atomic Number:	38	**Mass Number:**	90 (52 neutrons)
Chemical Form:	Strontium metal	**Physical Form:**	A strontium compound incorporated on a ceramic insert or rolled silver foil.

Part 2 – Radiation Characteristics

Physical half-life: 28.6 years **Specific Activity (GBq/g):** 5,050

Principle Emissions	E_{Max} (keV)	E_{eff} (keV)	Dose Rate (mSv/h/GBq at 1 m)	Shielding Required
Beta* (β)	546 (100%) 2,283 (99.9%)[b]	196 935	9.65[a,c]	-
Gamma (γ) / X-Rays	-	-	-	-
Alpha (α)	-	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.
Note: Only emissions with abundance greater than 10% are shown.
[a] *The Health Physics and Radiological Health Handbook*, Scintra, Inc., Revised Edition, 1992
[b] This beta is produced by the yttrium-90 progeny, which quickly comes into equilibrium with the strontium parent.
[c] Total dose produced by strontium-90 in equilibrium with the yttrium-90 progeny.

Progeny: Yttrium-90 (Yt-90) {half-life: 64.4 hours; decay progeny: zirconium-90 (Zn-90)}

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with a thin-window, energy-compensated Geiger Mueller detector.
2. A radiation contamination monitor equipped with a Geiger Mueller pancake detector.

3. A radiation survey meter equipped with a plastic scintillator detector.

Dosimetry

Whole Body ☐	Skin ☑	Extremity ☑	Neutron ☐

Internal:	Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.	
Critical Organ(s):	Bone tissues	
Annual dose limits:	*Non-nuclear energy workers:*	1mSv per year
	Nuclear energy workers:	a) 50 mSv in one year b) 100 mSv total over five years
	Pregnant nuclear energy workers:	4 mSv over the balance of the pregnancy

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:	Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.
Personal Protective Equipment (*for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled).* No special PPE required.	
Special Storage Requirements:	None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
1,110	740	2.96×10^{-7}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

None identified at this time.

OSHA Permissible Exposure Limit (PEL)
No limits set at this time

Part 7 - Emergency Procedures

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, first treat the injury, second deal with personal decontamination.

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing (as situation requires)

Revision Date: December 17, 2001

This information was compiled by:

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Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.
For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Cesium-137

Part 1 – Radioactive Material Identification

Common Names:	Cesium-137	**Chemical Symbol:**	Cs-137 or ^{137}Cs
Atomic Number:	55	**Mass Number:**	137 (82 neutrons)
Chemical Form:	Cesium chloride	**Physical Form:**	A pellet of cesium ceramic housed in a welded stainless steel capsule

Part 2 – Radiation Characteristics

Physical half-life: 30.22 years **Specific Activity (GBq/g):** 3,220

Principle Emissions	E_{Max} (keV)	E_{eff} (keV)	Dose Rate (μSv/h/GBq at 1m)	Shielding Required
Beta* (β)	511 (94.6%)	157	-	-
Gamma (γ) / X-Rays	662 (89.9%)	-	103[a]	HVL Lead: 0.65 cm
Alpha (α)	-	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.
Note: Only emissions with abundance greater than 10% are shown.
[a] *The Health Physics and Radiological Health Handbook*, Scintra, Inc., Revised Edition, 1992

Progeny: Barium-137m (Ba-137m)

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with an energy-compensated Geiger Mueller detector.
2. Ion chamber survey meter – tends to be less sensitive than a Geiger Mueller survey meter but is able to respond more precisely in higher radiation fields.
3. Gamma scintillation detector – very sensitive but is also energy dependent. Must be calibrated for Cs-137 before it can be used for dose assessment surveys.

Dosimetry

Whole Body ☑	Skin ☐	Extremity ☐	Neutron ☐

Internal:	Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.	
Critical Organ(s):	None known at this time.	
Annual dose limits:	*Non-nuclear energy workers:*	1mSv per year
	Nuclear energy workers:	a) 50 mSv in one year
		b) 100 mSv total over five years
	Pregnant nuclear energy workers:	4 mSv over the balance of the pregnancy

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:	Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.
Personal Protective Equipment (*for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled).* No special PPE required.	
Special Storage Requirements:	None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
3700	7400	2.2×10^{-3}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

No potential health effects are known regarding non-radiological hazards associated with cesium. However, large oral doses of the material may cause gastrointestinal disturbances. Chronic effects are not known at this time.

OSHA Permissible Exposure Limit (PEL):

15 mg/m3 total dust, 5 mg/m3 respirable fraction for nuisance dusts

Part 7 - Emergency Procedures

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, first treat the injury, second deal with personal decontamination.

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing (as situation requires)

Revision Date: December 17, 2001

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Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.
For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Radium-226

Part 1 – Radioactive Material Identification

Common Names: Radium-226 **Chemical Symbol:** Ra-226 or ^{226}Ra

Atomic Number: 88 **Mass Number:** 226 (138 neutrons)

Chemical Form: Radium bromide or radium chloride **Physical Form:** A pellet or solution housed within a ceramic outer-housing.

Part 2 – Radiation Characteristics

Physical half-life: 1,603 years **Specific Activity (GBq/g):** 36.6

Principle Emissions	E_{Max} (keV)	E_{eff} (keV)	Dose Rate (µSv/h/GBq at 1m)	Shielding Required
Beta* (β)	-	-	-	-
Gamma (γ) / X-Rays	186 (32.8%)	-	3.3[a]	HVL Lead: 0.04 cm
Alpha (α)	4,785 (94.6%)	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.
Note: Only emissions with abundance greater than 10% are shown.
[a] *The Health Physics and Radiological Health Handbook*, Scintra, Inc., Revised Edition, 1992

Progeny: Radon-222 (Ra-222)

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with an energy-compensated Geiger Mueller detector.
2. A radiation contamination monitor equipped with a Geiger-Mueller pancake detector.
3. An ZnS(Ag) alpha scintillation detector – must be calibrated to a radium-226 standard before used for a dose assessment survey.

Dosimetry

Whole Body ☑	Skin ☐	Extremity ☐	Neutron ☐

Internal:	Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.
Critical Organ(s):	Bone tissue
Annual dose limits:	*Non-nuclear energy workers:* 1mSv per year *Nuclear energy workers:* a) 50 mSv in one year b) 100 mSv total over five years *Pregnant nuclear energy workers:* 4 mSv over the balance of the pregnancy

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:	Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.
Personal Protective Equipment *(for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled).* No special PPE required.	
Special Storage Requirements:	None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
74	22.2	1.11×10^{-5}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

None identified at this time.

<u>*OSHA Permissible Exposure Limit (PEL)*</u>
No limit set at this time

Part 7 - Emergency Procedures

*The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, **first** treat the injury, **second** deal with personal decontamination.*

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
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Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Silver
Chemical Formula: Ag
CAS No.: 7440-22-4
Synonyms: argentum
Derivation: Occurs naturally in sea water (0.01 ppm) and the earth's crust (0.1 ppm). Silver containing ores include argentite, stephanite, polybasite, proustite, pyrargyrite, and cerargyrite. Extraction of silver is essentially as a by-product of copper, lead, or zinc extraction and this accounts for 3/4 of its production. The two main production methods are *slime melting* from electrolytic refining of copper and the *Parkes process* from lead and zinc ores.
General Use: Used in the manufacture of jewelry, tableware, ornaments, mirrors, electrical contacts, batteries, solder; in photography, dental amalgams; as a sterilant, for water purification, and as a coating for the inside of light bulbs (sandwiched between two layers of titanium oxide).
Vendors: Consult the latest *Chemical Week Buyers' Guide.* [73]

Section 2 - Composition / Information on Ingredients

Silver, ca 100 % wt. 97.5 % silver + 2.5 % copper = *sterling* silver.

OSHA PEL 8-hr TWA: 0.01 mg/m^3	DFG (Germany) MAK TWA: 0.01 mg/m^3 (total dust) Category III: Substances with systemic effects
ACGIH TLV TWA: 0.1 mg/m^3	Onset of Effect: > 2 hr Half-life: > shift length (strongly cumulative)
NIOSH REL 10-hr TWA: 0.01 mg/m^3	Peak Exposure Limit: 0.1 mg/m^3, 30 min. average value, 1/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Silver exists as a hard, brilliant white, malleable metal. It is noncombustible as a solid, but the finely divided powder is flammable. Silver has no known function in man and appears to have low toxicity other than a localized or general bluish-gray pigmentation of the mucous membranes, eyes, and skin due to deposition of silver particles over a period of time. The condition called *argyria* appears to be more of a cosmetic problem than a toxicological concern.

Wilson Risk Scale	
R	1
I	4
S	1
K	0

HMIS	
H	1*
F	0
R	0

*Chronic effects
PPE †
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.
Target Organs: Skin, eyes (especially the conjunctiva), and mucous membranes.
Acute Effects
Inhalation: Heavy exposure of a worker to heated metallic silver vapor for 4 hr caused lung damage and pulmonary edema (fluid in lungs). Diffuse pulmonary fibrosis is also possible.
Eye and Skin: Effects are generally chronic.
Carcinogenicity: IARC, NTP, and OSHA do not list silver as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: The main effect associated with exposure to silver is argyria, a bluish-gray pigmentation of the eyes, skin, and mucous membranes caused by deposition of silver particles. This effect can be either local or generalized. It appears that localized deposition occurs by penetration of fine, metallic particles and that generalized argyria occurs from inhalation or ingestion of silver salts. It is estimated that a gradual intake of 1 to 5g silver will lead to generalized argyria. Generalized argyria appears to be darker in areas exposed to the light. Silver deposition in the respiratory tract may result in a mild chronic bronchitis. Silver polishers exposed for long periods to silver and polishing dusts have developed increased lung densities (shown by x-ray). Argyria of the eyes is not accompanied by vision loss although there may be some difficulty adapting to the dark. There is some evidence for skin absorption; amalgam tattoos (accidental implantation of dental amalgams) caused fatigue, headache, sinusitis, and weight loss. Repeated skin contact may cause allergic contact dermatitis in some individuals.
Other: The reason that silver toxicity rarely occurs beyond argyria is due to rapid binding to various proteins and precipitation of silver chloride. Tissue damage only occurs when this binding ability is altered by a heavy dose. Kidney, liver, and neurologic damage has been associated with silver, but these cases are not well documented.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material and move quickly to a soap and water wash.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Silver deposited in tissues is relatively inert and does not respond well to chelation therapy. There is no known treatment for argyria. Background serum levels of silver vary widely: 0.004 mcg/g to 0.03 mcg/g of blood. Discoloration of Descemet's membrane is the most sensitive indicator of chronic exposure to silver. Background excretion is 8 to 28 nmol/L. In one study, the urinary enzyme, N-acetyl-ß-D glucosaminidase was significantly elevated and correlated with blood silver concentrations and age. It may be an indicator of exposure.

Section 5 - Fire-Fighting Measures

Flash Point: Noncombustible as the solid.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Silver fumes.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.
* Flammable when in highly divided powder form.

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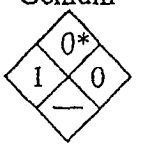

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area. Cleanup personnel should protect against inhalation and skin/eye contact with dusts.
Spills: Carefully scoop up spill and place in sealed containers for reclamation.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Wear appropriate PPE to avoid inhalation or skin/eye contact with silver dusts.
Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: No special controls needed.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, eyes, and mucous membranes (for presence of argyria).
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 0.25 mg/m^3, use any supplied-air respirator (SAR) operated in continuous-flow mode or any powered, air-purifying respirator with a high-efficiency particulate filter. Use eye protection when necessary. For ≤ 0.5 mg/m^3, use any high-efficiency particulate filter respirator with a full facepiece, any SCBA with a full facepiece, or any SAR with a full facepiece. For ≤ 20 mg/m^3, use any SCBA or SAR (with auxiliary SCBA) with a full facepiece and operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove silver from your shoes and clean personal protective equipment. *Do not* shake dust off contaminated clothing; vacuum with a HEPA filter.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using silver, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Hard, brilliant white, lustrous, ductile, malleable metal; odorless.
Vapor Pressure: 0 mm Hg at 77 °F (25 °C), 100 mm Hg at 3389 °F (1865 °C)
Atomic Weight: 107.868
Density: 10.5 g/mL
Thermal Conductivity: 101 cal/cm/sec/ °C
Water Solubility: Insoluble
Other Solubilities: Insoluble in most cold acids except dilute nitric acid. Reacts with hot, concentrated sulfuric acid. Soluble in fused alkali hydroxides in the presence of air, fused alkali peroxides, and in alkali cyanides in presence of air or oxygen.
Boiling Point: 4013 °F (2212 °C)
Melting Point: 1763 °F (961 °C)

Section 10 - Stability and Reactivity

Stability: Silver is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Include acetylene and acetylenic compounds (forms explosive silver acetylides), aziridine, bromine azide, 3-bromopropyne, carboxylic acids, copper + ethylene glycol, electrolytes + zinc, ethanol + nitric acid, ethylene oxide, ethyl hydroperoxide, iodoform, ethyleneimine, peroxomonosulfuric acid, and peroxyformic acid. Silver is flammable by chemical reaction with ammonia, chlorine trifluoride, ethylene imine, hydrogen peroxide, oxalic acid, and tartaric acid. It turns black (tarnishes) on contact with ozone, sulfur, or hydrogen sulfide.
Conditions to Avoid: Contact with incompatibles.
Hazardous Decomposition Products: Silver fumes will be given off when heated.

