

**HEALTH & SAFETY PLAN
(ACCIDENT PREVENTION SAFETY PROGRAM PLAN)
ROCKY FLATS PLANT PHASE II RFI/RI 903 PAD,
MOUND, AND EAST TRENCHES AREAS, (OPERABLE UNIT 2)
ROCKY FLATS PLANT
APRIL 1991
CONTRACT NO. BA71956 PB
VERSION 0.0**

WCFS Project No. 4006
WCC Project No. 22567E

Prepared by:

WOODWARD-CLYDE

Prepared for:

**EG&G, ROCKY FLATS, INC.
Rocky Flats Plant**

REVIEWED FOR CLASSIFICATION/LICN1

By J. A. Nasham 10/11

Date 06-06-91

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QA-0102-000990

EMERGENCY TELEPHONE NUMBERS

Site Health and Safety Officer Gregg Miller	(303) 966-5874
Business Unit Health and Safety Officer Mike Sams	(303) 740-2700
WCFS Corporate Manager, Health and Safety Jerry Andersen	(303) 740-2700
24-Hour Installation Health/Safety Coordinator	(303) 966-2911
Fire	(303) 966-2911
Ambulance	(303) 966-2911
Poison Center	(303) 629-1123
Security	(303) 966-2911
Police	(303) 966-2911

THE W-C TRAILER IS LOCATED AT: 901 Contractor's Pad, Trailer No. 22

**NEAREST MEDICAL
SERVICES ARE LOCATED AT: Building 122**

Directions:

From the Contractor's trailer compound, take a northbound street to Central Avenue and turn left onto Central Avenue: Building 122 will be on the left side and slightly west of a guard building on the right after approximately 1.25 miles.

From the RFP eastern boundary, upon entering RFP off of Indiana Street, you will be on Central Avenue. Proceed approximately 3.5 miles: Building 122 will be on the left side.

From the RFP western boundary at Hwy. 93, proceed along the entrance road to just past the second gate, at which time you will be east bound on Cactus Avenue. Then turn left onto the first street past Second Street, (Third Street which is not marked). Proceed up Third Street past Building 125, which is on the left: the next building on the left will be the medical facility (Building 122).

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- ACETONE
- CARBON DISULFIDE
- CARBON TETRACHLORIDE
- CHLOROFORM
- 1,1-DICHLOROETHANE
- 1,1-DICHLOROETHYLENE (SYNONYM: VINYLIDENE CHLORIDE)
- DI (2 ETHYLHEXYL) PHTHALATE (SYNONYM: BIS (2 ETHYLHEXYL)
PHTHALATE
- ETHYL BENZENE
- ETHYLENE DICHLORIDE (SYNONYM: 1,2-DICHLOROETHANE)
- METHYL CHLOROFORM (SYNONYM: 1,1,1-TRICHLOROETHANE)
- DIPHENYLNITROSAMINE (SYNONYM: N-
NITROSODIPHENYLAMINE)
- TETRACHLOROETHENE (SYNONYM: PERCHLOROETHYLENE)
- 1,1,2,2-TETRACHLOROETHANE
- TRICHLOROETHYLENE (SYNONYM: TRICHLOROETHENE)
- VINYL CHLORIDE
- TOTAL XYLENES

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- OPERATING PROCEDURE NO. HS-203, RESPIRATOR INSPECTION, CARE,
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- OPERATING PROCEDURE NO. HS-501, PERSONNEL DECONTAMINATION
- OPERATING PROCEDURE NO. HS-509, SAFETY GUIDELINES FOR
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1.0
PROJECT IDENTIFICATION

Project Name: Phase II RFI/RI
903 Pad, Mound and East Trenches Areas
(Operable Unit 2)

Project Number: Woodward-Clyde Federal Services
(WCFS): 4006
Woodward-Clyde Consultants
(WCC): 22567E

Project Location: Rocky Flats Plant
Jefferson County, Colorado

**WCC Administrative
Operating Unit:** Denver ESE

WC Operating Group: Central

Project Manager: Alan F. Claybourn

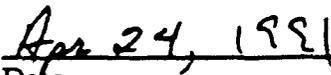
Author of the Plan: William M. Sams

Effective Dates: March 1, 1991 through December 31,
1992

APPROVALS



William M. Sams
Author



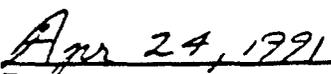
Date

Alan Claybourn, PE
Project Manager

Date



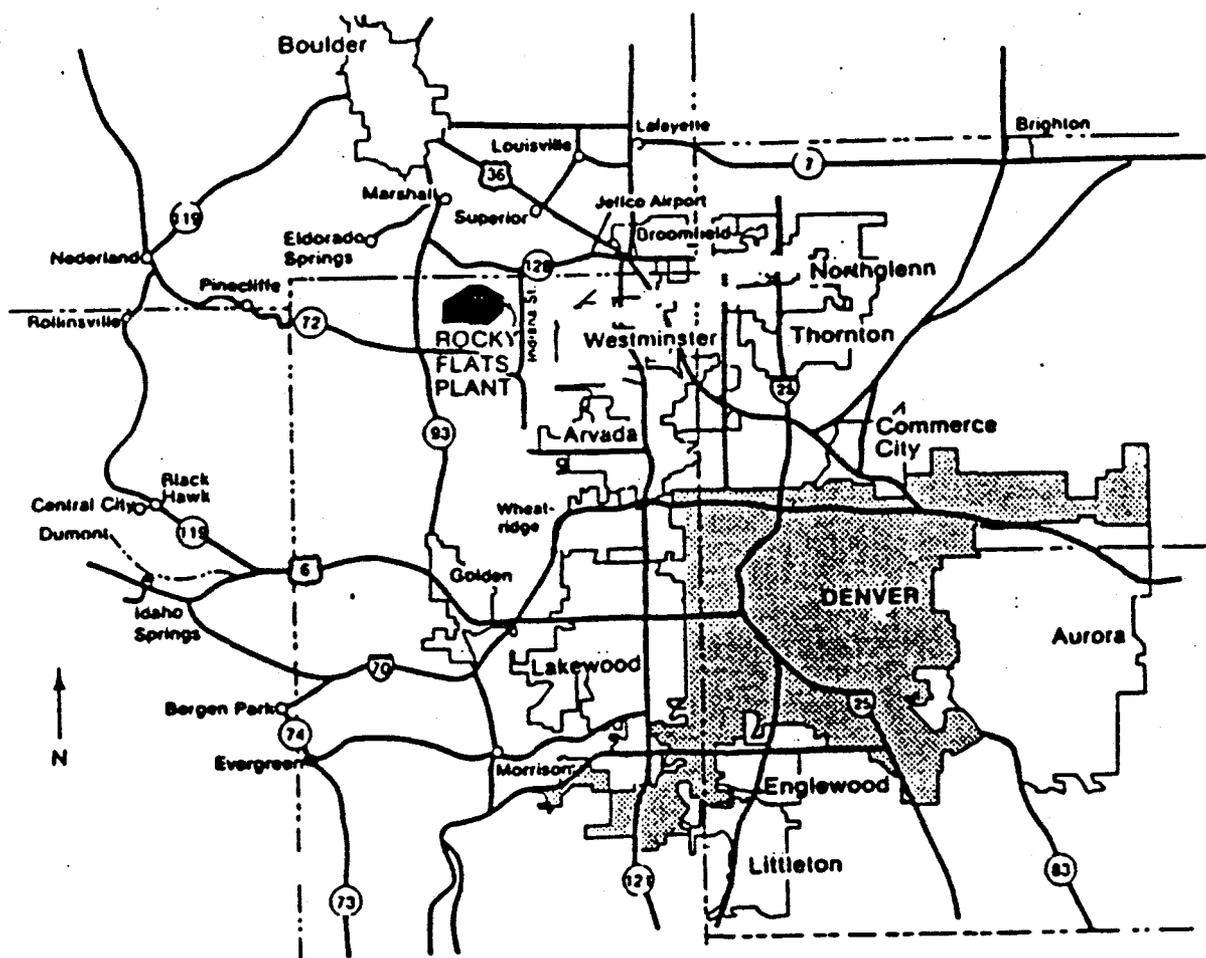
Jerry Andersen, PE, CIH
Corporate Manager, Health and Safety



Date

This Health and Safety Plan presents health and safety requirements and guidelines for performance of the work required for implementation of the Phase II RFI/RI Work Plan for the 903 Pad, Mound and East Trenches Areas at the Rocky Flats Plant (RFP). It is in compliance with applicable sections of 29 CFR 1910.120 and was prepared exclusively for use by employees of Woodward-Clyde (W-C) and its subcontractors. This plan shall not be modified or used after the expiration date without written approval by the Project Manager (PM), Health and Safety Officer (HSO), and Corporate Manager, Health and Safety (CMHS). In addition, this plan shall not be used by firms or persons not under contract to W-C without written approval by W-C's Executive Vice President-Practice. This plan is not valid until it is signed and dated by the Author, PM, and CMHS. Any modifications to this plan must be approved by the individuals signing on the title page or by their representatives.

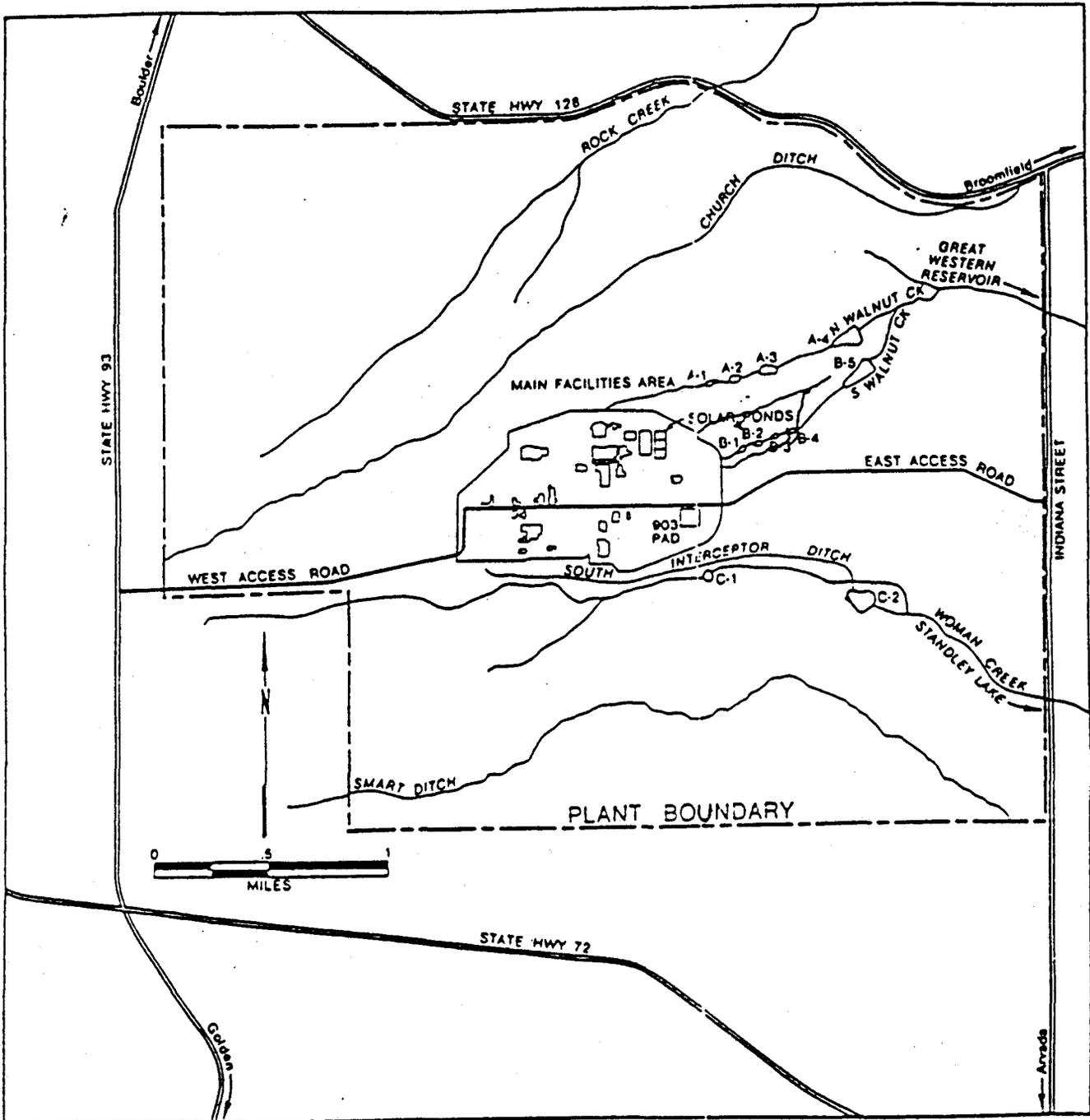
The project's location in relation to the Denver area is shown in Figure 1-1, Location Map. Figure 1-2, RFP General Map, shows the boundaries of RFP, and Figure 1-3: RFP - Facilities Map illustrates the developed area of RFP.