Section 11- Toxicological Information

Toxicity Data:*

Carcinogenicity: Rat, multiple routes: 330 mg/kg/43 weeks (intermittently) caused tumors at site of application.

* See NIOSH, *RTECS* (VW3500000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Sticklebacks, LD_{50} = 0.004 mg/L/168 hr; sticklebacks, LD_{50} = 0.1 mg/L/24 hr. Although silver accumulates in body tissue it does not appear to bioaccumulate through the food chain (no magnification at higher trophic levels).
Environmental Degradation: In water, silver will undergo absorption by manganese dioxide and precipitation with halides.

Section 13 - Disposal Considerations

Disposal: Return silver and silver-containing solutions from photography and x-rays to supplier for reclamation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Shipping Name:
Environmentally hazardous substances, solid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54, N50

Packaging Authorizations
a) **Exceptions:** 173.155
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** None
b) **Cargo Aircraft Only:** None

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** —

* Classified as a hazardous substance when silver is in a quantity, in one package, which equals or exceeds the RQ of 1000 lb (454 kg)

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Classification (40 CFR 261.24): D011, Characteristic of Toxicity (regulatory level = 5 mg/L)
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1000 lb (454 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 167, 176, 187, 189
Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... T Thoburn, MD, MPH
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Section 1 - Chemical Product and Company Identification 48

Product/Chemical Name: Strontium carbonate
Chemical Formula: $SrCO_3$
CAS Number: 1633-05-2
Synonyms: carbonic acid, strontium salt; strontianite
Derivation: Celestite ore is boiled with a solution of ammonium carbonate or is fused with sodium carbonate.
General Use: Used in pyrotechnics, manufacture of iridescent glass, refining sugar, manufacture of ceramic ferrites, glass face plates for color TV tubes; as a chemical intermediate for strontium nitrate, lead scavenger in zinc production, and as flux in production of high-grade alloy steels.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Strontium carbonate, ca > 99 % wt
Trace Impurities: May contain trace amounts of barium carbonate, sulfur, calcium carbonate, magnesium, sodium, silica, or iron.

OSHA PEL*	ACGIH TLV*	NIOSH REL	DFG (Germany) MAK
8-hr TWA: 15 mg/m^3 (total dust); 5 mg/m^3 (respirable fraction)	TWA: 10 mg/m^3†	None established	None established

* As nuisance particulates (not otherwise classified)

† Notice of intended change to 10 mg/m^3 (inhalable) and 3 mg/m^3 (respirable)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Strontium carbonate exists as a colorless to white, odorless powder. It has very low order of toxicity due to its poor absorption via the respiratory and gastrointestinal tracts. Ingestion of large amounts may cause nausea and vomiting. It is noncombustible.

Wilson Risk Scale	
R	1
I	1
S	1
K	1

HMIS	
H	1
F	0
R	0
PPE*	

*Sec. 8

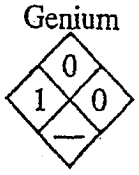
Potential Health Effects

Primary Entry Routes: Inhalation, ingestion.
Target Organs: Gastrointestinal tract, teeth; and bones (animals).
Acute Effects
Inhalation: May cause mechanical irritation of the respiratory tract.
Eye: May cause mechanical irritation.
Skin: May cause mechanical irritation.
Ingestion: Ingestion of large amounts may cause excessive salivation, nausea, vomiting, diarrhea and colic.
Carcinogenicity: IARC, NTP, and OSHA do not list strontium carbonate as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: Strontium in drinking water (13 mg/L) has been shown to cause mineralization of bones and teeth in 1 yr olds. It is not known whether deposition in teeth and bone could be a potential hazard from industrial exposure. Animals chronically exposed to strontium have developed strontium "rickets" (malformation of bone during growth from failure to use calcium and phosphorus normally). Workers in strontium salt plants were reported with decreased cholinesterase activity levels.(190)

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with plenty of water. Consult a physician or ophthalmologist immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water followed by a thorough soap and water wash. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treatment is symptomatic and supportive.

Section 5 - Fire-Fighting Measures



Flash Point: Noncombustible.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Carbon dioxide and strontium oxide.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.
Small Spills: Carefully scoop up or vacuum (with HEPA filter) and place in suitable containers.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Cleanup: Damp mop any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use sufficient ventilation to prevent build-up dusts. Cleanup personnel should protect against inhalation.
Storage Requirements: Store in a cool, dry, well-ventilated area away from heat sources.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: No special engineering controls are necessary.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2) for nuisance dusts. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: No specific controls recommended.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove strontium carbonate from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using strontium carbonate, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless to white powder, odorless.
Formula Weight: 147.64
Density (H_2O=1, at 4 °C): 3.5 g/cm^3
Water Solubility: 11 g/L at 18 °C
Other Solubilities: Soluble in dilute acids and ammonium salts.
Melting Point: 2727 °F (1497 °C) at 69 atm; decomposes at 2012 °F (1100 °C) into strontium oxide and carbon dioxide.
Refractive Index: 1.516, 1.664, 1.666

Section 10 - Stability and Reactivity

Stability: Strontium carbonate is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: None reported.

Conditions to Avoid: Excessive heat.
Hazardous Decomposition Products: Thermal oxidative decomposition (at 1100 °C) of strontium carbonate can produce carbon dioxide and strontium oxide.

Section 11 - Toxicological Information

Toxicity Data: Not listed by RTECS*

* Monitor NIOSH, *RTECS* for future toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Data not found.
Environmental Fate: Data not found.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 136, 190, 197, 209

Prepared By .....M Gannon, BA
Industrial Hygiene Review .....PA Roy, MPH, CIH
Medical Review .....R Teichman, MD

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Section 1. Material Identification

33

Vanadium Metal/Powder (V) Description: Occurs ubiquitously in the earth's crust. Its principle ores are patronite, roscoelite, carnolite, and vanadinite. There are more than 65 different vanadium-containing ores. Also found in crude petroleum, in flue-gas deposits from oil-fired furnaces, or in slags from ferrovanadium production. Vanadium production includes roasting ores and electrolytic refining using a molten salt electrolyte containing vanadium chloride. Used to manufacture rust-resistant vanadium steel, alloy steels, vanadium compounds; as a target material for x-rays; and as a catalyst for sulfuric acid and synthetic rubber.

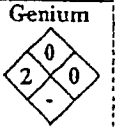
Other Designations: CAS No. 7440-62-2

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Vanadium is a primary irritant of the mucous membranes of the respiratory tract and the conjunctiva (eye).

R	0
I	4
S	1
K	0

Genium



HMIS
H 2
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Vanadium, ca 100%

1989 OSHA PEL
Vanadium, as V_2O_5, Respirable Dust and Fume
8-hr TWA: 0.05 mg/m^3

1990-91 ACGIH TLV
Vanadium, as V_2O_5, Respirable Dust and Fume
TWA: 0.05 mg/m^3

1985-86 Toxicity Data*
Human, inhalation, TD_{Lo}: 4 µg/kg; affected the lungs, thorax, or respiration (sputum, cough); and sense organs and special senses (changes in circulation)

1987 IDLH Level
Vanadium Pentoxide Dust or Fume (as V)
70 mg/m^3

1988 NIOSH REL
Vanadium, as V_2O_5, Respirable Dust and Fume
15-min Ceiling: 0.05 mg/m^3

* Monitor NIOSH, *RTECS* (YW1630000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 6116 °F (3380 °C)
Melting Point: 3434 + 10 °F (1890 + 10 °C)
Vapor Pressure: 1.5 mm Hg at 4172 °F (2300 °C)
Atomic Weight: 50.92
Specific Gravity: 5.96
Water Solubility: Insoluble in hot or cold water

Appearance and Odor: Light gray powder or white, lustrous bulk solid; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature:* layer 914 °F (490 °C), cloud 932 °F (500 °C)	LEL: 0.22 oz/ft^3*	UEL: None reported

Extinguishing Media: Use dry chemical powder or CO_2 to extinguish a metal fire.

Unusual Fire or Explosion Hazards: Very hot vanadium can burn in air. When dispersed in air as dust, it can be exploded by an ignition source.* However, it has a low explosibility index (0.1) and low ignition sensitivity (0.3) on a scale of 10.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective gear. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

* Vanadium metal dust whose particle size is 100% below 75 µm. Reported minimum ignition energy is 60 mJ for dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Vanadium is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Massive metal is relatively inert to O_2, N_2, H_2, and H_2O at ambient conditions, but vanadium reacts when heated, and still more readily if powdered. When heated in air, vanadium oxidizes to brownish-black trioxide, blue-black tetroxide or yellow-red pentoxide, depending on temperature.

Chemical Incompatibilities: Vanadium is incompatible with bromine trifluoride, chlorine, nitryl fluoride, lithium, and oxidants. Some samples of vanadium prepared by magnesium reduction of vanadium dichloride or vanadium trichloride are pyrophoric (ignite spontaneously).

Conditions to Avoid: Avoid creating airborne dusty conditions.

Hazardous Products of Decomposition: Thermal oxidative decomposition of vanadium can produce toxic fumes of vanadium oxides (VO_x).

Section 6. Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list vanadium metal powder as a carcinogen.
Summary of Risks: Elemental vanadium is considered relatively nontoxic and the risks noted in mining operations are usually limited. However, toxic vanadium compounds form easily with the addtion of heat, and may be present in many occupational settings. Vanadium compounds ar very irritating to mucous membranes including the respiratory tract. Although no specific lesions are noted, inflammation of all portions of ti airways, as well as pulmonary edema, pneumonia, and emphysema are described. The presence of vanadium compounds in areas where residue from the burning of fuel oil may accumulate presents particular problems with unrecognized risk.
Medical Conditions Aggravated by Long-Term Exposure: No permanent effects are reported, but respiratory symptoms may persist for years.
Target Organs: Respiratory system, skin, and eyes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: *Skin*: eczema-like reaction with intense itching. Sensitization or generalized hives may occur. Green discoloration of the hands and groin area is noted. *Eyes*: severe irritation with burning and tearing may occur. *Airway*: nasal congestion, throat irritation, dry mouth, green discoloration of the tongue, metallic taste, coughing, bronchitis, pneumonia, chest pain, and pulmonary edema are noted. *Cardiovascular*: constriction of blood supply to the lungs, spleen, kidneys, and intestines. *CNS*: headaches, decreased constriction mentation in severe exposures. *GI*: diarrhea, black stools, cramping.
Chronic Effects: The lung effects may last up to two weeks following exposure. Skin and tongue discoloration may develop gradually.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Notes to Physician: Include diagnostic tests such as vanadium in urine (normal <1 μg/g creatine), patch (eczema), and pulmonary function (FEV_1 and FVC).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For concentrations less than or equal to 70 mg/m^3, use a powered air-purifying respirator with full facepiece and high-efficiency particulate filter. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks) or concentrations >70 mg/m^3, wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations just below the exposure limits (Sec. 2). Exhaust ventilation systems discharging to outside air must conform with applicable local, state, and federal air pollution regulations. Ventilation systems need to be cleaned and their effectiveness tested with airflow measurements taken at least every 3 months. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area. Protect containers from damage. Use good housekeeping practices to prevent accumulation of dust and follow cleaning techniques that minimize airborne particulate.
Engineering Controls: Avoid dust, vapor, or fume inhalation when generated. Prevent contact with eyes and skin. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and periodical medical examinations that emphasize the eyes, skin, and lungs. For biological monitoring of exposed workers use urinary vanadium excretion. Include pulmonary function tests in periodical medical examinations.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 2-10, 12, 14, 20, 26, 40, 41, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 146
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: W Silverman, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 73
Zinc Metal/Powder

Issued: 7/80 Revision: A, 11/89

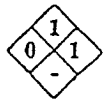
Section 1. Material Identification

30

Zinc Metal/Powder Description: A metallic element extracted from ores which are first roasted to form zinc oxide and then: 1) the zinc oxide is leached from the roasted material with sulfuric acid to form a zinc sulfate solution which is electrolyzed in cells to deposit zinc on cathodes and 2) the zinc oxide is reduced with carbon in retorts (distilling vessels) to yield distilled and condensed zinc. Used as ingredient in alloys such as brass, bronze, and die-casting alloys; galvanizing sheet iron; for electrical apparatus, especially castings, building materials, dry cell batteries, automotive equipment, household utensils, railroad car linings; as a fungicide; in nutrition (essential growth element); as reagent in analytical chemistry; in bleaching bone glue, manufacturing sodium hydrosulfite, and insulin zinc salts.
Other Designations: Blue powder; spelter; granular zinc; jasad; merrillite; pasco; Zn; CAS No. 7440-66-6.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R	1
I	1
S	1
K	1

NFPA



HMIS
H 0
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Zinc metal/powder, ca 99%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
None established*	None established*	None established*	Human, inhalation, TC_{Lo}: 124 mg/m³/50 min, pulmonary system effects

* The current OSHA standard and ACGIH (1989-1990) TWA for zinc oxide (ZnO) fumes is 5 mg/m³. The ACGIH TWA for zinc oxide dust is 10 mg/m³, providing that total contains no asbestos and is <1% crystalline silica. NIOSH has recommended a 10-hr TWA of 5 mg/m³ and a ceiling level of 15 mg/m³ (15-min sample) for zinc oxide fume. The TLV-TWA level was set to prevent metal fume fever.
† See NIOSH, *RTECS* (ZG8600000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 907 °F (1663 °C)
Melting Point: 419 °F (787 °C)
Vapor Pressure: 1 mm Hg at 909 °F (487 °C)
Brinell Hardness: 31
Atomic Weight: 65.37 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.13 at 77 °F (25 °C)
Water Solubility: Insoluble
Index of Explosibility, Zn Powder (<0.1 weak, >10 severe): 0.1

Appearance and Odor: Bluish-white lustrous metal, also finely divided forms.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Cloud, 1256 °F (680 °C);* dust layer, 860 °F (460°C);* powder, 650 mJ* **LEL:** Dust cloud explosion, 0.5 oz/ft³ **UEL:** None reported

Extinguishing Media: Use special dry chemical or clean dry sand. *Never* use CO_2. Using a direct stream of water may scatter the fire or disperse dust, creating a potentially explosive mixture if exposed to heat or ignition sources. A water spray may be used to cool fire-exposed containers and disperse vapors.
Unusual Fire or Explosion Hazards: Flammable hydrogen gas is liberated by reaction with alkali hydroxides (sodium, potassium, and calcium hydroxides), acids, or even water (when material is in dust form) and is an explosion hazard in a confined space. In a fire, zinc may melt, vaporize, and burn to form ZnO fumes (Sec. 2).
Special Fire-fighting Procedures: For major fires, or if large quantities of this material are involved, fire fighters should wear appropriate protective clothing and respiratory protection. Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Zinc dust refers to the product of zinc vapor condensation, and zinc powder to the product of molten zinc atomization (*Zinc Dust and Zinc Powder: Their Production, Properties, and Applications,* B.C. Hafford, W.E. Pepper, and T.B. Lloyd, 1982). Dust 100% thru 74-µm sieve; a 0.96-J spark can ignite a cloud. The ignition temperature in CO_2 is 896 °F (480 °C). The reaction temperature in a nitrogen atmosphere is 1112 °F (600 °C).

Section 5. Reactivity Data

Stability/Polymerization: Zinc is stable in dry air at room temperature. Moist zinc dust can react exothermically and ignite spontaneously in air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Zinc dust is an explosion hazard when reacted with acids, chlorates, oxidizing agents (sulfur and oxygen), halogenated hydrocarbons, hydrazine mononitrate, hydroxylamine, ammonium nitrate, barium dioxide, barium nitrate, cadmium, performic acid, manganese chloride, nitric acid, ethyl acetoacetate and tribromoneopentyl alcohol, tellurium, carbon disulfide, lead azide, magnesium and barium nitrate and barium dioxide, selenium, sodium peroxide, potassium nitrate, and water. In humans, a toxic effect results from inhaling 124 mg/m³ of zinc metal/powder for 50 min.
Hazardous Products of Decomposition: Thermal oxidative decomposition of zinc can produce highly toxic fumes. Above 999 °F (537 °C) vaporized zinc burns in air with a blue-green flame to produce zinc oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists zinc as a carcinogen.
Summary of Risks: Zinc is relatively nontoxic, but when combined with other materials such as oxygen or mineral acids, the resulting compounds can have toxic effects. It is not readily absorbed through the skin, gastrointestinal (GI tract), or lungs. Although most inorganic zinc compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Zinc is considered essential to life. Ingestion of soluble salts may cause nausea and vomiting, sluggishness, and light-headedness. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause *metal fume fever*, which is accompanied by throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching that generally passes within 24 hr. These symptoms usually begin 3 to 10 hr after exposure and resolve within 24 to 48 hr. Inhalation of zinc dust may cause mild irritation to the upper respiratory tract. Prolonged skin contact with zinc may cause a mild, drying dermatitis.
Medical Conditions Aggravated by Long-Term Exposure: Since metallic zinc particulates can be considered a niusance dust, repeated inhalation of zinc dust could lead to respiratory complications.
Target Organs: Respiratory system.
Primary Entry: Inhalation, ingestion.
Acute Effects: Metal fume fever is an acute, self-limiting condition, without recognized complications, aftereffects, or chronic forms. Symptoms appear several hours after exposure. Removal from exposure normally alleviates symptoms with no residual or chronic effects. A degree of tolerance may result from continued exposure, but is quickly lost after a day or two of nonexposure.
Chronic Effects: Zinc and zinc powder have little history of causing chronic effects.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. **Physician's Note:** Calcium disodium edetate ($CaNa_2$-EDTA) has been used medically to increase the rate of zinc removal from the body; however, this usually results from chronic fume exposure or exposure to zinc salts, not to zinc metal powders.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Eliminate all heat and ignition sources. Cleanup personnel should protect against dust inhalation and eye contact. Use nonsparking tools for cleanup. Sweep or otherwise place the spilled material in an appropriate, pressure-vented, dry-metal container (with lid) for later disposal. Container should be pressure vented. Avoid creating airborne dust conditions.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Zinc (fume or dust) is listed as SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: For zinc oxide dust or fume concentrations up to 50 mg/m^3 and 250 mg/m^3, use, respectively, a fume (high-efficiency particulate) respirator or an air-supplied or self-contained respirator with a full facepiece. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below established TLVs-TWAs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. Wash thoroughly before changing to street clothes.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in covered metal containers in a dry, well-ventilated, low fire risk area. Protect containers from physical damage. Never store with acids, halogenated hydrocarbons, or strong alkalis.
Engineering Controls: Avoid breathing dust or fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide suitable training in personal hygiene and in the cause and effect of metal fume fever. Prevent exposure of workers with respiratory problems or gastrointestinal disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Zinc, powder or dust, nonpyrophoric	**IMO Shipping Name:** Zinc, powder or dust, pyrophoric
IMO Hazard Class: 4.3	**IMO Hazard Class:** 4.2
IMO Label: Dangerous when wet	**IMO Label:** Spontaneously combustible
IMDG Packaging Group: II	**IMDG Packaging Group:** II

MSDS Collection **References:** 2, 4-11, 24, 31, 39-41, 80, 81,84,85,91, 109
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

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ATTACHMENT 2

ACTIVITY HAZARD ANALYSES

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to remove the vegetation that exists within the limits of work. Initially, mechanical equipment will be used to cut the overgrown vegetation. Mechanical equipment may include, but is not limited to, excavators, backhoes, tractors, mowers, chipper/shredders, brush hog, tub grinders, and similar equipment. Hand-operated weed-eaters/whackers, chainsaws, or similar equipment typically used for vegetative removal will be used to clear the vegetation growing over areas that are sloped, uneven, bumpy, or too densely vegetated to allow for mechanical equipment access.		
1. Drive equipment transport vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively, and be aware of police and fire emergency vehicles around shipyard.
2. Inspect work area.	Failure to inspect work area may result in trips and falls from the same level.	Ensure that work area is free from potential trip hazards and that only a minimum of authorized personnel are permitted in the work zone.
3. Inspect first aid kit, eye wash station and fire extinguisher.	Failure to have proper medical supplies during emergency could result in inadequate treatment of personnel or potentially increase injuries.	Ensure that first aid kit contains all necessary supplies and that eye wash station is capable of supplying a 15-minute steady supply of solution.
4. Conduct daily inspection of equipment.	Failure to conduct daily inspection of equipment may cause injury to personnel and or property damage.	Ensure that all operating components, parts, systems, and mechanisms will operate as intended and inspected by a qualified person. Ensure that a copy of the inspection is available and on file.
5. Unload equipment and materials.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
6. Perform site work.	Local vehicle traffic could strike and injure surveyors.	Ensure all individuals participating in the survey wear reflective vests. Workers will not work in street areas unless flaggers, signs, barricades and/or cones are used.

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Contact with radioactive material.	Wear appropriate protection as defined in the RWP or recommendation of a RCT and concurrence with CHP, SHSS and the PESM. Ensure that good hygiene practices are followed such as washing thoroughly prior to eating meals.
	Workers could interact with nearby residents, other tenants and local civilians.	Notify police if nearby civilians threaten planned operations. Avoid wearing respirators or Tyvek coveralls outside of the building. Post a guard (or watch person) at entrance to worksite.
	Exposed to dust, potentially biologically contaminated dust, radioactive airborne particulates, chemically contaminated dust, and asbestos-contaminated dust.	Minimize the area that is to be disturbed for sampling. Wear level C PPE to include coveralls, nitrile gloves, full-face respirator with P-100 cartridges and/or PPE specified in the RWP and HSP. Coordinate requirements with SHSS, CHP and CIH. Minimize generation of dust (use a mist of deionized water for dust suppression). (Add to this AHA any specific tool handling and associated hazards and controls.)
7. Locate utilities.	Failure to identify underground, as well as overhead hazards may result in personal injury and or property damage.	Ensure that USA has identified all underground utilities prior to any clearing or grubbing. The contact number for northern California is 1-800-642-2444.
	See AHA on Utility Locates	
8. Sample vegetation within limits of work.	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified in the this AHA and the RWP. Remove PPE properly and wash hands. Avoid pulling up of roots or disturbing ground surface when cutting plants.
9. Pack samples for shipment.	Manually moving materials and equipment could cause strains.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck when handling more than one box at a time. Try to pack shipping boxes so that each box does not exceed 50 pounds. For loads greater than 50 pounds, use two people to carry.

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Contents of sample containers could leak, causing exposure to worker and possibly to people handling shipping box.	Ensure that each container top is securely tightened. Pack each container in a manner to prevent damage to container during handling of shipping box and during transportation. Ensure that boxes meet required packaging standards based on mode of transportation used for shipping.
10. Inspect equipment.	Improper inspection of equipment could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that a competent person inspects equipment before use and at start of each shift, and that equipment is in safe operating condition. Tag "out of service" and remove from service faulty or unsafe equipment. If applicable, verify that emergency shutdown system is clearly marked and location is known by all site workers. Verify that shutdown system works properly when trip wire is pulled or pushed. Operator's manual must be available and reviewed prior to operation.
11. Clear vegetation with mechanical equipment.	Failure to review site layout plan could cause exposure to potential hazards such as electrocution or tipping equipment over in unstable soil conditions.	Do not move equipment into any work area until site layout plan has been completed and route of travel to worksite has been assessed for hazards (overhead lines, stability of roads and ground, etc.). At pre-activity safety briefing, discuss site layout plan and analysis of travel route, along with AHAs. Do not place equipment within 15 feet of any overhead electrical lines. Use a spotter for positioning as necessary.
	Worker could become pinned between or under equipment components.	When any part of equipment is in motion, stand far enough away from moving parts to avoid being pinned between moving parts. If work must be done under equipment, SHSS must be contacted to ascertain a safe method for lockout of equipment to ensure that adequate blocking is installed.
	High winds could destabilize equipment.	Check weather conditions and forecasts to determine if conditions are acceptable for use of equipment. Do not operate equipment if winds exceed manufacturer's recommended tolerances.
	Worker could be exposed to noise.	Wear earplugs whenever equipment is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts as gloves or clothing may become entangled in the moving part.)
	Workers could place hands into moving parts of equipment, or loose clothing or long hair could become entangled in moving machine parts.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing, long hair, or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of dangerous parts of equipment before starting or engaging equipment.
	Electrocutions, explosions, etc. could occur.	Obtain and examine copies of all pertinent drawings prior to performing this task. Inspect the area for overhead obstructions. Contact service facility engineer before working near utilities.