U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado
 OPERABLE UNIT 2
 PHASE II RPI/RI HEALTH AND SAFETY PLAN

 LOCATION MAP

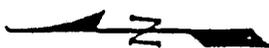
 Figure 1-1 1/22/91



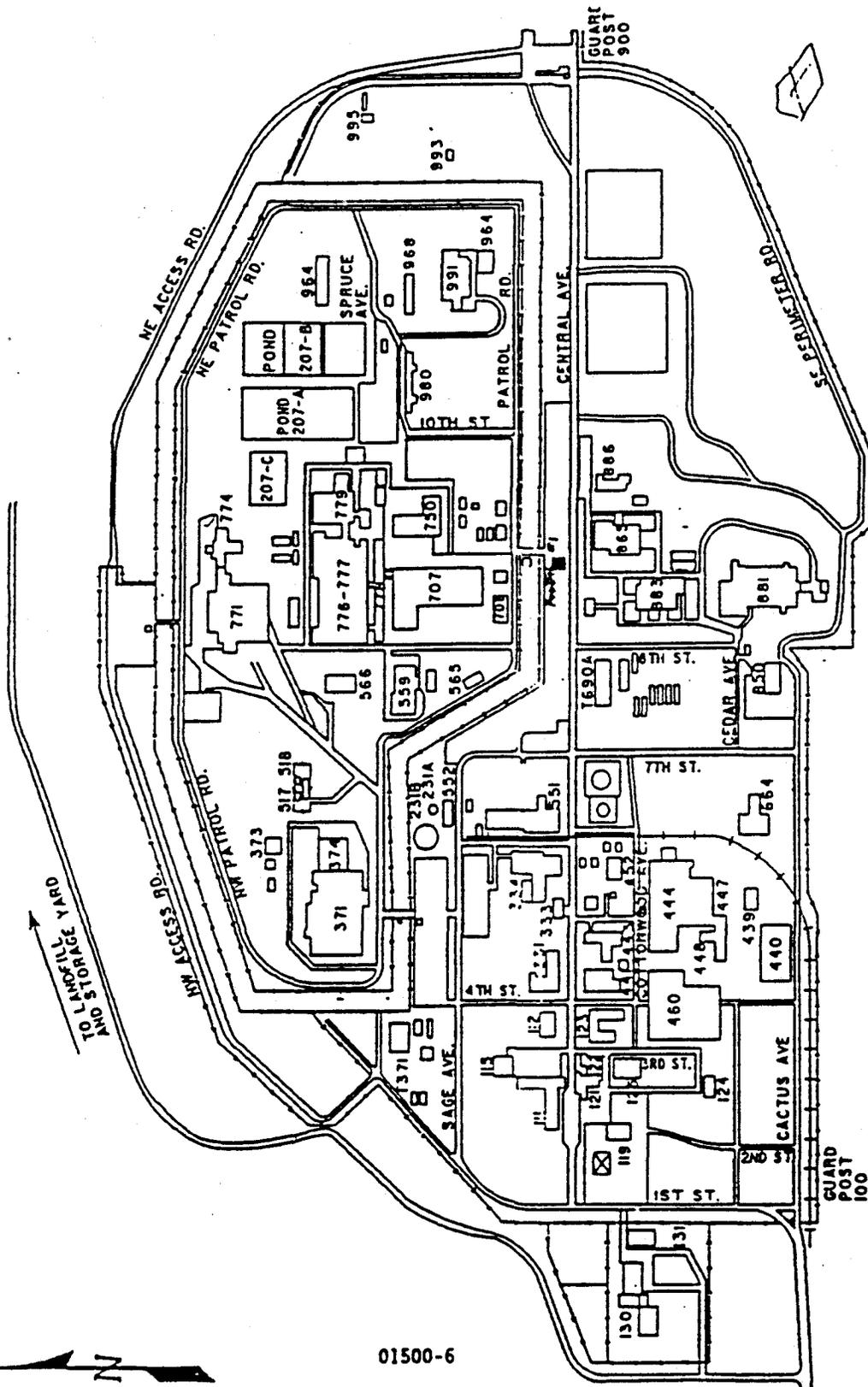
U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant, Golden, Colorado
 OPERABLE UNIT 2
 PHASE II RPI/RI HEALTH AND SAFETY PLAN

RFP - GENERAL MAP

Figure 1-2



01500-6



U.S. DEPARTMENT OF ENERGY
Rocky Plate Plant, Golden, Colorado
OPERABLE UNIT 2
PHASE II RPI/IN HEALTH AND SAFETY PLAN

RFP FACILITIES MAP

Figure 1-3

This section describes project staff organization, with regard to the roles of the various positions on this project as they pertain to health and safety. The responsibilities and authority of each subcontractor individual with a role in health and safety administration are presented in Table 2-1. The responsibilities of RFP individuals with a role in health and safety are presented in Attachment L.

W-C and W-C subcontractor personnel who have been identified as having a potential for being involved in the Operable Unit 2 field activities are listed below. Others will be identified as activities progress.

- Andersen, Jerry J.
- Bell, Richard
- Bender, Joseph
- Bender, Patricia
- Bender, Daniel R.
- Bianco, Ed
- Brooman, David L.
- Bufo, David
- Burgess, Dan
- Claybourn, Alan F.
- Conner, Darrel
- Cox, Jeff
- Dal Lago, Ed
- Doherty, John
- Durand, Roy L.
- Durand, Thomas K.
- Erwin, Larry
- Fleming, Richard L.
- Glasgow, Willard
- Hencmann, Robert
- Holmes, Ron
- Hosey, Bert Lee
- Jehn, John
- Jones, Chuck
- Jubenville, David M.
- LaRue, Bruce
- Lahn, Robert
- Mast, Edward
- May, Michael
- McGee, Gary Gale
- Merrel, Harvey
- Miller, Greg
- Miyoshi, Kerry
- Montgomery, Brian
- O'Brien, James P.
- Owenby, Robert K.
- Pacheco, Ken
- Ryan, Mike
- Rupp, Richard J.
- Rupp, Robert L.
- Sams, William
- Silva, Roderick W.
- Schreiber, Mike
- Shuey, Steven
- Spruce, David
- Terry, Tom
- Trimbach, Kent
- Van Santen, Luke
- Wilson, Robert
- Wigel, Matthew
- Zitek, James

Personnel to be assigned to field activities must be approved by the Site Safety Officer (SSO) or HSO before commencing with field work at RFP.

TABLE 2-1

RESPONSIBILITIES AND AUTHORITY OF HEALTH AND SAFETY PERSONNEL

VICE PRESIDENT-PRACTICE (VPP) D. Connors

Responsibilities

- Direct and monitor the implementation of the health and safety program.
- Advise the president on health and safety matters.
- Issue directives, advisories, and information to the WCFS Corporate Manager, Health and Safety (CMHS).
- Advise the CMHS on policy, liability, and professional practice issues.

Authorities

- Direct changes in the health and safety program.
- Determine and implement personnel disciplinary actions, as required.
- Review and approve the WCFS corporate health and safety budget.
- Approve and audit corporate health and safety expenditures.

CORPORATE MANAGER, HEALTH AND SAFETY (CMHS): Jerry Andersen

Responsibilities

- Track health and safety regulations and implement improvements to the WCFS health and safety program.
- Ensure records are maintained pertaining to medical surveillance, training, fit testing, chemical exposure, and incidents.
- Update health and safety manual.
- Manage medical surveillance program.
- Ensure health and safety training is obtained.

TABLE 2-1
(Continued)

- Provide industrial hygiene/chemical safety guidance to WCFS HSOs.
- Audit key aspects of health and safety program and report effectiveness to VPP.
- Coordinate health and safety activities of the business unit offices.
- Investigate reports of incidents or accidents and report accidents or incidents to the VPP.
- Coordinate a mutually beneficial cooperation with the WCC Health and Safety Administrator.

Authorities

- Approve the qualifications of employees to work at hazardous waste sites.
- Approve health and safety plans.
- Establish employee training and medical surveillance procedures.
- Suspend work on any project that jeopardizes the health and safety of personnel.
- Access project files to perform health and safety audits or investigate accidents/incidents.
- Remove individuals from projects if their conduct jeopardizes their health and safety or that of coworkers.
- Approve the appointments of business unit HSOs.
- Perform audits of office and/or field Health and Safety Activities.

BUSINESS UNIT HEALTH AND SAFETY OFFICER (HSO): William M. Sams

Responsibilities

- Coordinate with project managers in matters of health and safety.
- Report to CMHS on health and safety matters.

**TABLE 2-1
(Continued)**

- Develop or review and approve project health and safety plans prior to submittal to the CMHS for review.
- Conduct staff training and orientation on health and safety related activities.
- Appoint or approve site safety officers.
- Monitor compliance with health and safety plans and conduct site audits.
- Assist project managers to obtain required health and safety equipment.
- Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training.

Authorities

- Suspend work or otherwise limit exposures to personnel if health and safety plan appears to be unsuitable or inadequate.
- Direct personnel to change work practices if existing practices are deemed to be hazardous to health and safety of personnel.
- Remove personnel from projects if their actions or condition endangers their health and safety or the health and safety of coworkers.
- Approve restart of field activities following a temporary suspension that was based upon health and safety consideration.

PROJECT MANAGER AND SITE MANAGER: Al Claybourn/Ken Pacheco

Responsibilities

- Ensure that the project is performed in a manner consistent with the WC health and safety program.
- Provide the HSO with the project information needed to develop health and safety plans.
- Ensure that the project health and safety plans are prepared/approved and properly implemented in a timely manner.

TABLE 2-1
(Continued)

- Ensure that adequate funds are allocated to fully implement project health and safety plans.
- Ensure compliance with health and safety plans of contractor personnel.
- Coordinate with the HSO on health and safety matters.

Authorities (Safety Related)

- Assign an HSO approved SSO to project and, if necessary, assign a suitably qualified replacement.
- Temporarily suspend field activities, if health and safety of personnel are endangered, pending an evaluation and approval for resumption of work by the HSO and/or CMHS.
- Temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation and approval for resumption of work by the HSO, and/or CMHS.

SITE SAFETY OFFICER (SSO): Gregg Miller

The SSO will be appointed by the Project Manager with the approval of the HSO.

Responsibilities

- Direct health and safety activities onsite.
- Report immediately all safety-related incidents or accidents to the HSO and project manager.
- Assist project managers in all aspects of implementing health and safety plans.
- Maintain health and safety equipment on site.
- Implement emergency procedures as required.
- Approve personnel to work in the field on the Phase II RFI/RI for Operable Unit 2.

**TABLE 2-1
(Continued)**

Authorities

- Can temporarily suspend field activities, if health and safety of personnel are endangered, pending further consideration and approval for resumption of work by the HSO and/or CMHS.
- Can temporarily suspend an individual from field activities for infractions of the health and safety plan, pending further consideration and approval for resumption of work by the HSO and/or CMHS.

HEALTH AND SAFETY TECHNICIAN (HST): As assigned by the Site Manager

The health and safety technicians (HSTs) shall assist the SSO in implementing site Health and Safety Plans (HSP). An HST will be present (in the immediate vicinity) during all activities involving drilling, trenching, or sampling of wastes or soils. None of these activities shall be permitted in the absence of an HST.

Responsibilities

- Ensure that each individual within his/her jurisdiction complies with the provisions of the HSP.
- Provide on-site air monitoring during field activities.
- Audit safety practices used by on-site teams.
- Communicate with command post for on-site activities.
- Supervise decontamination, monitor workers for heat or cold stress, and distribute health and safety equipment.
- Document safety practices.
- Initiate appropriate emergency procedures.

Authority

The health and safety technician shall have the authority to stop work in case of an imminent safety hazard or potentially dangerous situation. After stopping work, the health and safety technicians shall immediately consult the SSO.

3.1 INTRODUCTION

The Rocky Flats Plant (RFP) began operations in 1952 and is part of the nationwide nuclear weapons development, production, and research complex currently administered by the Department of Energy (DOE). Primary production activities include fabrication of nuclear weapons components from beryllium, plutonium, stainless steel, and uranium; assembly of components; and chemical recovery and purification of recyclable transuranic radionuclides. The major classes of waste generated include solid waste, hazardous waste, radioactive waste, and mixed (radioactive and hazardous) waste.

Accidental releases of wastes have occurred over the years. The Environmental Protection Agency (EPA) published the final decision to add Rocky Flats to the National Priorities List in the October 4, 1989 Federal Register. Cleanup at Rocky Flats is being conducted under two major environmental laws according to an Interagency Agreement (IAG) (dated January 22, 1991) between the DOE, EPA, and CDH: (1) the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as Superfund), which addresses inactive waste disposal sites at the plant; and (2) the Resource Conservation and Recovery Act (RCRA), which addresses past and active storage and disposal areas of the plant.

3.2 PHYSICAL FEATURES

RFP is located northwest of Denver in central Colorado. The Plant consists of approximately 6,550 acres of federally owned land. Major buildings are located within a plant security area of approximately 400 acres. The plant security area is surrounded by a buffer zone of approximately 6,150 acres. The entire facility is roughly bounded by State Highway 93 on the west, State Highway 128 on the north, Indiana Street on the east, and State Highway 72 on the south.

3.3 TOPOGRAPHY

The natural environment of RFP and vicinity is influenced primarily by its proximity to the Front Range of the Rocky Mountains. The Plant is directly east of the north-south trending Rocky Mountains, with an elevation of approximately 6,000 feet above sea level. RFP is located on a broad, eastward-sloping plain of overlapping alluvial fans developed along the Front Range. The fans extend about 5 miles in an eastward direction from their origin in the abruptly rising Front Range and terminate on the east at a break in slope to rolling hills. The Continental Divide is about 16 miles west of the Plant. The Plant Security Area is located near the eastern edge of the fans on a terrace between stream-cut valleys (North Walnut Creek and Woman Creek).

3.4 HYDROLOGY

There is considerable interaction between surface water and groundwater. Surface water and groundwater flow in the unconfined system is generally from west to east.

3.5 BIOLOGY

Animal life inhabiting RFP and its buffer zone consists of species associated with Western prairie regions. The most common large mammal is the mule deer, with an estimated 100 to 125 permanent residents. There are a number of small carnivores, such as coyote, red fox, striped skunk, and long-tailed weasel. A profusion of small herbivores can be found throughout the Plant site and buffer zone, consisting of species such as the pocket gopher, white-tailed jackrabbit, and the meadow vole. Bull snakes and rattlesnakes are the most frequently observed reptiles. Eastern yellow-bellied racers have also been seen. Western plains garter snakes are found in and around many of the ponds.

3.6 HISTORY OF OPERABLE UNIT NO. 2 (OU2) AND OUTLYING AREAS

Site descriptions presented in the following sections are taken from the final Phase II RFI/RIFS Work Plan (Alluvial) Rocky Flats Plant 903 Pad, Mound and East Trenches Areas (Operable Unit 2) 12 April 1990. These descriptions are based on historical records, aerial photography review, and interviews with Plant personnel. Further characterization of each site based on other historical reports is also included in the following discussions.

For the purposes of this Health and Safety Plan, OU2 has been subdivided into four areas: the 903 Pad Area, the Mound Area, the East Trenches Areas, and Outlying Areas. The first three of these areas are further subdivided into Individual Hazardous Substance Sites IHSSs with an assigned reference number. The fourth area consists of outlying areas surrounding each IHSS.