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Refueling may cause spills and fire.	Refuel equipment on a level surface after engine has cooled. Refuel only in designated areas. Do not smoke while refueling.
	Operation of equipment may cause debris to fly out from the decking area.	Wear proper PPE including hearing protection. Ensure other individuals maintain safe distances while equipment is in operation. Ensure equipment checks are completed daily and follow manufacturer guidelines.
	Mower and or towing unit for brush hog may tip over while being operated.	Never ride or pull equipment along the horizontal plane of a steep slope. Ride perpendicular to the grade. Operate at safe speeds. Be observant for pits, depressions, large rocks and any other object that can destabilize equipment.
	Worker could be exposed to chemical or radiological contaminants via dust, root balls, etc.	Wear PPE and respiratory protection as specified in this AHA and the RWP. Survey and decontaminate equipment after use. Avoid exposure to dust. Use dust control as necessary and possible. Dispose of cleared vegetation and used PPE properly.
12. Clear vegetation with hand-operated equipment.	Carrying and using equipment could cause injury to lower back.	Bend knees and use proper posture and back support while using hand-operated mechanical equipment to clear vegetation.
	Using equipment over long periods of time could cause muscle strain.	Maintain steady pace and follow rest periods given on job. Select a position during clearing activities to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward positions; repetitive forceful motions; or excessive gripping, pinching, or pressing.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Barricade and mark area of activity for visibility. If necessary, perform traffic controls in accordance with the Traffic Control Plan.
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified in the this AHA and the RWP. Remove PPE properly and wash hands. Survey and decontaminate equipment after use. Avoid exposure to dust. Use dust control as necessary and possible. Dispose of cleared vegetation and used PPE properly.
	Worker could be exposed to noise.	Wear earplugs whenever equipment is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts as gloves or clothing may become entangled in the moving part.)

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Workers could place hands into moving parts of equipment, or loose clothing could become entangled in moving parts.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of equipment before starting or engaging equipment. Long hair will be put under the hard hat so it does not get entangled in equipment.
	Chain saws can be hazardous if operated incorrectly.	Prior to operating a chain saw, ensure that the operator has read the operator's manual, and is familiar with its operation. Ensure that the saw has not been 'rigged' to stay in the on position ---saw must automatically shut off when the trigger is released. While operating chain saw, ensure that the operator does not operate saw above shoulder height, is wearing leg protection, a face shield, and with hearing protection. Operator must be standing on firm ground and must watch footing. Refuel saw in designated area only and only after it is turned off and allowed to cool. Never handle the chain unless wearing cut resistant gloves and ensure that saw has been turned off and is disconnected from power source or spark plug wire is removed.
13. Load and haul materials.	Workers could be struck by limbs, branches, etc.	Do not walk under suspended loads. Ensure that waste material is compatible and acceptable for proper disposal.
14. Survey green waste or debris pile.	Workers could be exposed to potentially radioactive dust.	Minimize the area that is to be disturbed for sampling. Wear level C PPE to include coveralls, nitrile gloves, and full-face respirator with P-100 cartridges. Minimize generation of dust (use a mist of deionized water for dust suppression). (Add to this AHA any specific tool handling and associated hazards and controls.)
15. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear PPE and respiratory protection as specified in this AHA and the RWP. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.
16. Follow documentation procedures.	Failure to document survey findings could result in additional surveys.	Ensure qualified RCTs are aware of documentation procedure. The SHSS will be given a copy of all documentation.

ACTIVITY HAZARD ANALYSIS (AHA) #1: Clearing of Vegetation for Hunters Point PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
17. Demobilize site.	Workers could be vulnerable to slips, trips, falls, pinch points, and back and muscle strain.	Use proper lifting techniques when demobilizing. Be aware of pinch points and use leather gloves. Get help with loads of 50 or more pounds.

Notes:

AHA – Activity Hazard Analysis
CHP – Certified Health Physicist
CIH – Certified Industrial Hygienist
HSP – Base-wide Health and Safety Plan
PCB – polychlorinated biphenyl
PESM – Project Environmental and Safety Manager
PPE – personal protection equipment
RCT – Radiation Control Technician
RWP – Radiation Work Permit
SHSS – Site Health and Safety Specialist
USA – Underground Service Alert

ACTIVITY HAZARD ANALYSIS (AHA) #2
Initial Geophysical and Land Surveying
PCB Hot Spot

Created by: Richard Quinn CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to gather geophysical and topographic information that will be used to evaluate whether undocumented utilities or other subsurface features exist in the survey area and to assess existing site topographic features.		
1. Call Underground Service alert (800) 642-2444.	Failure to call could cause utilities to be missed	Call and get ticket number even if they decline to come to site.
2. Review as-builts and other site drawings. Walk the site to look for obvious utility locations.	Failure to review and walk the site could cause utilities to be missed during locating survey.	Document that drawings have been reviewed and that site has been walked.
3. Drive survey vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively, and be aware of police and fire emergency vehicles around shipyard.
4. Unload equipment from vehicle.	Lifting of instruments from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
5. Move equipment to designated survey location.	Handling of instruments could cause strain to worker.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other, uneven surfaces, if possible.
6. Survey and mark subsurface features, as necessary.	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Post an observer, as needed, when surveyor is using instruments (a surveyor is often focused on the task and may not be aware of nearby traffic). Use traffic controls or barricades, if necessary, to keep traffic away from workers.
	Use of spray paint to mark underground utilities and anomalies could expose worker to paint or fumes.	Follow manufacturers' instructions on use of paint. Review MSDSs. Never point spray paint canisters at another person.

ACTIVITY HAZARD ANALYSIS (AHA) #2
Initial Geophysical and Land Surveying
PCB Hot Spot

Created by: Richard Quinn CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Mismarking utilities could create unknown hazards.	Use following universal color codes for utilities: Blue – Water; Red – Electrical; Yellow – Gas; Green – Sewer.
	When carrying stakes, worker could trip and impale body.	Carry stakes in leather or canvas bag that is puncture-proof, and carry bag to side of body. Ensure that all tips are pointed toward the ground at all times.
	Installation of wooden stakes presents puncture and splinter hazards.	Keep stake tip pointed at ground. Wear leather gloves. Use caution when using tools to pound stake in.

Notes:

CIH – Certified Industrial Hygienist
MSDS – Material Safety Data Sheets
PCB – polychlorinated biphenyl

ACTIVITY HAZARD ANALYSIS (AHA) #3
Radiological Surface Surveillance
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of the radiological surface survey is to identify surface and near-surface (less than 12 inches bgs) radioactive material for subsequent removal and off-site disposal. The survey will consist of a high-density gamma scan performed with use of NaI detectors and supported by GPS equipment. ATVs may be used to assist in the collection of survey data. The high-density survey process will result in a 100 percent scan survey.		
1. Drive survey vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively, and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment from vehicle.	Lifting of instruments from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
3. Receive and inspect ATV.	Defective ATV could cause injury to workers.	The Class I ATV must be less than 800 pounds and less than 50 inches wide. The ATV must have four wheels. Inspect the ATV as specified by the operator's manual. Pay particular attention to steering, brakes, and tires. Check function of horn, tail lights, and brake lights
	ATV without muffler could create noise and cause fires due to sparks.	ATV must have muffler and spark arrestor.
4. Verify training of ATV operators.	Untrained operators could have accidents and injure themselves or others.	Operators must complete a nationally recognized ATV training course and pass an operating skills test. Proof of training must be available.
5. Connect trailer for transporting survey equipment onto ATV.	Lifting trailer to hitch could cause strain or back injury to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, and limiting twisting. Use multiple people to lift trailer to hitch if needed.
	Failure to properly connect trailer to ATV could cause damage to equipment or injury to workers.	Use only approved trailer hitch for the type of ATV. Payload must not exceed capacity of the ATV.
	Trailer connection could fall on and injure worker's feet.	Keep feet away from trailer hitch connection. Wear steel-toed boots.
6. Move survey equipment onto trailer.	Handling of instruments could cause strain to worker.	Carry instruments as required by manufacturers of instruments. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause worker to strain to maintain control of instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
7. Operate ATV and perform surveying.	Failure to operate ATV properly could cause damage to ATV or injury to workers.	Only trained workers may operate ATVs. Follow manufacturer's requirements for operation. Operate the ATV only at safe speeds.

ACTIVITY HAZARD ANALYSIS (AHA) #3
Radiological Surface Surveillance
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Carrying passengers could cause injury to passengers.	Carrying passengers on the ATV is prohibited.
	Failure to wear proper PPE could cause injury to operator.	Operators must wear gloves and an approved motorcycle helmet with full face-shield or goggles.
	ATV could be struck by other vehicles.	Wear high-visibility reflective vests. Make eye contact with operators of vehicles. Use traffic controls or barricades, if necessary, to keep traffic away from survey area.
	ATV may not be visible in all areas.	The ATV must have a high-visibility flag or windsock so that its location can be readily ascertained by others in the area. The ATV must only be operated during daylight hours.
	Workers could be exposed to chemical or radiological contaminants.	Avoid generating dust. For potential radioactivity exposure wear PPE as specified in the RWP. For potential chemical exposure, wear a minimum of Tyvek coveralls, steel-toe boots with covers, nitrile gloves, safety glasses, and hard hat. Remove PPE properly and wash hands after use.
8. Mark suspected radioactive material, if necessary.	Use of spray paint to mark suspected radioactive material could expose worker to paint or fumes.	Follow manufacturers' instructions on use of paint. Review MSDSs. Never point spray paint canisters at another person.
	When carrying flags or stakes, worker could trip and impale body.	Carry flags or stakes in leather or canvas bag that is puncture-proof, and carry bag to side of body. Ensure that all tips are pointed toward ground at all times.
	Installation of wooden stakes presents puncture and splinter hazards.	Keep stake tip pointed at ground. Wear leather gloves. Use caution when using tools to pound stake in.
9. Refuel ATV.	Worker may be exposed to gasoline.	Wear appropriate PPE.
	Gasoline can ignite, causing a fire.	Refuel only when engine is off and has been cooled slightly. Have fire extinguisher 20-pound dry chemical ABC within 75 feet of refueling point (but not too close) Do not leave the gasoline near those smoking or source of heat or flame. Ground fuel can using a grounding wire connected to a ground rod.
	Gasoline spills may damage the environment.	Have spill control supplies available and ready for use. Refuel only in a designated area.
10. Store fuel (assuming gasoline is used to fuel ATV).	Improper storage could cause spills or create the potential for fires.	Only store gasoline in approved metal safety cans, not exceeding 5 gallons each.

Notes:

ATV – all-terrain vehicle
bgs – below ground surface
GPS – Global Positioning System
MSDS – Material Safety Data Sheet
NaI – sodium iodide
PCB – polychlorinated biphenyl
PPE- personal protective equipment
RWP – Radiation Work Permit

ACTIVITY HAZARD ANALYSIS (AHA) #4
Point Source Identification and Removal
PCB Hot Spot

Created by: Richard Quinn CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to remove the point sources and/or contaminated soil/debris associated with radioactive material identified during the radiological surface surveillance activities. The locations with elevated radiation levels will be excavated using a small backhoe fitted with a smooth blade bucket and/or hand-digging tools until the source of the elevated gamma activity reading is discovered and removed, or a depth of 12 inches has been reached. All removal and storage activities will be performed under the supervision of a qualified RCT. Personnel performing removal of point sources and/or contaminated soil/debris will wear modified Level D PPE, including Tyvek coveralls and booties, nitrile gloves, hard hats, steel-toe boots, and eye protection, or as specified by the RWP and with the concurrence of the SHSS and the PESM.		
1. Drive equipment transport vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively, and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment and materials.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Worker could get caught between load, equipment or vehicles.	Avoid placing body, hands, or feet between material and equipment.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
3. Inspect equipment.	Improper inspection of equipment could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that a competent person inspects equipment before use and at start of each shift, and that equipment is in safe operating condition. Tag "out of service" and remove from service faulty or unsafe equipment. If applicable, verify that emergency shutdown system is clearly marked and location is known by all site workers. Verify that shutdown system works properly when trip wire is pulled or pushed. Operator's manual must be available and reviewed prior to operation.
4. Scan area around elevated measurements to verify specific location.	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.

ACTIVITY HAZARD ANALYSIS (AHA) #4
Point Source Identification and Removal
PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
5. Excavate radioactive material with backhoe.	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damage to underground utilities, or tipping equipment over in unstable soil conditions.	Do not move equipment into any work area until site layout plan has been completed and route of travel to worksite has been assessed for hazards (overhead lines, underground utilities, stability of roads and ground, etc.). At pre-activity safety briefing, discuss site layout plan and analysis of travel route, along with AHAs. Do not place equipment within 15 feet of any overhead electrical lines. Use a spotter for positioning as necessary. Operator must be qualified to operate backhoe and an operator's manual must be available and reviewed. Equipment must be inspected each day before use.
	Worker could become pinned between or under equipment components.	When any part of equipment is in motion, stand far enough away from moving parts to avoid being pinned between moving parts. If work must be done under equipment, SHSS must be contacted to ascertain a safe method for lockout of equipment to ensure that adequate blocking is installed.
	High winds could destabilize equipment.	Check weather conditions and forecasts to determine if conditions are acceptable for use of equipment. Do not operate equipment if winds exceed manufacturer's recommended tolerances.
	Worker could be exposed to noise.	Wear earplugs whenever equipment is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts as gloves or clothing may become entangled in the moving part.)
	Workers could place hands into moving parts of equipment, or loose clothing could become entangled in moving machine parts.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of dangerous parts of equipment before starting or engaging equipment.
	Electrocutions, explosions, etc. could occur.	Obtain and examine copies of all pertinent drawings prior to performing this task. Locate and mark existing underground utilities using universal marking codes. Obtain Underground Service Alert clearance (800-642-2444) prior to work. Inspect the area of drilling activity for overhead obstructions. Contact service facility engineer before working near utilities. All existing utilities should have already been marked. Inspect for these marks. Ensure that weight of rig is evenly distributed on ground and is not so heavy as to damage any underground lines that may be near the surface (e.g., shallow buried PVC lines).

ACTIVITY HAZARD ANALYSIS (AHA) #4
Point Source Identification and Removal
PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified in this AHA and the RWP. Survey and decontaminate equipment after use. Avoid exposure to dust. Use dust control as necessary and possible. Properly dispose of all radioactive material and excavated soil. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the RTM and PESM.
6. Excavate radioactive materials by hand.	Hand digging could cause injury to lower back.	Bend knees and use proper posture and back support while hand digging excavation pit.
	Hand digging over long periods of time could cause muscle strain.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select a position during hand digging to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward positions; repetitive forceful motions; or excessive gripping, pinching, or pressing.
	Slip, trip, and fall hazards could be present due to excavation pits.	Protect all open excavation pits if left unattended (on this project, all excavation pits should be filled before end of day).
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Barricade and mark area of activity for visibility. If necessary, perform traffic controls in accordance with the Traffic Control Plan.
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified in this AHA and the RWP. Remove PPE properly and wash hands. Survey and decontaminate equipment after use. Avoid exposure to dust. Use dust control as necessary and possible. Properly dispose of all radioactive materials and excavated soil. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the RTM and PESM.
7. Scan excavation pit after radioactive material removal.	Slip, trip, and fall hazards could be present due to excavation pits.	Be aware of footing within open excavation pits if surveying within pits. Protect all open excavation pits if left unattended (on this project, all excavation pits should be filled before end of day). Do not enter any excavation 5 feet or greater in depth. [If excavation is greater than 5 feet in depth and a person must enter, a competent person will evaluate the excavation and ensure that protective systems are in place (shoring, sliding trench shield, or appropriate sloping).] Excavation inspection forms will be completed prior to entry.

ACTIVITY HAZARD ANALYSIS (AHA) #4
Point Source Identification and Removal
PCB Hot Spot

Created by: Richard Quinn CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified this AHA and the RWP. Wear respiratory protection full-face respirator with P-100 cartridges and disposable gloves, coveralls, booties (any material).
8. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear PPE and respiratory protection as specified in this AHA and the RWP. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

Notes:

AHA – Activity Hazard Analysis
PCB – polychlorinated biphenyl
PESM – Project Environmental and Safety Manager
PPE – personal protective equipment
PVC – polyvinyl chloride
RCT – Radiation Control Technician
RTM – Radiological Task Manager
RWP – Radiation Work Permit
SHSS – Site Health and Safety Supervisor

ACTIVITY HAZARD ANALYSIS (AHA) #5
Pre-excavation Characterization Sampling
PCB Hot Spot

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Sampling will be performed using a hand-auger.		
1. Inspect work area.	Failure to inspect work area may result in trips and falls from the same level due to uneven work surfaces.	Ensure that work area is free from potential trip hazards and that only a minimum of authorized personnel are permitted in the work zone.
2. Inspect first aid kit, eye wash station, and fire extinguisher.	Failure to have proper medical supplies during emergency could result in inadequate treatment of personnel or potentially increase injuries.	Ensure that first aid kit contains all necessary supplies and that eye wash station is capable of supplying a 15-minute steady supply of solution.
3. Conduct daily inspection of auger.	Failure to conduct daily inspection may cause injury to worker if hand-auger is defective.	Destroy damaged hand-auger and obtain replacement.
4. Collect samples.	Local vehicle traffic could strike and injure samplers.	Ensure that all individuals participating in the sampling crew wear reflective vests. Workers will not work in street areas unless flaggers, signs, barricades and/or cones are used.
	Workers could come into contact with radioactive material contaminating vegetation, soil, office furniture, equipment, etc.	Wear appropriate protection defined in the RWP or recommendation of a RCT and coordinated with SHSS and PESM. Ensure that area has already been surveyed. Ensure that good hygiene practices are followed, such as washing thoroughly prior to eating meals.
	Incorrect use of hand-auger could cause injury to worker.	Ensure that all samplers are familiar with the tools and equipment selected for samples to be collected. All samplers should be able to demonstrate to the sampling lead they are familiar with the tools and their function. Rotate task among workers so no one worker is collecting all the samples. Allow for rest breaks.
	Failure to decontaminate sampling tools may cross-contaminate future samples.	Ensure the protocol defined in the SAP is followed.
	Workers could be exposed to dust, potentially biologically contaminated dust, radioactive airborne particulates, chemically contaminated dust, and asbestos contaminated dust.	Minimize the area that is to be disturbed for sampling. Wear PPE and respiratory protection as specified in the RWP for radioactive airborne particulates. Wear Level C PPE to include coveralls, nitrile gloves, full-face respirator with P-100 cartridges, for potential chemical exposures. Minimize generation of dust (e.g., use a mist of deionized water for dust suppression).

ACTIVITY HAZARD ANALYSIS (AHA) #5
Pre-excavation Characterization Sampling
PCB Hot Spot

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Potential interaction could occur between workers and nearby residents, other tenants or local civilians.	Notify police if nearby civilians threaten planned operations. Avoid wearing respirators or Tyvek coveralls outside of the work area. Post a guard (or watch person) at any entrance to the site.
5. Label the samples.	Failure to label sample jars, cores, containers, etc., may result in false identification.	Ensure samplers are familiar with the identification system defined in the SAP.
	Failure to affix chain-of-custody labels may result in noncompliance with established work protocol.	Ensure that application of chain-of-custody seals follow the SAP protocol.
6. Perform decontamination.	Failure to decontaminate sampling tools may cross-contaminate future sample.	Ensure that the protocol defined in the SAP is followed.
	Improper decontamination could cause worker to be exposed to contaminants.	Follow the procedure. Wear PPE.
7. Follow documentation procedures.	Failure to document survey findings could result in additional surveys.	Ensure qualified RCTs are aware of documentation procedures.
8. Demobilize the site.	Workers could be vulnerable to slips, trips, falls, pinch points, back/muscle strain.	Use proper lifting techniques when demobilizing. Be aware of pinch points and use leather gloves. Use the buddy system; get help with loads in excess of 50 pounds. Ensure that good hygiene practices are followed and samplers wash thoroughly prior to taking any food or drink.

Notes:

PCB- polychlorinated biphenyl
PESM – Project Environmental and Safety Manager
PPE – personal protective equipment
RCT – Radiation Control Technician
RWP – Radiation Work Permit
SAP – Sampling and Analysis Plan
SHSS – Site Health and Safety Specialist

ACTIVITY HAZARD ANALYSIS (AHA) #6
Protection or Removal of Utilities, Wells and Piezometers
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Areas that require excavation may have utilities, structures, wells, or piezometers that require protection. However, some of these may have to be removed or wells may be destroyed in place to facilitate the excavation cleanup goals and remedial removal objectives.		
1. Park contractor vehicle carrying drill rig and equipment.	Vehicle could hit someone or something.	Use spotters when positioning vehicle if needed. Ensure that spotters know how to communicate with driver of vehicle.
	Location could create a traffic hazard.	Locate vehicle in an area that will not obstruct traffic.
2. Unload equipment and materials.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position heavy equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded.
3. Install barricades around wellheads, piezometers, and supporting props for utilities or structures.	Use of hand tools and carrying materials could cause injury to workers.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift. Hand tools must be inspected before use. Discard tools that are damaged. Power tools when connected to a generator or other power source must be grounded or double-insulated. All cords and extension cords must be inspected daily. All outdoor connections must be made to a GFCI protected circuit. Generator must be inspected daily, installed as required by the manufacturer and grounded if required by the manufacturer. All workers must have training on the use of tools and the generator.

ACTIVITY HAZARD ANALYSIS (AHA) #6
Protection or Removal of Utilities, Wells and Piezometers
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
4. If wells must be destroyed, inspect drill rig.	Improper inspection of rig could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that rig and all associated equipment are inspected by a competent person and that rig is in safe operating condition. Inspect equipment, including brakes, tire pressure, cables, and hydraulic and pneumatic hoses, before use and at start of each shift. Tag and remove from service faulty or unsafe equipment. Verify that emergency shutdown system is clearly marked and location is known by all site workers. Verify that shutdown system works properly when trip wire is pulled or pushed. There must be two kill switches. Operator's manual must be available and reviewed prior to operation.
5. Position and set up drill rig and associated equipment.	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damaging of underground utilities, or tipping rig over in unstable soil conditions.	Do not move drill rig into any work area until site layout plan has been completed and route of travel to any work site has been assessed for hazards (overhead lines and stability of roads and ground). At the pre-activity safety briefing, discuss site layout plan and analysis of route of travel, along with AHAs. Do not place rig within 15 feet of any overhead electrical lines. Use a spotter for positioning as necessary. Inspect ground where outriggers will be placed. If necessary, use recommended cribbing for support of outrigger.
	Rig could contact overhead lines if transported with mast raised, causing electric shock.	Never move rig when mast is extended.
	Worker could become pinned between rig and other truck components, or worker could be pinned under rig if rig is serviced from under the truck.	When any part of rig or equipment is in motion, stand far enough away from moving parts to avoid being pinned between moving parts. Do not work under rig or truck while rig is supported by lifting jacks. If work must be done under rig or truck, drill crew supervisor must contact SHSS to ascertain a safe method for lockout of equipment to ensure that adequate blocking is installed.
	High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. Do not operate rig if winds exceed manufacturer's recommended tolerances.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts, as gloves or clothing may become entangled in the moving part.)