3.6.1 903 Pad Area

Five IHSSs are located within the 903 Pad Area (Figure 3-1). These sites are:

- 903 Drum Storage Site (IHSS No. 112)
- 903 Lip Site (IHSS No. 155)
- Trench T-2 Site (IHSS No. 109)
- Reactive Metal Destruction Site (IHSS No. 140)
- Gas Detoxification Site (IHSS No. 183)

A brief history of each IHSS within the 903 Pad Area is provided in the following subsections.

3.6.1.1 903 Drum Storage Site (IHSS No. 112)

The 903 Drum Storage Site is located in the eastern portion of the Plant Security Zone. This area was used from October 1958 to January 1967 for storage of radioactively contaminated oil drums. Presented below is a description (extracted from Calkins, 1970) of drums stored at the Drum Storage Site.

"Most of the drums transferred to the field were nominal 55-gallon drums, but a significant number were 30-gallon drums. Not all were completely full. Approximately three-fourths of the drums were plutonium-contaminated, while most of the balance contained uranium. Of those containing plutonium, most were lathe coolant consisting of a straight-chain hydrocarbon mineral oil (Shell Vitrea) and carbon tetrachloride in varying proportions. Other liquids were involved, however, including hydraulic oils, vacuum pump oil, trichloro-ethylene, perchloroethylene, silicone oils, acetone still bottoms, etc. Originally, contents of the drums were indicated on the outside, but these markings were made illegible through weathering and no other good records were kept of the contents. Leakage of the oil was recognized early, and in 1959 or possibly earlier ethanalamine was added to the oil to reduce the corrosion rate of the steel drums."

Drum leakage was noted at the 903 Drum Storage Site in 1964 during routine drum handling operations (Dow Chemical, 1971). Corrective action consisted of transferring the contents of leaking drums to new drums and fencing the area to restrict access (Dow Chemical, 1971). Approximately 420 drums leaked to some degree, and, of these, an estimated 50 leaked their entire contents (Dow Chemical, 1971). An estimated 5,000 gallons of liquid (Freiberg, 1970) containing 5.3 curies (Ci) of plutonium leaked into the soil (Dow Chemical, 1971). A heavy rainstorm in 1967 spread contaminants to a ditch south and southeast of the drum storage site (Dow Chemical, 1971).

The shipment of drums to the 903 Drum Storage Site ended in January 1967 when drum removal efforts began. Removal of all drums and wastes was completed in June 1968.

Presented below is a chronology of the 903 Drum Storage Site cleanup as described by Freiberg (1970).

- From January 23, 1967 through March 10, 1967, uranium oil drums which were in good condition were transferred to Building 774 and processed.
- Building 903 . . . on March 10, 1967, started processing oil drums. This building was designed to prefilter the oil prior to transferring plutonium contaminated oil to Building 774 for final processing.

- From March 10, 1967 through May 18, 1967, there were a total of 191 drums of plutonium contaminated oil filtered and shipped to Building 774.
- On May 18, 1967, operations at Building 903 were discontinued due to the amount of time this process was taking.
- Drum-to-drum transfer in the field began May 18, 1967, and the drums were [SIC] shipped to Building 774 without prior filtration in Building 903.
- From March 17, 1967 through May 10, 1967, in addition to the plutonium transfers, there were 297 drums of uranium contaminated Alk-Tri waste shipped to Building 774 and processed.
- May 10, 1967 through May 28, 1968, a total of 4,826 drums containing 50 gallons of oil each were sent to Building 774 and processed.
- During the transfer operations, it was noted that at the bottom of all drums a deposit of sludge remained after removal of the oil. This sludge varied in depth from ½ inch to 3 inches and averaged approximately 1 inch. By drum counter results, the sludge within the empty drums contained a total of 5, 152 grams of plutonium. These empty drums were later disposed of by adding Oil Dry and MicroCel to absorb the sludge. The drums containing the plutonium sludge and absorbent were then incased in plastic, placed in boxes, and shipped to the burial grounds." The location of the burial grounds is not provided.

There were originally a total of 5,237 drums at the drum storage site when cleanup operations began in 1967. After transfer of the contents to new drums, 4,826 drums were transported to Building 774, of which 3,572 drums contained plutonium-contaminated oil. This leaves the contents of 411 drums unaccounted for. The most probable explanation for this discrepancy is a combination of the following factors according to Freiberg (1970):

- All of the drums originally sent to the storage site were not completely full
- Some of the volume was taken up by the sludge that was discarded with the empty barrels
- Leakage out of the barrels and onto the ground occurred

Information provided by Freiberg (1970) indicates that an estimated 5,000 gallons of oil leaked from drums onto the ground at the Drum Storage Site. This estimate was based on the memory and knowledge of those involved in site operations (Freiberg, 1970).

In November 1968, site grading began at the 903 Drum Storage Site in preparation for applying an asphalt cap over the area. This work included moving "slightly" contaminated soil from around to inside the fenced area (Freiberg, 1970). A total of 33 drums of radioactively contaminated rocks were removed from the area in May 1969, and two courses of clean fill material were placed over the site during the late summer of 1969. The asphalt was applied in October 1969, and in February 1970, additional road base course material was applied to soils directly east and south of the asphalt pad due to soil contamination (Freiberg, 1970).

The asphalt containment cover is rectangular and oriented north-south (370 feet) and east-west (395 feet). The pad slopes slightly to the northeast at a drop of 1 foot per 100 feet. The asphalt cover is approximately 8 centimeters (cm) (3.2 inches) thick and it is underlain by approximately 15 cm (6 inches) of loose gravel and 8 cm of soil fill.

3.6.1.2 903 Lip Site (THSS No. 155)

During drum removal and cleanup activities associated with the 903 Drum Storage Site, winds redistributed plutonium beyond the asphalt pad (not present at that time) to the south and east. An estimated 1 Ci of plutonium was redistributed beyond the pad, and, of that 1 Ci, approximately 0.56 Ci is believed to have been deposited in the 903 Lip Site (Barker 1982). The most contaminated area was immediately adjacent to the pad to the south and southeast.

Surveys at the time of the drum removal project and subsequent annual soil sampling from 1969 to 1972 showed a maximum plutonium concentration of 2,258 picoCuries per gram (pCi/g) in the top 5 cm (2 inches) of soil at the 903 Lip Site (Barker, 1982).

Soil cleanup efforts were undertaken in 1976, 1978, and 1984 to remove plutonium-contaminated soils from three different areas within the 903 Lip Site. The 1976 soil removal operation began in June 1976 and ended in September 1976. This cleanup consisted of hand-excavating contaminated soils from an area near the Reactive Metal Destruction Site until soil-contamination levels were below the detection limit of the Field Instrument for Detection of Low Energy Radiation (FIDLER). The detection limit of the FIDLER is 250 counts per minute (cpm) (Barker, 1982). The excavated area was covered with clean top soil and reseeded with native grasses. Thirty-five boxes, weighing a total of 125,000 pounds, were removed and shipped off site for disposal during the 1976 cleanup (Barker, 1982).

The 1976 soil-removal technique of hand-excavation was inefficient, considering the large amount of contaminated soils requiring removal at the 903 Lip Site. In June 1978, a second soil removal project began north of the 1976 removal using a front-end loader alone and with a bulldozer. All soil that exceeded 2,000 cpm, as determined by a FIDLER survey, was removed. Cleaned areas were resurveyed and soil removal continued until background readings (approximately 250 cpm by a FIDLER survey) were obtained. Topsoil was then applied to the excavated area, and the site was revegetated with native grasses. During the 1978 soil removal, 1,448 boxes, weighing approximately 4.7 million pounds, were removed and shipped off site (Barker, 1982).

Approximately 0.5 Ci of plutonium were removed from the 903 Lip Site during the two soil removal projects. This quantity is based on an average soil plutonium concentration of 545 pCi/g and a soil density of 1 gram per cubic centimeter (g/cm^3) (Barker, 1982).

A third soil cleanup was performed along the eastern edge of the 903 Lip Site in 1984. A total of 214 tri-wall pallets of contaminated soil were removed from the area. The excavated area was backfilled with clean topsoil (Setlock, 1984).

3.6.1.3 Trench T-2 Site (IHSS No. 109)

Trench T-2 is located south of the 903 Drum Storage Site and west of the Reactive Metal Destruction Site. This trench was used before 1968 for the disposal of sanitary sewage sludge and flattened drums contaminated with uranium and plutonium. This trench is believed to measure approximately 15 feet wide by 200 feet long by 5 feet deep (Rockwell International, 1987). Barrels were noted in the western end of Trench T-2 during 1987 investigations.

3.6.1.4 Reactive Metal Destruction Site (IHSS No. 140)

The Reactive Metal Destruction Site is located on the hillside south of the 903 Drum Storage Site. This site was used during the 1950s and 1960s primarily for the destruction of lithium metal (U.S. DOE 1986). Approximately 400 to 500 pounds of metallic lithium were destroyed on the ground surface in this area and the residues, primarily nontoxic lithium carbonate, buried. Smaller unknown quantities of sodium, calcium, magnesium, solvents, and unknown liquids were also destroyed at this location (Illsley, 1978).

Based on review of historical aerial photography, the Reactive Metal Destruction Site was used from 1968 to 1971. Barrels were noted in the southwestern corner of IHSS No. 140 during 1987 investigations (U.S. DOE, 1990).

3.6.1.5 Gas Detoxification Site (IHSS No. 183)

Building 952, located south of the 903 Drum Storage Site, was used to detoxify various gases from lecture bottles between June 1982 and August 1983. The lecture bottles held approximately 1 liter of compressed gas each. The gases consisted of various types of nitrogen oxides, chlorine, hydrogen sulfide, sulfur tetrafluoride, methane, hydrogen fluoride, and ammonia that were used in Plant research and development work. Gas detoxification was accomplished by using various commercial neutralization processes available at the time. After neutralization, glassware used in the process was triple-rinsed, crushed, and deposited in the present landfill. The neutralized gases were released to the environment during detoxification.

3.6.2 Mound Area

The Mound Area is composed of four sites (Figure 3-1). These are:

- Mound Site (IHSS No. 113)
- Trench T-1 Site (IHSS No. 108)
- Oil Burn Pit No. 2 Site (IHSS No. 153)
- Pallet Burn Site (IHSS No. 154)

A brief history of each IHSS within the Mound Area is provided in the following subsections.

3.6.2.1 Mound Site (IHSS No. 113)

The Mound Site, located north of Central Avenue in the eastern Plant Security Zone was used between April 1954 and September 1958 for drum disposal. Approximately 1,405 drums primarily containing depleted uranium and beryllium-contaminated lathe coolant (a mixture of about 70 percent hydraulic oil and 30 percent carbon tetrachloride) were placed at the Mound Site (Rockwell International, 1987). Records do not indicate that the barrels were actually buried (Calkins, 1970). It is likely that some of the coolant also contained enriched uranium and plutonium (Rockwell International, 1987). Some drums also contained Perclene, a brand name of tetrachloroethene (PCE) (Sax and Lewis, 1987). Some of the drummed wastes placed in the Mound Site were in solid form (Rockwell International, 1987).

Cleanup of the Mound Site was accomplished in May 1970, and the materials removed were packaged and shipped to an off-site DOE facility for disposal. Listed below is an inventory of the 1,405 drums removed from the Mound Site in 1970 (Dow Chemical 1971).

<u>No. of Drums</u>	<u>Contents</u>
903	30-gallon drums of depleted uranium solid waste
21	30-gallon drums of depleted uranium oil waste
12	30-gallon drums of plutonium-contaminated oil waste. "The plutonium content was so low that it was measurable only by the most sensitive laboratory techniques."
102	55-gallon drums of depleted uranium solid waste
282	55-gallon drums of depleted uranium oil waste
<u>85</u>	55-gallon drums of enriched uranium oil waste
1,405	TOTAL DRUMS

Subsequent surficial soil sampling in the vicinity of the excavated Mound Site indicated 0.4 to 51 pCi/g activity. This radioactive contamination is thought to have come from the 903 Drum Storage Site via wind dispersion rather than from drums previously stored at the Mound Site as it was limited to the surface (Rockwell International, 1987).

3.6.2.2 Trench T-1 Site (IHSS No. 108)

The trench was used from 1954 until 1962 and contains approximately 125 drums filled with approximately 25,000 kilograms (kg) (55,115 pounds) of depleted-uranium chips (Dow Chemical, 1971) and plutonium chips coated with a small amount of lathe coolant (Rockwell International, 1987). The estimated dimensions of Trench T-1 are 15 feet wide by 200 feet long by 5 feet deep. Trench T-1 was covered with about 2 feet of soil, and the corners have been marked.

Weed-cutting activities in October and November 1968 unearthed two drums inadequately covered with fill material. Both drums were sampled and analyzed for total plutonium and uranium content before they were disposed off site (Illsely, 1983). The off-site disposal location is not known. One of the drums sampled contained an oil-water mixture with 55 pCi/l of

plutonium and 2.3×10^5 pCi/g of uranium. The other drum contained an oily sludge with 4.6 pCi/g of plutonium and 1.2×10^6 pCi/g uranium (Illsley, 1983).

3.6.2.3 Oil Burn Pit No. 2 (IHSS No. 153)

Oil Burn Pit No. 2 is actually two parallel trenches that were used in 1957 and from 1961 to 1965 to burn approximately 1,082 drums of oil-containing uranium (Rockwell International, 1987). In March and April of 1957, the contents of an estimated 169 uranium contaminated waste oil drums were burned. No further burning took place until 1961. Frequent burning of waste oil took place from June 1961 to May 1965. The contents of approximately 914 drums were burned during this time. The drums used for the oil burning operations were generally reused; however, 300 empty drums were discarded by flattening and burying them in the burning pits (Dow Chemical, 1971). The uranium concentrations of the burned waste oil is unknown. The residues from the burning operations and the flattened drums were covered with backfill. In 1978, the area was excavated to a depth of approximately 5 feet and 239 boxes (56 cubic feet per box) of contaminated soil were removed and shipped off site to an authorized DOE disposal site (Illsley, 1983). The off-site disposal location was not known.