ACTIVITY HAZARD ANALYSIS (AHA) #6
Protection or Removal of Utilities, Wells and Piezometers
PCB Hot Spot

Created by: Lisa Bercik | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Electrocutions, explosions, disastrous events, etc. could occur.	Ensure that utility clearances have been performed and verified. Ensure that weight of rig is evenly distributed on ground and is not so heavy as to damage any underground lines that may be near the surface (e.g., shallow buried PVC lines).
6. Start up rig and perform overdrilling.	Pressurized hydraulic lines could rupture, causing release of hot hydraulic fluid. Hot fluid could ignite if contact is made with engine, burn workers, and cause environmental contamination.	Ensure that personnel are trained in use of drilling equipment. Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. Immediately shut down equipment if lines rupture. Ensure that first aid kit is readily available to treat injured workers. Ensure that a 20-pound dry chemical ABC fire extinguisher is readily available. Ensure that a spill control kit is available at drilling location. If rupture occurs, as quickly as possible, berm the liquid to minimize the area over which the liquid spreads. Ensure that all pressurized lines have whip checks.
	Air hoses or hydraulic hoses under pressure could suddenly release, whip, and hit workers causing severe injury.	Do not disconnect air hoses and compressors until hose line has been bled. Visually inspect all connections of any lines under pressure. Use safety clamps (whip checks) to connect each side of connection to other if connection breaks (safety clamps will keep hoses from whipping under sudden release of pressure). Tie back or attach hoses wherever possible to minimize length of hose that could whip around if there is sudden release of pressure.
	Worker could be exposed to chemical agents and/or radioactive contamination.	Verify selection of PPE with ambient air/visual monitoring and RWP. Review all MSDSs. Any removed materials will be surveyed for radioactive contamination. Survey and decontaminate drilling implements after use. Avoid exposure to dust. Use dust control as necessary and possible. Drum and label all soil cuttings. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the Project Manager and PESM.
	Workers could place hands into moving parts of rig, or loose clothing, long hair or jewelry could become entangled in moving machine parts, either of which could injure worker.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing, long hair or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of dangerous parts of equipment before starting or engaging equipment. Ensure that auger is protected by an enclosed cage.

ACTIVITY HAZARD ANALYSIS (AHA) #6
Protection or Removal of Utilities, Wells and Piezometers
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate. Keep constantly alert.
7. Remove overdrilled materials from site for disposal.	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Cuts and abrasions could occur if casing requires cutting.	Wear leather gloves if cutting casing. Secure well casing before cutting. Use edge protection. Ensure that fire extinguisher is nearby if using grinder.
	Large materials could make contact with someone or something while being carried and are prone to slip.	Wear gloves, as appropriate. Be aware of people or objects that may be vertically or horizontally within length of materials.
	Worker could be exposed to chemical and radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP and RWP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
8. Mix grout (cement and bentonite).	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to cement dust or bentonite dust. Worker could be come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands. Avoid generating dust. Review MSDS for grout. If high in silica content, wear dust mask when handling dry cement. Wear nitrile gloves, at a minimum.

ACTIVITY HAZARD ANALYSIS (AHA) #6
Protection or Removal of Utilities, Wells and Piezometers
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
9. Tremie grout into borehole to seal.	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands. Wear nitrile gloves.
10. Finish boring at surface with bentonite pellets.	Worker could be come into contact with bentonite. Surface area is slippery.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands. Wear boots with good traction soles.
11. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical and radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP and RWP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands. All parts and debris will be screened for radioactivity.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

Notes:

AHA – Activity Hazard Analysis
GFCI – ground fault circuit interrupter
MSDS – Material Safety Data Sheet
PESM – Project Environmental and Safety Manager
PPE – personal protective equipment
PVC – polyvinyl chloride
RWP – Radiation Work Permit
SHSP – Site-Specific Health and Safety Plan
SHSS – Site Health and Safety Specialist

ACTIVITY HAZARD ANALYSIS (AHA) #7
Excavation
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
During this phase, soil will be excavated in 12-inch lifts to remove PCB-contaminated soil and subsequent radioactive materials. Prior to the removal of contaminated soil, the soil will be surveyed for radiation. If any radioactive materials are encountered they will be removed as described in AHA #4. Soil will only be removed to 3 feet below ground surface, unless there is visible contamination or radioactive contamination greater than the remedial removal objectives. Once soil is removed, it will be trucked or placed to a dewatering pad from where it will be placed in a stockpile for ex situ radiological screening via a conveyor.		
1. Inspect work area/excavation.	The following excavation hazards could be present: improper shoring or sloping could cause excavation to collapse; accumulation of water can erode excavation; and personnel could be struck by operating equipment. Loads in equipment could drop on top of workers. Workers or others could inadvertently fall into an excavation.	Reverify all utility markings. Protect all utilities, wells, and piezometers. Ensure proper shoring or sloping. Spoil banks and equipment must be at least 3 feet away from the excavation. [Cal-OSHA requires at least 2 feet from the edge of the excavation.] If personnel must enter excavations: for excavations that are over 4 feet in depth, ladders will be placed in the excavation to provide access and egress within 25 feet lateral. For example, one ladder placed in center of a 50-foot lateral provides egress within 25 feet on either side. Ramps must have a minimum slope of 1.5:1. Daily inspections of excavation, the adjacent areas, and protective systems shall be made by the project-assigned competent person. Workers will never work under loads.
2. Inspect first aid kit, eye wash station, and fire extinguisher.	Failure to have proper medical supplies during emergency could result in inadequate treatment of personnel or potentially increase injuries.	Ensure that first aid kit contains all necessary supplies and that eye wash station is capable of supplying a 15-minute steady supply of solution.
3. Conduct safety inspection of excavators or backhoes, dump trucks, water truck (for dust control) and site pickup trucks.	Workers could be vulnerable to slips, trips, and falls, getting caught in between equipment, pinch-points, and cuts. Damage to equipment could occur if not in good working condition.	When accessing heavy equipment (climbing on or off) always use the "Three Points of Contact" system to prevent falls.
	Failure of equipment to operate in a safe manner could causes injury to worker.	Crew needs to remain alert to work flow and hazards as they change. Equipment Safety Inspections must be conducted for each piece of equipment; use the correct forms.

ACTIVITY HAZARD ANALYSIS (AHA) #7
Excavation
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Broken hydraulic/oil lines could cause burns.	An inspection of oil lines and connections should be performed and any suspect leaks should be reported immediately to management. Do not use equipment until is repaired or specifically authorized by the Project Superintendent or Project Manager. Operator's manual must be on site and reviewed to ensure proper inspection and operation of equipment.
4. Inspect and load tools and supplies into work trucks.	Workers could be vulnerable to muscle/back strain, slips, trips, falls, cuts, abrasions, and splinters.	Handle tools and material carefully. Make sure tools are clean and in good working order. Only pick up one tool at a time. Do not carry loads over 50 pounds. Employee need to be aware of working areas. Wear leather gloves.
5. Excavate the soil.	Heavy equipment could pose hazards to workers.	Equip all heavy equipment on this project with rollover protection systems and backup alarms. Stay clear of moving equipment unless necessary. (If working near equipment, workers must be in visual contact with the operator.) Be aware of the swing radius of the equipment, especially the counterbalance on an excavator. Inspect all equipment daily before use to ensure that proper maintenance is being performed. Make eye contact with operator. Heavy equipment has right-of-way.
	Workers could be exposed to radioactive contamination, PCB-contaminated soil or soil contaminated with metals.	Wear PPE and respiratory protection as specified in the RWP for radioactive contamination. For other contaminants, wear Tyvek coveralls, nitrile gloves, and avoid generating dust (use a water truck). Wear a full-face respirator with P-100 cartridges. Conduct air monitoring as specified in the SHSP.
	Landfill gases in area could be ignited or expose workers.	Use combustible gas meter as described in SHSP to monitor area as excavation proceeds. Leave area if LEL exceeds 10 percent.
6. Use shovels.	Workers could get strains from use of shovels.	Maintain steady work pace. Avoid pivoting at waist; rather, pivot using feet. If possible, rotate tasks among the workers. Inspect tools to ensure that they are in good condition.

ACTIVITY HAZARD ANALYSIS (AHA) #7
Excavation
PCB Hot Spot

Created by: Richard Quinn, CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
7. Excavate near sheet pile barrier.	If more soil needs to be removed from either or both sides of the barrier, barrier could fail.	Evaluate methods for shoring or supporting barrier as excavation proceeds. Obtain engineering support before proceeding or exposing too much of the barrier.
8. Load trucks.	Workers could be hit by debris or be crushed by loads.	Prohibit truck drivers from standing near trucks as they are being loaded. Prohibit truck drivers from sitting in the cab of trucks as they are being loaded, unless the truck is equipped with a cab protector (FOPS). Load trucks so that dust generation is minimal, by dropping the load as close as possible to the top of the truck.
9. Material will be hauled from the excavation to a dewatering pad or directly to a staging pile.	Workers could be struck by or against heavy equipment or trucks.	Establish and follow a Traffic Control Plan. Wear reflective warning vests. Avoid equipment swing areas, and designated traffic routes/staging areas. Make eye contact with operators before approaching equipment or trucks. Understand and review posted hand signals. Use spotters and flaggers as necessary to direct trucks, as well as any nearby traffic.

Notes:

AHA – Activity Hazard Analysis
Cal-OSHA – California Occupational Safety and Health Administration
FOPS – falling object protective system
LEL – lower explosive limit
PCB – polychlorinated biphenyl
PPE – personal protective equipment
RWP – Radiation Work Permit
SHSP – Site-Specific Health and Safety Plan

ACTIVITY HAZARD ANALYSIS (AHA) #8
Dewatering of Excavated Materials
PCB Hotspots

Created by: Richard Quinn, CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Soil removed from the excavation will be placed on an adjacent dewatering pad that has been constructed.		
1. Clear area of rocks, debris and other objects that may puncture liner.	Use of heavy equipment could cause workers to be struck. Use of tools such as hand shovels could cause back strains from stooping and bending to pick up various loose debris.	Maintain eye contact with operators. Wear high-visibility vests. When using shovels, always pivot with feet, not at waist. When stooping or bending over, always use legs and bend at knees. Avoid bending over as this puts tremendous strain on back.
2. Lay out first layer of 20-mil HDPE or PVC liner.	Liner material can be heavy and bulky. Liner can be picked up by wind making it difficult to handle. When cutting liner, the worker could be injured by cutting blade. Once, laid, liner can be slippery to walk on.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift. Avoid placing liner when windy. Always cut away from the body, never toward the body. Always wear slip-resistant work boots. Avoid walking on wet liner.
3. Place a 6-inch layer of course sand and slope to a sump.	Sand with a high content of quartz could be inhaled and cause lung damage.	Use dust control. Sand could be analyzed to determine type of silicates present. Wear P-100 full-face respirator if dust cannot be suppressed and sand has respirable silica quartz.
	There is potential damage the base liner when sand is placed on liner. Damaged liner could cause workers to trip or fall or liquid to contact ground.	Ensure that sand has no other debris, especially sharp objects such as rocks. Do not place a lot of weight on liner until the sand is evenly dispersed.
4. Construct a sump.	Sump could be a fall or trip hazard.	Ensure that sump is clearly marked or barricaded. Sump should not exceed a 4-foot depth. If sump is deeper than 4 feet it must be protected. More than 6 feet deep requires full fall protection by means of guard rails meeting OSHA requirements.
5. Place second layer of liner.	Liner material can be heavy and bulky. Liner can be picked up by wind making it difficult to handle. When cutting liner, worker could be injured by cutting blade. Once, laid, liner can be slippery to walk on.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift. Avoid placing liner when windy. Always cut away from the body, never toward the body. Always wear slip-resistant work boots. Avoid walking on wet liner.
6. Place watery soils on pad.	Workers could be exposed to chemical or radiological contaminants.	Avoid generating dust. Wear PPE as specified in the RWP and as recommended by the RCT. Wear polycoated Tyvek coveralls (or PVC rainsuit), nitrile gloves (two layers), steel-toe boots with protective covers (or PVC steel toe boots), hard hat, and safety glasses for protection from other contaminants. Remove PPE properly and wash hands.

ACTIVITY HAZARD ANALYSIS (AHA) #8
Dewatering of Excavated Materials
PCB Hotspots

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely, be especially careful of any holes or depressions under the liner and watch out for the sump. The wet liner is slippery. Avoid walking on liner, or at a minimum wear boots with slip-resistant soles.
7. Collect runoff water and store in tank.	Improper use of pump and failure to inspect hoses could cause spills and worker exposure to contamination.	Inspect all pumps and hoses before use. Follow manufacturers' operating instructions for pump. Inspect all connections.
	Workers could climb tank for placing hoses through the top and thus expose workers to potential fall or trip hazard.	Workers working on top of tank must have fall protection. If dome lid is open two workers are required, with one worker acting as an observer so that the other worker does not trip or fall over the opening.
	Tank could leak.	Ensure that the tank meets specifications for storage of potentially contaminated water.
	Workers could be exposed to chemical or radiological contaminants.	Wear PPE as specified in the RWP and as recommended by the RCT. Wear polycoated Tyvek coveralls (or PVC rainsuit), nitrile gloves (2 layers), steel-toe boots with protective covers (or PVC steel-toe boots), hard hat, and safety glasses for protection from other contaminants. Remove PPE properly and wash hands.
8. Sample and characterize runoff water.	Workers could be exposed to chemical or radiological contaminants.	Wear PPE as specified in the RWP and as recommended by the RCT. Wear polycoated Tyvek coveralls (or PVC rainsuit), nitrile gloves (2 layers), steel-toe boots with protective covers (or PVC steel-toe boots), hard hat, and safety glasses for protection from other contaminants. Remove PPE properly and wash hands.
	Spills could contaminate nearby environment.	Use techniques that minimize potential for spills. Have spill control supplies readily available. Be sure to close covers of sample containers tightly. Clean off the outside of the containers.
	Failure to label container could cause workers to be exposed.	Label containers immediately after placing samples in container.
9. Remove soil from dewatering pad.	Workers could be exposed to chemical or radiological contaminants.	Wear PPE as specified in the RWP and as recommended by the RCT. Wear polycoated Tyvek coveralls (or PVC rainsuit), nitrile gloves (2 layers), steel-toe boots with protective covers (or PVC steel-toe boots), hard hat, and safety glasses for protection from other contaminants. Remove PPE properly and wash hands.

ACTIVITY HAZARD ANALYSIS (AHA) #8
Dewatering of Excavated Materials
PCB Hotspots

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Soil could fall on to ground and contaminate the ground.	Establish a plan to prevent dropping or spilling of materials. Have spill control equipment and supplies immediately available in the area.

Notes:

AHA – Activity Hazard Analysis
HDPE – high-density polyethylene
OSHA – Occupational Safety and Health Administration
PCB – polychlorinated biphenyl
PPE – personal protective equipment
PVC – polyvinyl chloride
RCT – Radiation Control Technician
RWP – Radiation Work Permit

ACTIVITY HAZARD ANALYSIS (AHA) #9
Screening Conveyor System
PCB Hot Spot

Created by: Richard Quinn, CSP

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Soil removed from the excavation will be placed into a grizzly that removes large objects and debris. The smaller debris drops onto a conveyor belt for secondary screening for radioactivity. PCB-contaminated soil with no radioactivity will be moved to a stockpile, soil contaminated with PCB and radioactivity will be moved to another stockpile, soil contaminated with radioactivity only will be moved to a third stockpile, and soil with no contamination will be moved to a fourth stockpile.		
1. Fuel and oil screen plant (grizzly) and conveyor.	Fueling and oiling screen plant could cause a fire.	The screen plant will be turned off when fueling. Only NFPA-approved fuel cans will be used. Fuel cans will be equipped with pouring spout or a funnel will be used. Fuel caps will be secured prior to restart of machinery. Fuel cans will be removed from the area prior to starting screen plant. Twenty-pound ABC fire extinguishers will be readily available. Smoking and open flames will not be permitted in fueling areas.
	Fueling and oiling could expose worker to chemical.	Protective clothing (chemical gloves and safety glasses) will be worn during fueling and oiling. Exposed skin areas will be rinsed with water immediately if contact with hazardous materials occurs. A portable eye wash station and first aid kit will be readily available.
	Improper fueling could cause spills.	Fuel/oil caps will be secured on equipment and containers after use. Spills will be cleaned up immediately. Spill and absorbent materials will be readily available adjacent to fueling/oiling areas.
2. Start up conveyor system and screen plant.	Improper operation of conveyor system and screen plant could expose workers to injury.	Whenever conveyors start up, an audible alarm must sound prior to startup of conveyor. Use Level D PPE as a minimum: safety shoes, safety glasses, hard hat, and traffic vest in SZ and CRZ. The screen plant shall be free of obstructions prior to startup. Employees shall be trained as to the manufacturer-recommended startup/operating procedures prior to commencing work. All conveyors and screen plant machines will have emergency stops. Conveyors will have emergency stops along the length of the conveyor. Personnel shall be clear of the screen plant exhaust and conveyor prior to starting. Ensure that all guards are secure and in place prior to starting. No guards shall be removed unless proper lockout procedures are implemented. Personnel shall know the location of the "kill switch" (emergency stop button). Position the conveyors and screen plant machine in a downwind location to minimize dust exposure. Ensure that legs for vibrating grid are positioned correctly and safety pins are in place.
	Worker could experience heat exhaustion or stroke.	Heat stress prevention will be implemented under guidelines established in EHS 4-6, Temperature Extremes.

ACTIVITY HAZARD ANALYSIS (AHA) #9
Screening Conveyor System
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
3. Operate screen plant.	Workers could be struck by materials.	Material shall be added using excavator/loader/heavy equipment only. All conveyors will have guards protecting workers from all moving parts. Operator loading material shall have the remote control device, if available. Employees shall never place hands, arms, feet, legs or any other body part on the feed table or within the limits of the in-feed hopper when Screen plant is in operation. All employees working around the conveyors and screen plant machine will eliminate loose clothing. No jewelry or long hair is allowed in the EZ. Push sticks shall be used if necessary. ANSI approved safety glasses and face shields shall be worn to protect workers from projectiles thrown back from the chute. All workers shall stay clear of the conveyor chutes. The work area shall be secured to prevent unauthorized personnel from entering during operation. Material to be placed in screen plant should be moist to reduce dust produced. Water trucks shall mist materials on a regular basis.
4. Operate conveyor.	Workers may come into contact with exposed gears or pulleys.	Install guards around all exposed gears and pulleys. Ensure that all operators are trained in accordance with manufacturer's operation and maintenance manual. Comply with all safety directives contained therein. Use lockout/tagout equipment as per TtFW's EHS Procedure 6-4 and manufacturer's recommendation during maintenance work. Clear area and sound alarm before startup. Note: Before initial plant startup, the plant will be inspected by the PESM or a CIH or CSP or designee. All ground personnel will wear reflective safety vests.
	Operating conveyor will expose worker noise.	Wear hearing protection.
	Workers could fall when working on top of equipment taller than 6 feet.	Wear personal fall protection and ensure that worker is trained in using this equipment.
5. Operate screen plant.	Screen plant operations will expose water to flying debris.	Unit may cause debris to be expelled out of the top at a high force. Avoid working too close to unit. Wear hard hat and safety shield.
	Worker may be exposed to dust.	Use dust control measures. Assess dust levels. Wear respiratory protection if dust levels exceed 1.5 mg/m^3 as measured by a MiniRAM® or equivalent.

ACTIVITY HAZARD ANALYSIS (AHA) #9
Screening Conveyor System
PCB Hot Spot

Created by: Richard Quinn, CSP | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could be exposed to chemical or radiological contaminants.	Wear PPE and respiratory protection as specified in the RWP for radiological contaminants. Wear Tyvek coveralls, nitrile gloves (two layers), full-face respirator with P-100 cartridges, steel-toe boots, hard hat, and safety vest for chemical protection. Survey and decontaminate equipment after use. Avoid exposure to dust. Use dust control as necessary and possible. Properly dispose of all radioactive material and excavated soil. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the RCT and PESM.
	Materials being processed through screen plant could cause fire/explosion.	Stop the screen plant if UXO is discovered or any abnormal objects are discovered. Contact police or EOD personnel. Do not touch or move any of these objects.
	Materials being processed through screen plant could present biological hazards.	Proper PPE will be worn (long sleeves and light-colored coveralls/Tyvek) to avoid skin contact with contaminated soil, plants or other irritants. Personnel will be instructed on how to recognize hazardous species (i.e. ticks, spiders and snakes).
6. Shut down screen plant.	Accidental startup could cause injury to worker.	Screen plant shall be equipped with a locking device on the ignition system or lockout/tagout procedures will be followed to prevent unauthorized startup of equipment.
7. Perform maintenance of screen plant.	During routine maintenance activities, workers could be exposed to injury.	Lockout/tagout procedures outlined in EHS 6-4 will be followed to prevent accidental startup of machines. All personnel will be given proper instruction on lockout/tagout procedures. All machinery will be shut down prior to maintenance. Additionally, the screen plant must come to a complete stop after shutdown prior to commencing maintenance operations.
8. If necessary, relocate screen plant.	Relocating the screen plant on uneven terrain could cause the screen plant to roll after detachment.	Screen plant will be located on even terrain free of obstruction. Screen plant will be checked and otherwise secured prior to beginning activities.

Notes:

ANSI – American National Standards Institute
CIH – Certified Industrial Hygienist
CRZ – contamination reduction zone
CSP – Certified Safety Professional
EHS – Environmental Health and Safety
EOD – explosive ordnance disposal
EZ – exclusion zone
mg/m^3 – milligrams per cubic meter
NFPA – National Fire Protection Association
PCB – polychlorinated biphenyl
PESM – Project Environmental Safety Manager
PPE – personal protective equipment
RCT – Radiological Control Technician
RWP – Radiation Work Permit
SZ – support zone
TtFW – Tetra Tech FW, Inc.
UXO – unexploded ordnance

ACTIVITY HAZARD ANALYSIS (AHA) #10
Hauling and Stockpiling
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Once soil is removed and characterized, it is placed into separate stockpiles. Each stockpile is ultimately managed for proper disposal or re-use.		
1. Load and haul soil.	Workers could be struck by or against heavy equipment or trucks.	Establish and follow a Traffic Control Plan. Wear reflective warning vests. Avoid equipment swing areas, and designated traffic routes. Make eye contact with operators before approaching equipment or trucks. Understand and review posted hand signals. Use spotters and flaggers as necessary to direct trucks as well as any nearby traffic.
	Drivers of trucks could be injured by loads as they are being placed in trucks.	Prohibit truck drivers from standing near trucks as they are being loaded. Prohibit truck drivers from sitting in the cab of trucks as they are being loaded, unless the truck is equipped with a cab protector (FOPS). Load trucks so that dust generation is minimal, by dropping the load as close as possible to the top of the truck.
	Dirt and dust can accumulate on roads used for transport of material.	Brush off trucks before they enter a paved road. Tarp truck or load truck in such a manner to prevent dirt and dust from getting on to paved roads.
2. Manage stockpile.	Stockpiles could create dust while soil is being stored.	Cover all stockpiles at the end of each day. Use dust suppression during operational hours.
	Improper stockpile management could cause workers to be injured by material falling from stockpile.	Spoil banks, stockpiles, and equipment must be at least 3 feet away from the excavation. Avoid climbing on stockpiles. Cover all stockpiles to minimize generation of dust. Avoid walking on plastic covers of stockpiles as they will be slippery, especially if wet. Do not lift more than 50 pounds when handling sandbags to secure cover. Use safe lifting techniques when handling sandbags. Do not toss sandbags. Use mechanical assistance whenever possible.
3. Load truck from stockpile.	Loaders operate quickly with loaders operating in reverse a large amount of the time and may hit other equipment or workers on ground.	If workers on the ground must be in the vicinity, they must maintain visual contact with the operator at all times. Operator must use good judgement in operating loader by weighing safety factors over productivity. Operators must look in the direction they are traveling. Loaders must load trucks from sides and not the rear of the truck.
	Workers must climb stockpile to remove sandbags and walk on plastic sheeting. Workers could slip and workers could injure themselves by lifting sandbags improperly.	Watch step when walking on stockpile. Use boots with slip-resistant soles. Do not bend over to pick up sandbags. Bend at the knees to lift sandbags. No sandbag should exceed 35 pounds. Do not toss sandbags to the side. Always keep sandbags in front of body. Avoid twisting at waist.
	While loading or picking up the plastic sheeting, dust could be released.	Provide dust control. Avoid handling plastic sheeting during periods of wind in excess of 15 miles per hour. Be sure a tarp is placed over truck before truck leaves stockpile area.