3.6.2.4 Pallet Burn Site (IHSS No. 154)

An area southwest of Oil Burn Pit No. 2 was reportedly used to destroy wooden pallets in 1965. The types of hazardous substances or radionuclides that may have been spilled on these pallets is unknown. This site was cleaned up and reclaimed in the 1970s (U.S. DOE, 1986).

3.6.3 East Trenches Area

The East Trenches Area consists of nine burial trenches and two spray irrigation sites. A brief history of these IHSSs is provided in the following subsections.

- Trench T-3 (IHSS No. 110)
- Trench T-4 (IHSS No. 111.1)

- Trench T-5 (IHSS No. 111.2)
- Trench T-6 (IHSS No. 111.3)
- Trench T-7 (IHSS No. 111.4)
- Trench T-8 (IHSS No. 111.5)
- Trench T-9 (IHSS No. 111.6)
- Trench T-10 (IHSS No. 111.7)
- Trench T-11 (IHSS No. 111.8)
- East Spray Irrigation Sites (IHSS Nos. 216.2 and 216.3)

3.6.3.1 Trenches T-3 through T-11 (IHSS Nos. 110 and 111.1-111.8)

Trenches T-3, T-4, T-10, and T-11 are located north of the east access road, and Trenches T-5 through T-9 are south of the east access road. The wastes in these trenches have not been disturbed since their burial. These trenches, as well as Trench T-2 discussed earlier, were used from 1954 to 1968 for disposal of approximately 125,000 kg of sanitary sewage sludge contaminated with uranium and plutonium and approximately 300 flattened empty drums contaminated with uranium (Illsley, 1983). Radiation content of the *sewage sludge ranged from 382 pCi/g to 3,590 pCi/g* (Owen and Steward, 1973). Trenches T-4 and T-11 also contain some plutonium- and uranium-contaminated asphalt planking from the solar evaporation ponds (Illsley, 1983).

According to Illsley (1983), soil samples have been collected from Trenches T-9, T-10, and T-11, and the results were as follows:

"Samples from T-11 contained plutonium in the range from 4.5 to 50 pCi/g and uranium-238 in the range between 0.9 and 158 pCi/g. Trench T-10 was found to contain uranium in the range between 40 and 126 pCi/g and Pu-239 in the range from 0.18 to 14 pCi/g Plutonium concentrations in collected samples varied from 0.40 to 68 pCi/g and uranium was found in the range between 2.4 and 450 pCi/g in Trench T-9."

The sampling dates and collection methods of these samples are unknown.

3.6.3.2 East Spray Irrigation Sites (IHSS Nos. 216.2 and 216.3)

IHSSs 216.2 and 216.3 were used for spray irrigation of sewage treatment plant effluent. These areas have been designated as IHSSs because effluent containing low concentrations of chromium was inadvertently sprayed in the area in February and March 1989. The chromium entered the sanitary sewage treatment plant on February 23, 1989 subsequent to a spill of chromic acid in Building 444 (Rockwell International, 1989).

3.6.4 Outlying Areas

The Outlying Areas are defined as those areas that are not within the boundaries of an IHSS but that surround any given IHSS. There is a potential for contaminant plumes being present in Outlying Areas.

This Health and Safety Plan covers activities associated with the Phase II RFI/RI for Operable Unit 2. The required sampling and investigative activities are described in the Phase II Work Plans for alluvial and bedrock components of the RFI/RI and in the Rocky Flats Environmental Restoration Program Standard Operating Procedures (SOPs). The planned start date is May 1991 and the activities are expected to take 12 to 18 months to complete. The specific activities covered by this plan follow:

- Surveying and staking borehole and monitoring well locations
- Nonintrusive geophysics
- Well drilling and construction (approximately 150 to 200 wells)
- Borehole drilling (approximately 60 to 80 boreholes)
- Shallow (less than 1 inch deep) surface soil samples at approximately 1,500 locations
- Trenching to allow for sampling of soil from the sides of shallow (approximately 3 feet deep) trenches at approximately 24 locations
- Packer testing
- Personnel decontamination
- Equipment decontamination
- Core logging
- Operating a main decontamination facility

5.1 OVERVIEW

A review of Rocky Flats Plant history and previous studies of the regional animal life, climate, and the general industry-wide experience with using heavy equipment, indicates that there are several sources of potential hazards to be assessed. The potential hazards have been placed into one of five classifications listed below.

- Encounters with native wildlife (See Attachment A for a narrative concerning the types of wildlife found at Rocky Flats Plant and the associated diseases).
- Climatic conditions such as temperature extremes, thunder storms (lightning) and high winds.
- Working around light and heavy equipment.
- Radioisotopes in the soils and groundwater (Attachment B provides basic information regarding characteristics of the radioisotopes likely to be encountered).
- Nonradioactive potentially hazardous chemicals in soils and groundwaters (Attachment C contains Material Safety Data Sheets (MSDSs) for nonradioactive potentially hazardous chemicals known to exist on site.

5.2 METHODOLOGIES USED TO COMPLETE THE HAZARD ASSESSMENTS

The following is a brief summary of how hazard assessments were accomplished. Detailed information regarding how hazard assessments were accomplished is presented in various attachments as specified in the text below. A summary of results from the hazard assessment process is given in Subsection 5.3.

5.2.1 Methodology Employed to Assess Wildlife, Environmental Extremes, and Working With Equipment

There is a certain likelihood for each of the potential hazard classifications listed in Subsection 5.1 above to become a true hazard. But we have not attempted to estimate the likelihood of such occurrences for all classifications of potential hazards. Our assessment of the first three classifications of potential hazards (encounters with native wildlife, environmental extremes, and working with equipment) is subjective and indicates that they will exist at each work site, and, therefore, that steps must be taken to minimize the hazard (see Section 6.0, General Health and Safety Requirements; Section 7.0, Site-Specific Health and Safety Requirements; and various standard operating procedures (SOPs) contained in Attachment D).

5.2.2 Methodology Employed to Assess Radioisotopes and Nonradioactive Potentially Hazardous Chemical Exposures

Our assessments of the last two classifications of potential hazards (radioisotopes in the soils and groundwater and nonradioactive potentially hazardous chemicals in soils and groundwaters) are presented by discussing the three potential routes of exposure. The routes of exposure discussed are absorption and injection (through the skin), ingestion, and inhalation.

5.2.2.1 The Absorption, Injection, and Ingestion Routes Of Exposure

A subjective manner of evaluation was used to assess the first three routes of exposure. Our assessment indicates that these three routes of exposure will exist at each work site, and, therefore, that steps must be taken to minimize exposures by these routes. Methods of decreasing the likelihood of an exposure occurring via these routes are provided in Section 6.0, General Health and Safety Requirements; Section 7.0, Site-Specific Health and Safety Requirements; and various standard operating procedures (SOPs) contained in Attachment D.

5.2.2.2 The Inhalation Route of Exposure

Mathematical modeling was used to estimate maximum airborne concentrations and thereby assess the potential for inhalation hazards to exist (see Attachment E, Estimating Airborne Concentrations of Radioisotopes From Soils; and Attachment F, Estimating Airborne Concentrations of Volatile and Semivolatile Organic Compounds In Groundwater). Estimates of airborne concentrations of radioisotopes assume the airborne dust concentration to be 450 $\mu\text{g}/\text{m}^3$.

No attempt has been made to estimate airborne concentrations of organic compounds, metals, pesticides, or PCBs from soils for the following reasons:

- There is no prescribed method for estimating airborne concentrations of organic compounds from soils likely to be emitted up through a hollow-stem auger. However it is accepted practice industry wide to accomplish organic vapor measurements at each site of intrusive activity to monitor for the airborne concentration of organics and we will accomplish those measurements.
- The levels of metals, pesticides and PCBs found during Phase I RI are generally so low as not to be a potential inhalation hazard for occupational exposures.

With two exceptions, the maximum estimated airborne concentrations are below the level requiring classification as a potential inhalation hazard. The maximum estimated airborne concentration of plutonium-239 (Pu-239) at the 903 Pad (IHSS No. 112) is sufficient to indicate classification as an inhalation hazard is appropriate (see Subsection 5.3.2.1). The maximum estimated airborne concentration of vinyl chloride from groundwater in the Outlying Area north of the Mound Area is sufficient to indicate classification as a potential inhalation hazard is appropriate (see Subsection 5.3.2.21).

5.2.3 Classification of Maximum Expected Airborne Concentrations

The following terminology and criteria have been adopted for use in this Health and Safety Plan when discussing the results of calculations to determine the airborne concentration of a potential contaminant:

- **Derived Air Concentration (DAC):** For the purposes of this health and safety plan a DAC is an upper limit established by the Department of Energy (DOE) in DOE Order 5480.11, Radiation Protection for Occupational Workers, dated December 21, 1988. However, it is the policy of both DOE and W-C to maintain personnel exposures to ionizing radiation as low as reasonably achievable. Exposures above the DAC may increase the potential for occurrence of genetic effects, carcinogenic effects, and/or other health effects.
- **Permissible Exposure Limit (PEL):** For the purposes of this health and safety plan a PEL is an upper limit established by OSHA or another nationally recognized body in lieu of a existing OSHA standard for occupational exposures to nonradioactive airborne substances. Exposures above the PEL may increase the potential for ill effects. The potential ill effect is dependent upon the specific substance involved.
- **No Potential Inhalation Hazard:** The maximum estimated airborne concentration of a radioisotope is less than 1/10th the applicable DAC or the maximum estimated vapor concentration of a substance is less than 1/2 the PEL.
- **Potential Inhalation Hazard:** The maximum estimated airborne concentration of a radioisotope is equal to or greater than 1/10th the applicable DAC or the maximum estimated vapor concentration of a substance is equal to or greater than 1/2 the PEL. In any case, the maximum airborne concentration must be less than the applicable DAC or PEL.

- **Inhalation Hazard:** The estimated airborne concentration of a radioisotope is equal to or greater than the applicable DAC or PEL.

5.3 HAZARD ASSESSMENTS FOR EACH IHSS SITE AND OUTLYING AREAS

The following subsections contain our assessments of the hazards in a worst-case scenario when working at each IHSS and Outlying Area. Hazard assessments for maintenance activities associated with a main decontamination facility and during core logging are provided in Section 5.4. These assessments do not consider the effects of implementing the practices and required exposure controls described in Section 6.0, General Health and Safety Practices, or in Section 7.0, Site-Specific Health and Safety Requirements.

5.3.1 Wildlife, Climatic Conditions, and Working With Equipment

Although not specified under each IHSS, our assessment indicates the following potential hazards will exist at each field work site:

Potential hazards considered to be a plausible source of harm at each site include encounters with wildlife and their associated diseases, climatic conditions such as temperature extremes, thunder storms (lightning) and high winds, and working around light and heavy equipment.

5.3.2 Radioisotopes and Nonradioactive Potentially Hazardous Chemicals

The absorption, injection, and ingestion routes of entry are considered to be a source of potentially hazardous exposures to radioisotopes and nonradioactive hazardous chemicals at each site.

The inhalation route of exposure for each IHSS is discussed in the following subsections. The worst-case maximum airborne concentrations of radioisotopes known to exist in each IHSS are shown in Attachment E, Estimating Airborne Concentrations of Radioisotopes From Soils and Summarized in Table 5-1. The worst-case maximum airborne concentrations of organics known

TABLE 5-1
Estimated Airborne Concentrations and Potential
Hazard of Radionuclides From Soils

IISS NO / NAME	ISOTOPES FOUND	SOIL ACTIVITY USED IN CALCULATIONS (pCi/lb)	ESTIMATED AIRBORNE ACTIVITY (pCi/M ³)	DAC (pCi/M ³)	HAZARD ASSESSMENT
112/903 Pad	Pu-239	20,344	9.2	6	IH
	Am-241	2,270	1.02	3	PIH
155/903 Pad Lip Site	Pu-239	190	0.0053	6	NPIH
	Am-241	0.25	0.00011	2	NPIH
	U-233 & U-234	0.87	0.00009	20	NPIH
	U-238	0.81	0.00004	20	NPIH
	Sr-90	1.6	0.00072	60,000	NPIH
	Sr-90	1.6	0.00072	2,000	NPIH
108-111.8/T-1 through T-11 (all trenches)**	Pu-239	64	0.0006	6	NPIH
	U-238	430	0.202	20	NPIH
140/Reactive Metals Destruction Site	Pu-239	100	0.045	6	NPIH
	Am-241	13	0.0009	2	NPIH
	U-233 & U-234	3.3	0.0015	20	NPIH
	U-238	2.2	0.00099	20	NPIH
	Sr-90	1.6	0.00072	60,000	NPIH
	Sr-90	1.6	0.00072	2,000	NPIH
113/Mound Site	***	51	0.023	3	NPIH
216.2 & 216.3/East Spray Field (Center & South Areas And Outlying Areas	Pu-239	11.34	0.005	7	NPIH
183/Gas Detoxification Site	****				NPIH
153/Old Burn Pu	****				NPIH
154/Pallet Burn Pu	****				NPIH

* Definitions (see subsection 5.2.3): PIH - Potential Inhalation Hazard; NPIH - No Potential Inhalation Hazard; IH - Inhalation Hazard

** The amount of radioactivity/gram of soil has not been determined within all trenches. Although, the radioactivity/gram has been determined in three trenches with the highest activities found in Trench T-9 (IISS 111.6) and those values have been assigned to all trenches for the purposes of our hazard assessment.

*** A review of the site history indicates a soil activity of 51 pCi/g of an unspecified radionuclide has been noted. We have calculated the maximum expected airborne activity and compared it to the most restrictive DAC (Am-241) for the isotopes found at Rocky Flats Plant.

**** A review of the history of this IISS does not indicate radionuclides were disposed of here.

to exist in groundwaters are shown in Attachment F, Estimating Airborne Concentrations of Organics in Groundwaters.

5.3.2.1 903 Drum Storage Site (IHSS No. 112)

The maximum estimated airborne concentrations of Pu-239 (DAC=6 pCi/m³) and Americium-241 (Am-241) (DAC = 2 pCi/m³) that could be generated by disturbing soils beneath the asphalt pad indicates that classification as an inhalation hazard is appropriate. Although analysis of air samples collected east of the 903 Pad during 1964 through 1970 indicated that the maximum monthly average of daily sampling events was 0.25 pCi of total activity. And, at no time did values from the air samplers indicate that permissible levels of plutonium contamination in air had been exceeded. These analysis results are noteworthy because they represent conditions as the original contaminated soil surface was being graded in preparation for construction of the asphalt pad present today. Nonetheless, we consider airborne radioisotopes to be an inhalation hazard.

The maximum estimated airborne concentration of trichloroethene (TCE) and tetrachloroethene (PCE) that could be generated by disturbing groundwater beneath the asphalt pad does not indicate that classification as a potential inhalation hazard is appropriate.

5.3.2.2 903 Lip Site (IHSS No. 155)

The maximum estimated airborne concentrations of radioisotopes that could be generated by disturbing soils does not indicate that classification as a potential inhalation hazard is appropriate. The following radioisotopes are known to be present and were considered in this assessment: Pu-239; Am-241; uranium-233 (U-233), uranium-234 (U-234), and uranium-238 (U-238); strontium-89 (Sr-89) and strontium-90 (Sr-90).

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate that classification as a potential inhalation hazard is appropriate. TCE and PCE nonradioactive

potentially hazardous substances known to be present in groundwater and were considered in this assessment.

5.3.2.3 Reactive Metals Destruction Site (IHSS No. 140)

The maximum estimated airborne concentrations of radioisotopes that could be generated by disturbing soils does not indicate that classification as a potential inhalation hazard is appropriate. The following radioisotopes are known to be present and were considered in this assessment: Pu-239; Am-241; U-233, U-234, and U-238; Sr-89 and Sr-90.

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate that classification as a potential inhalation hazard is appropriate. The following nonradioactive potentially hazardous substances are known to be present in groundwater and were considered in this assessment: TCE, PCE, and CCl₄.

5.3.2.4 Gas Detoxification Site (IHSS No. 183)

Radionuclides are not considered to be a potential inhalation hazard in this IHSS area based upon a review of the site history and soil sampling results from the area.

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate that classification as a potential inhalation hazard is appropriate. The following nonradioactive potentially hazardous substances are known to be present in groundwater and were considered in this assessment: TCE, PCE, and CCl₄.

5.3.2.5 Mound Site (IHSS No. 113)

The maximum estimated airborne concentrations of radioisotopes that could be generated by disturbing soils does not indicate that classification as a potential inhalation hazard is

appropriate. Any of the following radioisotopes may be present: Pu-239; Am-241; U-233, U-234, and U-238; Sr-89 and Sr-90. The phrase "may be present" is used because although a soil activity of 51 pCi/gm has been reported, the isotope was not identified. Results of calculations to determine the maximum airborne concentration were compared to the most restrictive DAC for the isotopes that may be present (Am-241).

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate that classification as a potential inhalation hazard is appropriate. The following nonradioactive potentially hazardous substances are known to be present in groundwater and were considered in this assessment: TCE and PCE.

5.3.2.6 Oil Burn Pit No. 2 (IHSS No. 153)

Radionuclides are not considered to be a potential inhalation hazard in this IHSS area based upon a review of the site history and soil sampling results from the area.

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate that classification as a potential inhalation hazard is appropriate. The following nonradioactive potentially hazardous substances are known to be present in groundwater and were considered in this assessment: TCE and PCE.

5.3.2.7 Pallet Burn Pit (IHSS No. 154)

Radionuclides are not considered to be a potential inhalation hazard in this IHSS area based upon a review of the site history and soil sampling results from the area.

Airborne concentrations of nonradioactive potentially hazardous substances generated from groundwater are not anticipated in this IHSS area based upon a review of the site history and groundwater sampling results from the area.

5.3.2.8 Trenches T-1 Through T-11 (IHSSs Nos. 108 Through 111.8)

Although not all of the Trenches have been sampled to determine if radioactivity is present, Trench T-9 was found to have the highest soil activity of the trenches that have been sampled.

And in the interest of being conservative, the soil activity found in Trench T-9 was used to assess the potential hazard for working at all trenches within OU2.

The maximum estimated airborne concentrations of radioisotopes that could be generated by disturbing soils does not indicate that classification as a potential inhalation hazard is appropriate. The following radioisotopes are known to be present and were considered in this assessment: Pu-239 and U-238.

The maximum estimated airborne concentration of nonradioactive potentially hazardous substances that could be generated by disturbing groundwater does not indicate classification as a potential inhalation hazard is appropriate. The following nonradioactive potentially hazardous substances are known to be present in groundwater and were considered in this assessment: TCE and CCL₄.

5.3.2.9 East Spray Field, Center Area (IHSS No. 216.2)

Radionuclides are not considered to be a potential inhalation hazard in this IHSS area based upon a review of the site history and soil sampling results from the area.

Airborne concentrations of nonradioactive potentially hazardous substances generated by disturbing groundwater are not anticipated in this IHSS area based upon a review of the site history and groundwater sampling results from the area.

5.3.2.10 East Spray Field, South Area (IHSS No. 216.3)

Radionuclides are not considered to be a potential inhalation hazard in this IHSS area based upon a review of the site history and soil sampling results from the area.

Airborne concentrations of nonradioactive potentially hazardous substances generated from ground water are not anticipated in this IHSS area based upon a review of the site history and ground water sampling results from the area.

5.3.2.11 Outlying Areas (Non-IHSS Sites Within OU2)

Radionuclides are not considered to be a potential inhalation hazard in Outlying Areas based upon a review of the site history and soil sampling results from the area.

With one exception, potentially hazardous airborne concentrations of nonradioactive hazardous substances generated by disturbing groundwater are not anticipated in this area based upon a review of the site history and groundwater sampling results from the area. The one exception is the Outlying Area north of the Mound Area. The maximum estimated airborne concentration of vinyl chloride from groundwater indicates that classification as a potential inhalation hazard is warranted.

5.4 HAZARD ASSESSMENTS FOR MAINTENANCE ACTIVITIES ASSOCIATED WITH A MAIN DECONTAMINATION FACILITY AND CORE LOGGING ACTIVITIES

The following subsections contain our assessments of the hazards in a worst-case scenario when conducting maintenance activities at a main decontamination facility and during core logging activities. These assessments do not consider the effects of implementing the practices and required exposure controls described in Section 6.0, General Health and Safety Practices, or in Section 7.0, Site-Specific Health and Safety Practices.

5.4.1 Wildlife, Climatic Conditions, and Working With Equipment

Our assessment of these potential hazards is that they will exist at the MDF and during core logging operations conducted in the field.

5.4.2 Radioisotopes and Nonradioactive Potentially Hazardous Chemicals

The absorption, injection, inhalation, and ingestion routes of entry are considered to be a source of potentially hazardous exposures to radioisotopes and nonradioactive hazardous chemicals at the MDF and during core logging operations.

6.1 MEDICAL SURVEILLANCE

All W-C field staff shall be active participants in the W-C medical surveillance program or its equivalent. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, preferably an occupational physician. The examination shall include the tests, procedures, and frequencies described in Attachment G. And, although not specified in Attachment G, the examination will include a baseline and exit bioassay sample for radioisotopic analyses.

Radiation dosimeters will be furnished by RFP and are required for all field workers.

6.2 SAFETY TRAINING

Employees shall not participate in field activities until they have been trained to a level required by their job function and responsibility. Trainers shall have received a level of training higher than and including the subject matter of the level of instruction they are providing. All training and field experience shall be certified. Training requirements are discussed below.

6.2.1 Forty-Hour Basic Training

All field employees must have completed the 40-hour basic health and safety training required under 29 CFR 1910.120 and receive 8-hour annual refresher training thereafter.

6.2.2 Three-Day On-Site Supervision

All field employees shall be required to receive a minimum of 3 days of on-site training under the supervision of a trained and experienced supervisor. On-site time under supervision shall be documented.

6.2.3 On-Site Supervisor Training

The on-site supervisor (site manager) must have completed the basic 40-hour training course, 3 days of on-site training, first aid training, and at least 8 hours of specialized training on managing hazardous waste operations. The 8 hours of specialized training shall include instruction covering the WC health and safety program, employee training program, personal protective equipment program, spill containment procedures, and health hazard monitoring procedures and techniques.

6.2.4 Site Safety Officer (SSO) Training

The Site Safety Officer must have completed the 40-hour training, 3-day on-site supervision, and first aid training.

6.2.5 Site-Specific Safety Orientation Meeting

A site-specific safety orientation meeting shall be conducted for all project field staff, including subcontractors, prior to commencement of field activities. The following topics will be discussed at this meeting:

- Names of health and safety personnel and alternates responsible for site health and safety
- Health and safety organization
- Hazards at the site
- Exposure risk
- Personal protective equipment to be used
- Personnel and equipment decontamination procedures
- Air monitoring
- Emergency procedures

All field personnel must be provided with and read a copy of this Health and Safety Plan. At the end of the meeting, attendees should be informally quizzed to assess their understanding of the health and safety requirements, and should sign a safety compliance agreement form stating that they have read, understand, and agree to comply with the provisions of the plan. Anyone refusing to sign the form will be prohibited from working at the site.

If a new employee who has not gone through the site-specific safety orientation meeting is assigned to the site, the SSO must present a similar briefing to the new employee before he or she participates in any field activities. All new employees must sign the safety compliance agreement form before beginning fieldwork at RFP.

6.2.6 EG&G Radiation Safety Training

All field employees shall be required to receive a 1-day EG&G sponsored radiation worker safety course. This course is mandatory, and the SSO will schedule attendees.

6.3 ACCIDENT/INCIDENT REPORTING

6.3.1 Woodward-Clyde (W-C)/Woodward-Clyde Federal Services (WCFS) Procedures

In the event of an accident or incident, the SSO will immediately notify the W-C Project Manager, HSO, and CMHS. Types of accidents or incidents that are considered reportable are:

- Illness resulting from chemical exposure or unknown causes
- Physical injury, including an injury that does not require medical attention
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors
- Infractions of safety rules and requirements
- Unexpected chemical/radiological exposures
- Occurrence involving damage to equipment and/or threat of injury

Work will be suspended to correct the cause of the accident/incident and to modify this plan as necessary.

A W-C accident/incident report form (Attachment H) must be submitted to the PM and CMHS within 24 hours of occurrence.

6.3.2 Rocky Flats Plant Procedures

The Site Safety Officer will notify the W-C PM, the RFP Environmental Restoration (ER) Program Field Supervisor, the RFP ER Program Manager, and the RFP Area Health and Safety Engineer of any accidents or incidents that occur during field activities. The Site Safety Officer will also submit a completed DOE Form Fm 5484.X to the RFP Area Health and Safety Engineer for any of the following incidents:

1. "Recordable" occupational injuries or illnesses as defined below:

OCCUPATIONAL INJURY is any injury, such as a cut, fracture, sprain, or amputation, that results from a work accident or from an exposure involving a single incident in the work environment. NOTE: Conditions resulting from animal or insect bites, or one-time exposure to chemicals are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material.

2. PROPERTY DAMAGE LOSSES of \$1,000 or more are reported as follows: accidents that cause damage to Department of Energy (DOE) property, regardless of fault, or accident wherein DOE may be liable for damage to a second party are reportable if damage is \$1,000 or more. Include damage to facilities, inventories,

equipment, and properly parked motor vehicles. Exclude damage resulting from a DOE reportable vehicle accident.

3. ALL MOTOR VEHICLE ACCIDENTS will be reported.

6.4 VISITOR CLEARANCES

All visitors to the site must be cleared by RFP personnel.

6.5 BUDDY SYSTEM

The "buddy system" will be used during all field activities and during maintenance activities at the main decontamination facility. At no time will an individual conduct surveying, nonintrusive geophysics, drilling, soil scraping, or trenching alone. Core logging activities do not require the use of the "buddy system."

6.6 HEALTH AND SAFETY LOGBOOK

A separate health and safety logbook and sign-in/sign-out log shall be maintained by the SSO throughout the project and turned in to the HSO after the project is completed. Logged information shall include: (1) names of all W-C and subcontract personnel entering and leaving the site each day, (2) daily listing of data collection site numbers to be visited by field teams, (3) description of unforeseen hazards and steps taken to mitigate hazards, (4) summary of telephone conversations regarding health and safety, (5) safety infractions, if any, (6) accidents and injuries, and (7) all other significant health and safety items.

6.7 WORK ZONES

Three work zones will be established around each intrusive activity: the exclusion zone, the contamination reduction zone (CRZ), and the support zone.

6.7.1 Exclusion Zone

The exclusion zone for intrusive activities (such as collecting soil samples and soil boring) is the area where contaminants could or do occur and will normally encompass a 30 foot radius around the point of intrusive activities. The boundary of the exclusion zone will be marked with either pin flags or caution tape. Personal and equipment decontamination is required when exiting an exclusion zone at an intrusive activity. All individuals entering this area must be approved by the SSO.

With one exception, an exclusion zone will not normally be established around nonintrusive activities (such as surveying and nonintrusive geophysics) and personal/equipment decontamination will not normally be accomplished. Nonintrusive activities being conducted inside IHSS No. 155, the 903 Lip Site will require personal and equipment decontamination. And, the boundary of IHSS No. 155 will serve as the exclusion zone boundary where decontamination will take place.

Certain Level B work locations requiring the use of airline respirators may have significant and widespread surface contamination, making the exclusion zone so large that the allowable distances for use with air line respirators precludes location of the breathing air source in a contamination reduction zone. Work within such a Level B exclusion zone will require the following procedures:

The air supply (cascade type) trailer for operations may be brought onto the 903 Pad Drum Storage Site because of limitations on the length of air line allowed for supplied-air operations. The air supply trailer will be brought in from the upwind direction. The air supply technician may be allowed to use Level C respiratory protection when the air supply trailer is upwind of the work site. The air supply trailer shall then be decontaminated upon removal from the work site.