ACTIVITY HAZARD ANALYSIS (AHA) #10
Hauling and Stockpiling
PCB Hot Spot

Created by: Lisa Bercik | Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
4. Haul	Struck by or against heavy equipment or trucks.	Establish and follow a traffic control plan. Wear reflective warning vests. Avoid equipment swing areas and designated traffic routes. Make eye contact with operators before approaching equipment or trucks. Understand and review posted hand signals. Use spotters and flaggers, as necessary, to direct trucks, as well as any nearby traffic.
	Drivers of trucks could be injured by loads as they are being placed in trucks.	Prohibit truck drivers from standing near trucks as they are being loaded. Prohibit truck drivers from sitting in the cab of trucks as they are being loaded, unless the truck is equipped with a cab protector (FOPS).
	Dirt and dust can accumulate on roads used for transport of material.	Brush off trucks before they enter a paved road. Tarp or load truck in such a manner to prevent dirt and dust from getting onto paved roads.
5. Compact Soil.	Workers could injure feet while operating portable compactor.	Wear steel-toe boots. Avoid placing feet too close to the portable compactor. Follow manufacturers' operating instructions.
	Workers could injure themselves when lifting or maneuvering the heavy portable compactor.	Use two personnel when lifting equipment off truck. Follow safe lifting protocols. Use a mechanical device (dolly) or a vehicle to position the portable compactor - as close as possible to the work area.
	If a vehicular type of compactor is used, vehicle could tip over if the ground is not relatively flat or sloped properly or if vehicle is not operated at a safe speed.	Follow manufacturers' direction for safe operation. Operate vehicle only at speeds designated by manufacturer. Operate vehicle vertical to any slope. Open cab units require operator to wear hearing protection.
	Compactor is noisy and vibrates when operating.	Wear hearing protection. Wear anti-vibrations gloves. Be sure that compactor is in good condition and evenly balanced. Rotate the task with other workers.

Notes:

FOPS – falling object protective system
PCB – polychlorinated biphenyl

ACTIVITY HAZARD ANALYSIS (AHA) #11
Post-excavation Sampling
PCB Hot Spot

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
Sampling will be performed using a hand-auger.		
1. Inspect work area.	Failure to inspect work area may result in trips and falls from the same level due to uneven work surfaces.	Ensure that work area is free from potential trip hazards and that only a minimum of authorized personnel are permitted in the work zone.
2. Inspect first aid kit, eye wash station, and fire extinguisher.	Failure to have proper medical supplies during emergency could result in inadequate treatment of personnel or potentially increase injuries.	Ensure that first aid kit contains all necessary supplies and that eye wash station is capable of supplying a 15-minute steady supply of solution.
3. Collect daily inspection of auger.	Failure to conduct daily inspection may cause injury to worker if hand-auger is defective.	Destroy damaged hand-auger, and obtain replacement.
4. Collect samples.	Local vehicle traffic could strike and injure samplers.	Ensure that all individuals participating in the sampling crew wear reflective vests. Workers will not work in street areas unless flaggers, signs, barricades and/or cones are used.
	Excavation could be deeper than 4 feet and potentially expose samplers to engulfment hazards.	Excavations that are less than 15-feet wide and more than 4 feet deep are considered trenches and require either proper sloping or shoring. If the excavation is wider than 15 feet, it may be possible to enter the excavation as long as employees maintain a minimum 2-foot of distance for every foot of the sidewall. Consult with PESM for precise protective measures. It is preferred that samplers are protected by shoring or sloping in this situation.
	Incorrect use of hand-auger could cause injury to worker.	Ensure that all samplers are familiar with the tools and equipment selected for samples to be collected. All samplers should be able to demonstrate to the sampling lead they are familiar with the tools and their function. Rotate task among workers so no one worker is collecting all the samples. Allow for rest breaks.
	Failure to decontaminate sampling tools may cross-contaminate future samples.	Ensure the protocol defined in the SAP is followed.
	Workers could be exposed to dust.	Minimize the area that is to be disturbed for sampling. Use dust control. Wear a dust mask, if desired.

ACTIVITY HAZARD ANALYSIS (AHA) #11
Post-excavation Sampling
PCB Hot Spot

Created by: Richard Quinn, CSP Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
5. Label the samples.	Failure to label sample jars, cores, containers, etc., may result in false identification.	Ensure samplers are familiar with the identification system defined in the SAP.
	Failure to affix chain-of-custody labels may result in noncompliance with established work protocol.	Ensure that application of chain-of-custody seals follow the SAP protocol.
6. Perform decontamination.	Failure to decontaminate sampling tools may cross-contaminate future sample.	Ensure that the protocol defined in the SAP is followed.
7. Follow documentation procedures.	Failure to document survey findings could result in additional surveys.	Ensure qualified RCTs are aware of documentation procedures.
8. Demobilize the site.	Workers could be vulnerable to slips, trips, falls, pinch points, back/muscle strain.	Use proper lifting techniques when demobilizing. Be aware of pinch points and use leather gloves. Use the buddy system; get help with loads in excess of 50 pounds. Ensure that good hygiene practices are followed and samplers wash thoroughly prior to taking any food or drink.

Notes:
PCB – polychlorinated biphenyl
PESM – Project Environmental and Safety Manager
RCT – Radiation Control Technician
SAP – Sampling and Analysis Plan

ACTIVITY HAZARD ANALYSIS (AHA) #12
Hauling, Backfilling, and Compaction
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to remove the soil from clean stockpiles of fill material, haul the soil to the excavated areas and backfill the area, followed by compaction of the soil.		
1. Load truck from stockpile.	Loaders operate quickly with loaders operating in reverse a large amount of the time and may hit other equipment or workers on ground.	If workers on the ground must be in the vicinity, they must maintain visual contact with the operator at all times. Operator must use good judgement in operating loader by weighing safety factors over productivity. Operators must look in the direction they are traveling. Loaders must load trucks from sides and not the rear of the truck.
	Workers must climb stockpile to remove sandbags and walk on plastic sheeting. Workers could slip and workers could injure themselves by lifting sandbags improperly.	Watch step when walking on stockpile. Use boots with slip-resistant soles. Do not bend over to pick up sandbags. Bend at the knees to lift sandbags. No sandbag should exceed 35 pounds. Do not toss sandbags to the side. Always keep sandbags in front of body. Avoid twisting at waist.
	While loading or picking up the plastic sheeting, dust could be released.	Provide dust control. Avoid handling plastic sheeting during periods of wind in excess of 15 miles per hour. Be sure a tarp is placed over truck before truck leaves stockpile area.
	Struck by or against heavy equipment or trucks.	Establish and follow a Traffic Control Plan. Wear reflective warning vests. Avoid equipment swing areas and designated traffic routes. Make eye contact with operators before approaching equipment or trucks. Understand and review posted hand signals. Use spotters and flaggers, as necessary, to direct trucks, as well as any nearby traffic.
	Drivers of trucks could be injured by loads as they are being placed in trucks.	Prohibit truck drivers from standing near trucks as they are being loaded. Prohibit truck drivers from sitting in the cab of trucks as they are being loaded, unless the truck is equipped with a cab protector (FOPS).
	Dirt and dust can accumulate on roads used for transport of material.	Brush off trucks before they enter a paved road. Tarp or load truck in such a manner to prevent dirt and dust from getting onto paved roads.
2. Haul load.	Workers could be struck by or against heavy equipment or trucks.	Establish and follow a Traffic Control Plan. Wear reflective warning vests. Avoid equipment swing areas and designated traffic routes. Make eye contact with operators before approaching equipment or trucks. Understand and review posted hand signals. Use spotters and flaggers, as necessary, to direct trucks, as well as any nearby traffic.
3. Dump load at excavation site.	Workers could be struck by or against heavy equipment or trucks.	Provide spotters for dumping and/or direction of placement of loads. Ground workers will maintain distance from dumping truck and graders, dozers or compactors. Workers will avoid standing near edges of excavations.

ACTIVITY HAZARD ANALYSIS (AHA) #12
Hauling, Backfilling, and Compaction
PCB Hot Spot

Created by: Lisa Bercik

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
4. Place geotextile plastic marker fabric.	Inside an excavation greater than 4 feet deep, a worker can become engulfed. When cutting the fabric, the worker could be injured by cutting blade or membrane.	Avoid working took close to excavation walls unless sloping is 1 ½ to 1. Avoid tripping over membrane material. Avoid cuts from membrane or from blade used to cut membrane, never cut toward the body.
5. Compact soil.	If a vehicular type of compactor is used, vehicle could tip over if the ground is not relatively flat or sloped properly or if vehicle is not operated at a safe speed.	Follow manufacturers' direction for safe operation. Operate vehicle only at speeds designated by manufacturer. Operate vehicle vertical to any slope.
	Compactor without enclosed cab is noisy.	Wear hearing protection.

Notes:

FOPS – falling object protective system
PCB – polychlorinated biphenyl

ACTIVITY HAZARD ANALYSIS (AHA) #13
Site Restoration, Decontamination and Demobilization PCB Hot Spot

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to restore the site after removal activities and to demobilize. Demobilization includes decontamination and removal of all construction equipment and materials, cleaning the project site, inspecting the site, and issuing a certification of completion, including the free-release certification.		
1. Demobilize and restore site.	Workers could be struck by or against heavy equipment.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
	Improper grading operation could cause grader to overturn or hit other object.	Ensure that grading is done on relatively flat ground. On hills or slopes, grades must be operated only vertical to the hill. Avoid generating dust while grading.
	Electrocution hazards may be present.	Allow only qualified electricians to disconnect electrical circuits. Follow lockout, tagout protocols. Inspect all extension cords daily for structural integrity, ground continuity, and damaged areas. Document extension cord inspection. Use GFCIs on all outdoor 115- to 120-volt, 20 ampere or less, circuits. Cover or elevate electric wire or flexible cord passing through work area to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching. Keep plugs and receptacles out of water unless they are approved- submersible types. Ground all electrical circuits in accordance with the NEC or other applicable regulations or standards. Temporary wiring is not allowed to pass through walls, doors, or windows (extension cords are one type of temporary wiring). If a generator is used, be sure it is a type that does not require grounding. If it requires grounding, follow manufacturer's directions. NEC 250-6 lists the exceptions for grounding portable and vehicle-mounted generators. If electricity is used from nearby buildings verify that it is acceptable to the base to use those sources. In all cases, ensure that all connections meet NEC requirements. Ensure that voltage, amperage, and circuit breakers are rated for the equipment to be used.
	Material handling could expose worker to injury.	Identify and avoid pinch points. Maintain communication with others involved in material handling. Use appropriate PPE.

ACTIVITY HAZARD ANALYSIS (AHA) #13
Site Restoration, Decontamination and Demobilization
PCB Hot Spot

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Strains from manually moving materials and equipment.	Use proper lifting techniques such as keeping back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use lifting devices whenever possible. Pre-employment back evaluations are recommended for craft workers who may be at greater risk of developing low back pain or low back injury. This evaluation may be requested by contacting our CMC and may be performed by the local medical provider under the approval and direction of our CMC. Surveys shall be performed by qualified persons to identify and evaluate tasks which might result in injuries due to ergonomic hazards. The focus of the surveys will be operations which involve the manual lifting and moving of objects of excessive weight or asymmetric size. Hand tools shall be selected to minimize the following stressors: chronic muscle contraction or steady force, extreme or awkward finger/hand/arm positions, repetitive forceful motions, excessive gripping, pinching, pressing with hand and fingers. Do not lift more than 50 pounds without assistance.
2. Use water and detergents to decontaminate equipment.	Workers could be exposed to potentially contaminated water.	BHASP and for protection from radioactivity. Wear PPE consisting of nitrile glove, polytyvek coveralls (or PVC rain suit), rubber, latex or other type of boot covers, safety glasses, face shield, hard hats, and steel-toe boots also required.
	Potential use of pressure washer could cause workers to be exposed to hazards of that operation.	Refer to an existing AHA for use of pressure washers.
	Areas can be slippery.	Wear slip-resistant boots.
3. Use pumps to fill drums or tanks with decontamination water.	Hoses present trip hazards. Connecting and disconnecting hoses could cause injury to workers. Use of compressed air to operate pumps. Or use of electricity to operate pumps.	Place hoses away from common paths of travel. Avoid stepping over or on hoses. Use caution when disconnecting hoses (they should be drained first) and do not pull apart with excessive force. Review AHA for use of compressor and compressor hoses if compressor is used. Follow NEC requirements regarding use of generator. Ensure that pump is grounded or double-insulated.
4. Move and handle drums.	Potential for lifting hazards, pinching finger between drums, moving and dropping drums.	Refer to AHA on drum handling.

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Job Steps	Possible Hazards	Protection Against Hazards
5. Seed and hydroseed site areas.	Worker usually stands on truck bed while it is driving so that spray can be directed, which presents a truck/equipment hazard on non-paved ground.	Ensure that truck operates at slow speed, especially when worker is on bed of truck. Ensure that worker is protected with fall protection. These trucks normally require the worker to wear a tie-off to a cage system. Review and follow manufacturer's directions.

Notes:

AHA – Activity Hazard Analysis
BHASP – Building-specific Health and Safety Plan
CMC – Corporate Medical Consultant
GFCI – ground fault circuit interrupter
NEC – National electrical Code
PCB – polychlorinated biphenyl
PPE – personal protective equipment
PVC – polyvinyl chloride