6.7.2 Contamination Reduction Zone (CRZ)

In general, the CRZ is established immediately outside the exclusion zone to minimize the migration of contaminants from the exclusion zone to clean or support areas and to reduce the exposure potential of individuals leaving the exclusion zone. Specific personnel and equipment decontamination procedures are outlined in Attachment D. The CRZ for activities conducted within the boundaries of the 903 Lip Site (IHSS No. 155) will be established immediately outside of the boundaries of the 903 Lip Site.

6.7.3 Support Zone

The support zone is located in a clean area, preferably upwind and immediately outside of the CRZ, or in the on-site vehicles. Supplies, emergency equipment, and support personnel are located in the support zone or in the on-site vehicles.

6.8 FIELD ACTIVITIES

6.8.1 Personal Requirements/Prohibitions

- No running or horseplay.
- The required level of personal protective equipment must be worn by all on-site personnel.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the exclusion zone and the CRZ. Drinking of water, Gatorade, or equivalent fluids may occur in the CRZ at the discretion of the SSO.
- Smoking, carrying lighters and/or matches is prohibited in the exclusion zone and the contamination reduction zone.

- No contact lenses may be worn by personnel engaged in field work.
- No jewelry may be worn by personnel engaged in field work, except for watches, which will be disposed of if they become contaminated.
- No facial hair which interferes with a satisfactory fit of the mask-to-face seal is allowed on personnel required to wear respirators or SCBAs.
- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. PRESCRIBED DRUGS SHOULD NOT BE TAKEN BY PERSONNEL ON OPERATIONS WHERE THE POTENTIAL FOR ABSORPTION, INHALATION, OR INGESTION OF TOXIC SUBSTANCES EXISTS, UNLESS SPECIFICALLY APPROVED BY A QUALIFIED PHYSICIAN. Alcoholic beverage intake will not be allowed during breaks.
- The entire body should be thoroughly washed in the decontamination trailer after completing decontamination procedures.
- NO PERSON WILL ENTER THE EXCLUSION ZONE ALONE.
- Safety devices on equipment must be left intact and used as designed.
- Equipment and tools will be kept clean and in good repair, and used only for their intended purpose.
- A large-faced mallet will be used for driving wood stakes; small-faced hammers, such as a claw hammer, may not be used for driving wood stakes.
- Eye protection must be worn when any hammering or pounding that may produce flying particles or slivers is performed.

- Leather gloves must be worn when handling objects that may produce splinters (e.g., driving wood stakes).

6.8.2 Contamination/Exposure Prevention

Ways in which on-site personnel may become contaminated include the following;

- Being splashed by contaminated liquids while sampling or handling liquids
- Coming in contact with contamination solids or liquids
- Walking through contamination materials, either in solid or liquid state
- Being in contact with contaminated equipment
- Being in contact with contaminated solid substances in waste piles or on the soil surface
- Sitting or kneeling on the ground

On-site team members will avoid becoming contaminated.

On-site personnel will avoid exposure to hazardous chemicals by strictly adhering to the required personal protection equipment and decontamination procedures.

Care will be taken to prevent equipment contamination. Sampling and monitoring equipment will not be laid on contaminated surfaces. Monitoring equipment and communication equipment will be bagged, and the bag taped and secured around the instrument. Openings will be made in the bag for sample intake and exhaust ports.

Procedures for limiting the particulates suspended in air are contained in Attachment J.

6.8.3 Heavy Materials Handling Safety

Below are guidelines to follow when working with heavy materials:

- Be aware of footing at all times.

- Use chains, hoists, straps, and any other equipment to safely aid in the moving or lifting of heavy objects/materials.
- Use your legs, not your back.
- Get help whenever in doubt about a material's weight.
- Use the buddy system.

6.8.4 Safety Precautions When Drilling and/or Using Heavy Equipment

All personnel engaged in drilling operations shall wear eye protection, hard hats, steel-toed boots, and hearing and respiratory protection (if required). Because tools and heavy equipment can create major hazards at sites, the following procedures are to be observed during soil-boring activities. See W-C Operating Procedure No., HS-509, Safety Guidelines for Drilling Into Soil and Rocks, provided in Attachment D.

- Use common sense.
- Hard hats and steel-toed boots are to be worn.
- Pay attention at all times.
- Maintain visual contact with Health and Safety Technician at all times when working within the exclusion zone.
- Establish hand signal communication when verbal communication is difficult. Determine one person per work group to give hand signals to equipment operators.
- All heavy equipment shall have backup alarms as specified by 29 CFR 1926.601.
- Only qualified persons are to operate heavy equipment.
- Never walk directly in back of or to the side of heavy equipment without the operator's knowledge.
- Never use a piece of equipment unless you are familiar with the operation.
- Hearing protection will be provided if work site levels exceed the levels specified by OSHA, or if requested by an employee. The rule of thumb (and W-C policy) is that if you have to shout to be heard over equipment noise, protection shall be used.
- Be sure that any underground or overhead power lines, sewer lines, gas lines, and telephone lines have been identified and will not present a hazard in the work area.

- Check that air bottles are secured properly to heavy mobile equipment.
- Mechanical equipment will be inspected daily.
- Hard hats are required when working near the drilling rig.
- Goggles or safety glasses will be worn when operating power tools, sanding, grinding, or filing. Welders' glasses or mask will be worn near welding operations.
- No loose-fitting clothing, jewelry, or free long hair is permitted near the rig.
- Hands must be kept away from the moving parts of the machinery when drilling is in progress.
- Daily inspection of all ropes, cables, and moving parts of the rig is mandatory.
- A sealed first aid kit and fire extinguisher will be available within the exclusion zone.
- Self-contained breathing apparatus units will be identified so they can be obtained, if needed, for emergency use at well or boring sites. The Site Manager will locate this equipment before drilling.
- All crews will have at least two persons, and, in addition, a Health and Safety Technician will be stationed on site to monitor activities.
- No drilling will occur during impending electrical storms or when rain or icing conditions create a work hazard.

6.8.5 Housekeeping

Housekeeping is an important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all times, and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

W-C will implement a housekeeping program for the field activities to minimize the potential for slips, trips, and falls in the support zone. The program will include:

- Daily scheduling to police the area of debris, including paper products, cans, and other materials brought on site

- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing
- Any object capable of being blown away by high winds will not normally be left out of doors unless the object is secured to a fixed object.

6.8.6 Emergency Equipment

The following emergency equipment will be stored in sealed plastic bags and will be available at each site of intrusive activity:

- First aid kit
- Eye wash
- Gatorade or equivalent
- Fire extinguisher (10-lb ABC)
- An extra full set of the appropriate PPE for each team member

6.8.7 Heat Stress Monitoring

Warm weather and several layers of protective clothing may induce heat stress in field employees. The SSO or HST will be responsible for monitoring personnel for signs of heat stress. Heart rate monitoring will be performed, at a minimum, every time employees break. At the beginning of the work day, at lunch break, and at the end of the day, workers must weigh in on a scale. Body water loss during the work day should not exceed 1.5 percent of total body weight. The amount of fluids lost must be replaced. Potable water and Gatorade, or other electrolyte replacement fluid, will be available. Workers should be encouraged to drink fluids during breaks. Attachment D presents W-C Operating Procedure No. HS-102, Heat Stress.

If a field worker's heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third. If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the work cycle by another one-third.

be kept as clean as possible at all times, and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

W-C will implement a housekeeping program for the field activities to minimize the potential for slips, trips, and falls in the support zone. The program will include:

- Daily scheduling to police the area of debris, including paper products, cans, and other materials brought on site
- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing
- Any object capable of being blown away by high winds will not normally be left out of doors unless the object is secured to a fixed object.

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The following emergency equipment will be stored in sealed plastic bags and will be available at each site of intrusive activity:

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If a field worker's heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third. If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the work cycle by another one-third.

7.1 INTRODUCTION

This section relates specifically to activities conducted at sites indicated on Plate 1 under the RFP Phase II RFI/RI 903 Pad, Mound, and East Trenches Areas (Operable Unit 2). Site-specific health and safety requirements generally consist of protective equipment, decontamination procedures, environmental monitoring, and work practices specified by the RFP. The personal protective equipment (PPE) needed to comply with the various levels of protection are detailed below.

7.2 PERSONAL PROTECTIVE EQUIPMENT

The level of PPE required for the various work areas will be continually reevaluated as field work progresses. It is expected that there will be a tailoring of requirements for specific sites and seasonal variations. PPE requirements for specific operations shall be agreed upon beforehand by the Site Manager, the HSO or CMHS, and the SSO, and a document to that effect will be drawn up, dated, and signed by the Site Manager and SSO. The SSO shall post PPE requirements in the crew trailer and announce changes and justification for those changes at a site safety meeting. The HSO or CMHS will publish a change to this plan if PPE changes are permanent and if the HSO/CMHS considers the change substantive.

7.2.1 Clothing Inspection

Personal protective equipment should be inspected before and during use. The following checks should be made before use:

- Determine that the clothing material is correct for the specific task at hand.

- Visually inspect for:
 - Imperfect seams
 - Tears
 - Malfunctioning closures

- Hold up to light and check for pinholes.

During the work task, periodically inspect for the following:

- Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects.

- Closure failure.

- Tears.

- Punctures.

- Seam discontinuities.

Before using gloves, pressurize each glove to check for pinholes. To do so, blow or otherwise introduce air into glove, seal the wrist, and roll gauntlet toward fingers, or inflate the glove and hold it under potable water. In either case, no air should escape.

7.2.2 Personal Protective Equipment Levels

7.2.2.1 Level D

Level D may be used when the atmosphere contains no known hazard and when work functions preclude splashes, immersion, or the potential for unexpected inhalation of, or contact with hazardous levels of any radionuclides/chemicals. Level D consists of:

- Uncoated Tyvek or equivalent disposable overall.
- Steel-toed boots with disposable boot covers.
- Additional seasonal items may be required. Any such items will be worn under the disposable overall.
- During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Tape will be used to seal the joints between coveralls, protective gloves, and cuffs.

7.2.2.2 Modified Level D

Modified Level D may be used in areas that can normally qualify for Level D, but where a potential hazard requiring quick transition to Level C may be present. Modified Level D consists of:

- Uncoated Tyvek or equivalent disposal coverall.
- Disposal chemical-resistant inner gloves worn over disposable cotton liners.
- Chemical-resistant outer gloves.
- Boots and chemical-resistant boot covers.
- Full-face respirator with organic vapor/HEPA cartridges ready for immediate donning.
- Additional seasonal items may be required. Any such items will be worn under the disposable overall.
- Personnel shall upgrade to Level C (don the respirator) in the event of dusty conditions or if organic vapor detectors or monitors indicate levels above background. Respirators will be stored inside sealed plastic bags until needed.
- Steel-toed boots and hard-hats.
- During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Tape will be used to seal the joints between coveralls, protective gloves, and cuffs.

7.2.2.3 Level C

Level C consists of Modified Level D modified gear plus the full-face respirator, donned. The following constitutes Level C:

- Uncoated Tyvek or equivalent disposal coverall.
- Disposable rubber boot covers (booties).
- Disposable chemical-resistant inner gloves worn over disposable cotton liners.
- Butyl or nitrile gloves.
- Boots, chemical-resistant, steel toe and shank.
- Disposable chemical-resistant boot covers.
- Full-face respirator with organic vapor/HEPA cartridges.
- Additional seasonal items may be required. Any such items will be worn under the disposable overall.
- Hard hats.
- During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Tape will be used to seal the joints between coveralls, protective gloves, and cuffs.

7.2.2.4 Level B

Level B consists of the following:

- Uncoated Tyvek or equivalent disposable coverall.
- Saranex-coated outer coveralls with hood - all joints taped and sealed.
- Disposable chemical-resistant inner gloves worn over disposable cotton liners.
- Butyl or nitrile gloves.
- Boots, chemical-resistant, steel toe and shank.
- Disposable chemical-resistant boot covers.
- Pressure-demand, full-facepiece, self-contained breathing apparatus (SCBA) or supplied air respirator with escape SCBA.

- Steel-toed boots and hard hats.
- Additional items may be required in specific locations or tasks.
- During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Tape will be used to seal the joints between coveralls, protective gloves, and cuffs.

7.2.2.5 Respirators

Personnel are trained, fitted, and issued personal respirators for use during intrusive activities and for work at the equipment decontamination pad. Each individual is responsible for inspecting and maintaining his or her own respirator. W-C Operating Procedure No. HS-203 (Attachment D) provides general procedures for cleaning, inspection, maintenance, and storage of respirators. Procedures specific to operations within OU2 are provided in this Section.

Each individual is responsible for the cleaning, inspecting, maintenance, and storage of any respirator they use. Before being taken to the field, all respirators will be inspected, cartridges (if used) installed, a positive and negative pressure check conducted and then the entire respirator assembly will be sealed in a plastic bag. And, the respirator will remain in the sealed bag until needed. If the respirator is not used and the sealed bag is not damaged, the respirator may be left at the worksite inside an area protected from the elements. The enclosed cab of a vehicle is considered to be one example of a protected area.

After the respirator is used, the following procedures will be used. Cartridges from air purifying respirators will be removed and disposed of as contaminated PPE. The respirator face piece interior and exterior will be wiped down with premoistened towelettes such as baby wipes and subsequently sealed in a plastic bag for transport to the respirator cleaning station at the shower trailer. The respirator interior and exterior will be wipe tested for radioisotopes before being cleaned if radioactivity was detected while the respirator was being used. If the wipe test indicates the presence of radioactivity, the respirator will be thoroughly wiped down with baby wipes (or equivalent) and wipe tested again. The used baby wipes will be disposed of as contaminated PPE. If the second wipe test indicates the presence of radioactivity, the respirator

will be sealed in a plastic bag, the bag will be labeled to indicate the presence of radioactivity on the respirator and the SSO contacted. Respirators found to be radiologically contaminated will not be placed in the cleaning and rinse solutions at the shower trailer. After a respirator has been cleaned and rinsed, it will be patted dry with a clean towel and stored.

7.2.2.6 Personal Protective Equipment for Decontamination Workers

All team members responsible for conducting equipment decontamination at the vehicle decontamination station will wear the following Level C protective ensemble:

- Uncoated Tyvek or equivalent coveralls.
- Saranex-coated coveralls over uncoated coveralls.
- Steel-toed boots.
- Disposable boot covers.
- Disposable inner gloves.
- Butyl (chemical resistant) or nitrile exterior gloves.
- Full-face respirator with organic vapor/HEPA cartridges.
- Level B respiratory protection is required when decontaminating equipment known to be contaminated with radioisotopes.

7.3 REQUIRED LEVELS OF PPE PER TASK AND IHSS

7.3.1 Level D PPE

Surveying, staking, and nonintrusive geophysics may be accomplished in Level D PPE inside each IHSS and Outlying Area within OU2.

Main decontamination facility (MDF) maintenance operations that do not have a potential for splashes occurring will be accomplished in Level D PPE. If simple splashing (versus using a pressurized spray) is a potential hazard, a Saranex coverall will be worn in place of an uncoated

Tyvek coverall and either goggles designed to protect against splashes or a face shield will be worn.

Core logging activities for uncontaminated cores will be accomplished in Level D PPE and surgical type gloves. "Uncontaminated cores" are defined as soil cores collected without the OVD indicating organic vapor levels above background and without the RFP 881 Laboratory detecting an activity of greater than 50 pCi/g.

7.3.2 Level Modified D PPE

With the exclusion of the 903 Pad (IHSS No. 112), well drilling, soil boring, soil scraping, trenching, core logging of potentially contaminated cores and packer testing will be accomplished in Modified Level D. Potentially contaminated cores are defined as those soil cores that do not meet the definition of uncontaminated cores (see Subsection 7.3.1).

7.3.3 Level C PPE

Within the 903 Pad (IHSS No. 112), well drilling/construction, soil boring, soil scraping, trenching, and packer testing will be accomplished in Level C PPE.

MDF maintenance operations that entail the use of pressurized sprays or opening containers of wastes generated at either the MDF or at field sites will be accomplished in Level C PPE with a Saranex coverall worn as the outer most layer.

7.4 MONITORING INSTRUMENTS

Direct-reading real-time monitoring will be conducted.

- An organic vapor detector (OVD) (photoionization or flame ionization) and a Dräger hand pump with detector tubes for carbon tetrachloride (CCl₄) and vinyl chloride will be used to monitor for nonradioactive substances.

- A Ludlum Model 12-1A will be used to monitor dry equipment surfaces and dry PPE for the presence of alpha-emitting radioisotopes.

7.5 MONITORING STRATEGIES

An HST will be assigned to each field team and the MDF maintenance team. The individual logging cores will be responsible for conducting monitoring during the core logging process. The HST will conduct real-time monitoring as described below and provide monitoring results to the SSO.

7.5.1 Real-Time Monitoring

Real-time monitoring will be conducted to provide an indication of the presence of potential hazards.

7.5.1.1 OVD

An OVD will be used at each site of intrusive activity, the MDF, and during core logging operations.

- When soil boring and well construction activities are under way, the interior of the auger(s) will be monitored each time the auger is opened to add another auger flight. An OVD measurement result greater than background inside the auger will be cause to initiate OVD measurements in the breathing zone of the individual most likely to be exposed, such as the driller or the driller's helper. Results of breathing zone measurements will be compared to the action levels established in Subsection 7.6.
- When trenching activities are under way, the interior of the trench will be monitored before sampling of the trench wall is allowed to begin. OVD measurements made inside the trench will be treated as breathing zone measurements for the purposes of using action levels established in Subsection 7.6.

- An organic vapor detector (OVD) will be used to monitor the head space inside sealed containers of waste fluids from the field and when opening holding tanks containing wastes generated at the MDF. If the organic vapor concentration is greater than background, the individual will leave the head space open, move upwind, let the head space vent for ten minutes. Afterwards, the organic vapor concentration will be remeasured. If the organic vapor concentration is at the background level respiratory protection is not required, but the organic vapor concentration will periodically be measured in the worker's breathing zone. If the organic vapor level in the head space does not drop to background level the action levels established in Subsection 7.6 will be applied.
- When logging cores, an OVD will be used to monitor the core surface of potentially contaminated cores before the logging procedure begins. Results of the core surface monitoring will be compared to the action levels established in Subsection 7.6 and the appropriate action taken.
- Measurements with an OVD are not required during surficial soil sampling activities or packer testing.

7.5.12 Detector Tubes for Carbon Tetrachloride

A Dräger handpump with detector tubes for carbon tetrachloride will be used during all intrusive activities. The monitoring strategy will be the same as is described for an OVD during soil boring and trenching activities in Subsection 7.5.1.1.

7.5.13 Detector Tubes for Vinyl Chloride

A Dräger handpump with detector tubes for vinyl chloride will be used during all intrusive activities accomplished within the Outlying Area directly north of the Mound Area. The monitoring strategy will be the same as is described above in Subsection 7.5.1.1.

7.5.1.4 Ludlum Model 12-1A Count Rate Meter

A Ludlum Model 12-1A Count Rate Meter will be used at each site of intrusive activity. The Ludlum probe will be placed as close as possible and parallel to the material being monitored. In no case, should the probe be held farther than ¼ inch from the surface being measured. When monitoring, do not move the probe faster than 1 inch/second. However, the probe should not come in contact with the material being monitored. If activity is detected, the probe will be held stationary for a quantitative measurement. Soil cuttings, equipment, and PPE that are dry will be monitored with the Ludlum probe, although any surface that is dry may be monitored.

A health and safety technician (HST) that is familiar with how to operate a Ludlum Model 12-1A will be present at each activity that requires monitoring with a Ludlum Model 12-1A. The HSTs are considered to be semi-skilled radiation monitors and will conduct day-to-day monitoring activities, immediately implement the action levels in Subsection 7.6, and notify the site safety officer (SSO) of all monitoring results. The SSO will arrange for a skilled radiation monitor (SRM) to verify HSTs radiation monitoring results that indicate the presence of greater than 250 counts per minute (cpm). An SRM will have indepth familiarity and experience in radiation monitoring.

- During soil boring and well construction, the ground surface to be penetrated by the initial auger flight will be monitored before the auger bit is set on the ground, and soil cuttings will be wetted as they are brought to the surface (see Subsection 7.7.3). When the auger is stopped so that another flight may be added, the wetted soil cuttings will be removed. As additional (dry) soil cuttings are brought to the surface, a small (approximately 1 cup) sample will be collected and the wetting process of the remaining cutting will begin immediately. The soil sample will be spread on a smooth surface and monitored with the Ludlum probe. The results of monitoring will be compared to the action levels established in Subsection 7.6.

- When trenching activities are under way, the Ludlum probe will be used to monitor the soil surface to be excavated before trenching begins. The interior wall of the trench will be monitored before sampling of the trench wall is allowed to begin. The results of measurements made with the Ludlum probe will be compared to the action levels established in Subsection 7.6.
- During surficial soil sampling activities, the soil surface to be sampled will be monitored with a Ludlum probe. The results of monitoring will be compared to the action levels established in Subsection 7.6.
- During maintenance activities at the MDF all surfaces will be monitored for radiological contamination following decontamination of equipment known to be radiologically contaminated. A Ludlum Model 12-1A will be used to monitor dry surfaces and the action levels established in Subsection 7.6 will be applied.
- During core logging a Ludlum Model 12-1A will be used to monitor the core surface of potentially contaminated cores before the logging procedure begins and remonitoring of the core material will be accomplished periodically. The action levels established in Subsection 7.6 will be applied.
- Measurements with a Ludlum probe are not required when packer testing is under way.

7.5.1.5 Piezobalance Aerosol Mass Monitor

The piezobalance will be used to indicate the amount of particulate matter being generated so that the potential for spreading contamination is minimized. A piezobalance aerosol mass monitor will be placed downwind of intrusive activities and as close to the intrusive activity as feasible without interfering with the intrusive activity. The concentration of airborne particulate matter indicated by the piezobalance will be compared to the action levels established in Subsection 7.6.

7.5.1.6 Anemometer

An anemometer will be used to indicate wind speed during intrusive activities. The anemometer will be positioned upwind of the intrusive activity but close enough to the work site to permit ready access. Intrusive activities will not be conducted when sustained wind speeds above 35 miles per hour (mph) exist as measured by the anemometer. Sustained winds above 35 mph exist when the 15-minute average wind-speed exceeds 35 mph for two consecutive 15-minute periods.

7.5.2 Air Sampling

Air samples will be collected and a laboratory analysis conducted for substances classified as either potential inhalation hazard or an inhalation hazard (see Subsection 5.2.3). The substances to be sampled for, geographical areas in which sampling will occur, and sample collection procedures are specified in Subsections 7.5.2.1. and 7.5.2.2.

7.5.2.1 Vinyl Chloride

Vinyl chloride (see Subsection 5.3.2.11) will be sampled for during soil boring activities within the outlying area north of the Mound Area (IHSS No. 113) at "proposed plume characterization alluvial monitor well" numbers 32-91, 33-91, and 34-91 (see Plate 1). The sample collection will be accomplished as described in National Institute of Occupational Safety and Health (NIOSH) method 1007. NIOSH method 1007 is provided as Attachment K.

7.5.2.2 Radioisotopes

Radioisotopes (Pu-239 and Am-241) (see Subsections 5.3.2.1 and 5.3.2.2) will be sampled for during soil boring and surficial soil sampling activities conducted within the 903 Pad (IHSS No. 112) and the 903 Pad Lip Site (IHSS No 155). NIOSH has not published an air sampling methodology specifically for radioisotopes. Therefore, the following procedures will be utilized.

A three-piece, 37-millimeter air monitoring cassette containing a Type A/E 1 μm glass fiber filter will be used in the openface mode to collect airborne dust. A minimum air sample volume of 1 cubic meter is required, although 2 cubic meter air samples are desirable. A personal sampling pump with a representative sampler in line will be calibrated before and after each sampling event. A "bubble meter" will be used as the calibration standard.

7.6 ACTION LEVELS

All decisions regarding application of the following action levels for non-radioactive substances will be based upon breathing zone measurements. The action level for measurements of radioisotopes with the Ludlum Model 12-1A probe will be based upon surface measurements of dry soil, equipment, or PPE. The HST will notify the SSO immediately after any upgrade in PPE.

<u>Instrument</u>	<u>Action Level</u>	<u>Action</u>
OVD	greater than background greater than 5 ppm	Don Level C PPE Don Level B PPE
Carbon Tetrachloride Detector Tube	greater than 1 ppm greater than 50 ppm	Don Level C PPE Don Level B PPE
Vinyl Chloride Detector Tube	greater than 0.5 ppm greater than 25 ppm	Don Level C PPE Don Level B PPE
Ludlum Model 12-1A	greater than 250 counts per minute greater than 1250 counts per minute	Don Level C PPE and notify SSO Don Level B PPE and notify SSO
Piezobalance	6 milligrams/cubic meter	Curtail intrusive activities and contact the subcontractor's site manager
Anemometer	35 mph	See Subsection 7.5.1.6

7.7 WORK PRACTICES

7.7.1 Equipment Monitoring

Equipment decontamination will be accomplished by persons wearing the PPE specified in Subsection 6.10 of this plan. RFP Environmental Restoration Program Standard Operating Procedures (SOPs) establish monitoring, decontamination and record keeping requirements for equipment items. The following requirements are in addition to those established by the SOPs.

- Each equipment item will have an identification number stamped on it or otherwise permanently attached if such an identification number is not already present. This requirement applies to vehicles, augers and drill rods.
- A radiation monitoring log will be established for each equipment item with an assigned identification number. Results of all monitoring will be recorded in the log and will, as a minimum, include prework monitoring and post work monitoring.
- The air filter of each engine that operates within an exclusion zone as intrusive activities progress will be radiologically monitored when it is replaced with a new filter and after its last use during intrusive activities at RFP. Monitoring will be accomplished by wetting the filter element, disassembling the filter and using a Ludlum Model 12-1A to monitor the dirtiest portion of the filter after it has dried.
- Any surfaces of a vehicle or other equipment item that contacts the ground surface as it is being moved from a site of intrusive activity to another will be radiologically monitored with a Ludlum Model 12-1A immediately before it moves onto a public thoroughfare.

This requirement applies to items that have been used in any area that is either known to have surficial radiological contamination or such contamination was noted as the item was used on the field. Vehicles/items found to be contaminated immediately prior to moving onto a public thoroughfare will be handled as described in the appropriate RFP Environmental Restoration Program SOP.

- Before rented or leased equipment that has been used in the field is returned, it will be wipe-tested for radioisotopes and the results furnished to the HSO. The HSO will determine if the item is suitable for return to the owner.

7.7.2 Geophysics

As stated earlier, this Health and Safety Plan does not address the hazards associated with drilling into buried waste containers (filled containers such as in Trench T-1, or flattened containers such as may be found in other trenches). Therefore, geophysics will be employed before drilling or excavating into any trench. If an auger encounters a buried waste container, drilling will cease, all down-hole equipment will be removed from the hole, and radiation screening will be accomplished. Decontamination of equipment and personnel will be accomplished and the drilling operation will be relocated.

7.7.3 Intrusive Activities

All subsurface soils brought up to the ground surface shall be wetted immediately to limit the potential for dust becoming airborne. Soil samples collected for analysis are excluded from this requirement. In general, a hand-pressurized, garden-type sprayer should be used. The sprayer nozzle will be adjusted so that a mist (versus a pressurized stream) will be used to moisten the soil. The soil cuttings should not be saturated, since that could lead to the spreading of potential contamination by water runoff from the soil cuttings.

Personnel will not enter trenches that are deeper than four feet at the deepest point without approval of the HSO. The HSO will provide instructions for shoring and other safety measures.

7.7.4 Work During Darkness

This Health and Safety Plan does not cover field work after daylight hours.

7.7.5 Confined Work Space

No work in confined spaces or places with limited egress is permitted by this plan.

7.7.6 Core Logging

Potentially contaminated cores (see Subsection 7.3.2) will be logged out-of-doors within an exclusion zone.

8.1 RADIO COMMUNICATIONS

Field teams will have a method of communicating with both the field office trailer and other field teams.

A communication center will be established at the W-C field trailer office. This office will be equipped with telephone communications and shall be attended at all times during operations.

8.2 EMERGENCY TELEPHONE

The closest accessible telephone during all working hours will be identified by the SSO before beginning field activities in case communication with the W-C communications center is not possible. All guard posts have telephones. Emergency telephone numbers will be posted near the W-C field office telephone.

8.3 MEDICAL FACILITIES

Telephone numbers for the RFP medical facility are provided below (Building 122, Central Avenue) (See Figure 8-1):

- General Information 966-2594
- Ambulance Service 966-2911

8.4 EMERGENCY RESPONSE PROCEDURES

The Site Manager, with assistance from the SSO, has responsibility and authority for coordinating all emergency response activities until proper authorities arrive and assume control.

8.4.1 Fire/Explosion

Fire emergencies will be handled by immediately notifying the fire department. Only if a fire appears to be small and easily extinguishable, will personnel attempt to control it with fire extinguishers available in the work area. Otherwise, immediate evacuation of the area is indicated. In the event of an explosion, all personnel shall be evacuated and the fire department notified. No one shall re-enter the area until it has been cleared by explosives safety personnel.

8.4.2 Physical Injury

In case of injuries to personnel, first aid treatment will be initiated immediately by trained personnel. In case of serious injuries, the victim will be transported to the Rocky Flats Plant medical center as soon as possible. Minor injuries may be treated on site, but all injured personnel will be transferred to the nearest recommended medical treatment facility and examined by trained medical personnel. Victims of serious bites or stings will be taken to the RFP medical center. In the event that an injured person is contaminated with chemicals or radionuclides, the person shall be taken to the RFP medical center as soon as possible. Decontamination shall be performed to prevent further exposure only if it will not aggravate the injury. Treatment of life-threatening or serious injuries will always be considered first.

8.4.3 Injury Due to Heat

If a person is suffering from heat exhaustion (profuse perspiration, normal body temperature), the following procedures will be taken:

- Remove the person to a cooler, shaded area.
- Give 8 ounces of Gatorade (if available) every 15 minutes for three or four doses. Drinking water will be used if Gatorade is not readily available.
- Allow the person to rest.
- If the person is suffering from cramps, press warm, wet towels over the cramped area.

A life threatening situation exists and immediate action is indicated if a person is suffering from heat stroke (skin hot and dry, very high body temperature); the following procedures will be taken:

- Immediately contact the SSO and request the medical facility be alerted to the situation.
- Cool the victim quickly by soaking the person in cool but not cold water, sponging the body with rubbing alcohol or cool water, or pouring water on the body.
- Transport to hospital for medical attention as quickly as possible.

8.4.4 Injury Due to Cold

First aid for frostbite consists of the following procedures:

- Decontaminate the victim.
- Bring the victim indoors and quickly rewarm the affected areas in water between 102° to 105°F.
- Give victim a warm drink--NOT coffee, tea, or alcohol.
- Do not permit the victim to smoke.
- Keep the frozen parts in warm water or covered with warm cloths for 30 minutes, even though the tissue will be painful as it thaws.
- Evaluate the injured areas and cover with sterile, soft, dry material.
- Keep the victim warm and get immediate medical care.

- Do not rub the frostbitten part.
- Do not allow blisters to be broken.
- Do not use ice, snow, or anything cold on frostbite.
- Do not use heat lamps or hot water bottles to rewarm the body part.
- Do not place the affected part near a hot stove.

First aid for excessive exposure to cold (hypothermia) consists of the following procedures:

- Decontaminate the victim.
- Bring victim into a warm area as quickly as possible.
- Remove wet or cold garments.
- Dry the person thoroughly.
- Provide warm, dry clothing or covering.
- Provide rapid but gentle rewarming.
- Give victim a warm drink--NOT coffee, tea, or alcohol.
- Keep the victim warm and get immediate medical care.

8.4.5 Emergency Services

Emergency telephone numbers are listed in Table 8-1.

8.4.6 Notification Requirements

Reporting and notification of emergency situations shall be carried out in accordance with requirements in Department of Energy (DOE) Order 5484.1. The Team Leader of the field team involved will notify the site safety officer who will notify the appropriate emergency assistance personnel (for example, fire, police, ambulance) at extension 2911 immediately, and

then notify the Site Manager. The Site Manager will notify the EG&G Environmental Restoration (ER) Program Field Supervisor, PM, and HSE Area Safety Engineer. The responsibility of the SSO is to implement notification and reporting requirements of DOE Order 5484.1.

8.4.7 Spills

Current plans do not include handling the types or quantities of materials that, if spilled, would create a health hazard or generate environmental concerns. However, the SSO should be notified of all chemical spills for a determination of how to clean up and dispose of cleanup materials. Attachment C provides instructions for managing spills of some materials that may be found at RFP.

**TABLE 8-1
EMERGENCY TELEPHONE NUMBERS**

Site Health and Safety Officer Gregg Miller	(303) 966-5874
Business Unit Health and Safety Officer Mike Sams	(303) 740-2700
WCFS Corporate Manager, Health and Safety Jerry Andersen	(303) 740-2700
24-Hour Installation Health/Safety Coordinator	(303) 966-2911
Fire	(303) 966-2911
Ambulance	(303) 966-2911
Poison Center	(303) 629-1123
Security	(303) 966-2911
Police	(303) 966-2911

THE W-C TRAILER IS LOCATED AT: 901 Contractor's Pad in Trailer No. 22

**NEAREST MEDICAL
SERVICES ARE LOCATED AT:** Building 122

Directions:

From the Contractor's trailer compound, take a northbound street to Central Avenue and turn left onto Central Avenue: Building 122 will be on the left side and slightly west of a guard building on the right after approximately 1.25 miles.

From the RFP eastern boundary, upon entering RFP off of Indiana Street, you will be on Central Avenue. Proceed approximately 3.5 miles: Building 122 will be on the left side.

From the RFP western boundary at Hwy. 93, proceed along the entrance road to just past the gate, at which time you will be eastbound on Cactus Avenue. Then turn left onto the first street past Second Street, (Third Street, which is not marked). Proceed up Third Street past Building 125, which is on the left: the next building on the left will be the medical facility (Building 122).

9.1 GENERAL

Records shall be kept documenting the site safety program. A bound logbook will be used by the SSO/HST to record results of each environmental monitoring event within the exclusion zone, including those events specified below:

- Radiological
 - Ludlum Model 12-1A count rate meter
 - Other (specify in log book)
- Ambient Air
 - Photoionization detector
 - Organic vapor monitor
 - Piezobalance
 - Anemometer
 - Other (specify in log book)

9.2 PERSONNEL RECORDS

Records shall be kept on each on-site individual. Records include a medical clearance statement from a qualified physician, fit test, and training documentation. When site safety meetings are conducted, an attendance sheet must be kept.

9.3 CALIBRATION RECORDS

All monitoring equipment used for health and safety purposes will be calibrated as suggested by the manufacturer and records of calibration will be maintained.

**9.4 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION FORM (OSHA Form)
200**

An OSHA Form 200 will be posted in an area frequented by all subcontractor personnel. The SSO will be responsible for maintaining the form.

10.0
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ATTACHMENT A
NARRATIVE OF WILDLIFE FOUND AT ROCKY FLATS PLANT

The animal life inhabiting the Rocky Flats Plant (RFP) and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer, with an estimated 100-125 permanent residents. There are a number of small carnivores, such as the coyote, red fox, striped skunk, and long-tailed weasel. A profusion of small herbivores can be found throughout the plant and buffer zone consisting of species such as the pocket gopher, white-tailed jackrabbit, and the meadow vole (U.S. DOE, 1980).

Bull snakes and rattlesnakes are the most frequently observed reptiles. Eastern yellow-bellied racers have also been seen. The eastern short-horned lizard has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle and the western plains garter snake are found in and around many of the ponds (U.S. DOE, 1980).

Diseases that are endemic to the front range of the Rocky Mountains and, therefore, on RFP include: Plague, Rocky Mountain Spotted Fever, and Rabies. Each of those diseases is associated with one or more mammals inhabiting RFP.

ATTACHMENT B

**CHARACTERISTICS OF RADIOISOTOPES
FOUND IN OPERABLE UNIT NO. 2 (OU-2)**

The DOE Rocky Flats Plant produces "triggers" for nuclear weapons, which involves the processing and machining of plutonium, as well as the use of beryllium and other materials. Uranium and other radionuclides are known to be present on the site, either from process operations or from the disposal of wastes from other facilities.

Normal process releases from this facility are reported to be minimal, although there are several historical incidents that have released significant quantities of contaminants.

Plutonium can spontaneously combust in air, a characteristic which contributed to serious fires that released plutonium to the environment in 1957 and 1969. In 1969 a glovebox fire resulted in the release of several kilograms of plutonium to the environment. Analysis of soil samples, taken mostly east of DOE property, found up to 6 pCi/g on the top centimeter of soil (background is 0.04 pCi/g) shortly after this fire. In 1974 there was another accidental release of plutonium to the air.

Starting in 1958, barrels containing used machining fluids were stored outdoors at a location now called the 903 Pad. Leakage from the barrels was discovered in 1964. By 1968, the last barrels had been removed and the area was monitored for alpha activity. Levels of up to 13.5 μ Ci/g of soil were found, with activity penetrating to 8 inches deep. Rocks were removed from the area and fill was applied to the storage area, which was then paved. Additional fill was added to the area surrounding the 903 Pad in 1970 after soil sample analysis revealed greater than 50 pCi/g of alpha activity.

Other sites on the facility that may be significant contaminant sources include the West Spray Fields, an area east of the plant used for burial called the East Mounds, the 881 Hillside area, and the solar evaporation ponds. With the exception of the West Spray Fields, all of these locations are to the east of the new sanitary landfill sites.

The distribution of radioactive dusts in the environment is driven by prevailing wind patterns and drainage patterns at the Plant site. Both the prevailing winds and drainage patterns are west-to-east, with a significant north/south component for prevailing winds. This can be verified

by the distribution of radionuclides in the soil as reported by Rocky Flats Plant annual environmental reports.

Expected concentrations of plutonium near the areas of this work is thought to be approximately 0.05 pCi/gm (0.02 pCi/g [0.04 dis/min/g] is considered background). This level is well below levels considered hazardous. Reasonable dust control measures in areas containing 0.05 pCi/gm will provide adequate protection against exposure to plutonium by inhalation.

Elevated levels of plutonium have been measured in various areas in the buffer zone around the Rocky Flats Plant, primarily to the east of the facility. The highest levels of plutonium measured are to the east and south of the Plant, with the principal source being the 903 Pad. Soils at Indiana Avenue have been found to have an activity of 7.34 pCi/g.

Radionuclides of Concern

Pu^{239}

The predominant isotope present as an environmental contaminant is Pu^{239} . Major radiations from this material include the following:

alpha (He^{2+})	5.16 MeV (88%)
	5.11 MeV (11%)

Pu^{239} emits very little gamma (photons) of low energy, the most important being:

0.052 MeV (0.020%)

Pu^{239} is beta (e^-) stable.

The radiation of concern (alpha) is not sufficiently penetrating to penetrate the dead layers of the skin, which means Pu^{239} is not an external hazard. However, it is very important to avoid

inhalation or ingestion of this material, as alpha radiation may be very damaging from within the body.

Am²⁴¹

Am²⁴¹ is a contaminant of weapons-grade plutonium, present at less than 20% of the concentration of Pu²³⁹. Major radiations from this material include the following:

alpha (He ²⁺)	5.49 MeV (85%)
	5.44 MeV (13%)

Am²⁴¹ emits some gamma (photons) of low energy, the most important being:

0.060 MeV (36%)

Am²⁴¹ is beta stable.

The radiation of concern (alpha) is not sufficiently penetrating to penetrate the dead layers of the skin, which means Am²⁴¹ is not an external hazard. However, it is very important to avoid inhalation or ingestion of this material, as alpha radiation may be very damaging from within the body.

U²³⁵

U²³⁵ is also known to be present in some soils at this site. U²³⁵ is normally present as 0.7 percent of the total uranium present. Major radiations from this material include the following:

alpha (He ²⁺)	4.58 MeV (8%)
	4.40 MeV (57%)
	4.37 MeV (18%)

Gamma emissions are principally due to the presence of thorium daughter radiations, the most important being:

0.143 MeV (11%)

0.185 MeV (54%)

0.204 MeV (5%)

U^{235} is beta stable.

The radiation of concern (alpha) is not sufficiently penetrating to penetrate the dead layers of the skin, which means U^{235} is not an external hazard. However, it is very important to avoid inhalation or ingestion of this material, as alpha radiation may be very damaging from within the body. At concentrations much higher than are expected to be present at this site, U^{235} can be an external hazard from daughter gamma emissions.

U^{238}

U^{238} is also known to be present in some soils at this site. U^{238} is normally present as 99.276 percent of the total uranium present. Major radiations from this material include the following:

alpha (He^{2+})	4.20 MeV (75%)
	4.15 MeV (25%)
	4.37 MeV (18%)

Gamma emissions are principally due to the presence of daughter radiations, principally from Th^{234} and Pa^{234m} .

Beta emissions include:

(e^-)	0.030 MeV
	0.043 MeV

The radiation of concern (alpha) is not sufficiently penetrating to penetrate the dead layers of the skin, which means U^{238} is not an external hazard. However, it is very important to avoid inhalation or ingestion of this material, as alpha radiation may be very damaging from within

the body. At concentrations much higher than are expected to be present at this site, U^{238} can be an external hazard from daughter gamma emissions. The beta emissions are not sufficiently energetic to penetrate the outer (dead) layers of skin.

ATTACHMENT C

CHARACTERISTICS OF NONRADIOACTIVE HAZARDOUS SUBSTANCES FOUND IN OPERABLE UNIT 2 (OU2)

NOTE: The reader should keep in mind that a material safety data sheet for a given substance provides information concerning the substance in a relatively pure form and that the substances that may be encountered during this project will be at very low concentrations from the view point of significant occupational exposures.

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 300

ACETONE

(Revision E)

Issued: September 1985

Revised: November 1988

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SECTION 1. MATERIAL IDENTIFICATION

Material Name: ACETONE

Description (Origin/Uses): Used as a solvent for fats, oils, waxes, resins, rubber, plastics, varnishes, and rubber cements; also used in the manufacture of methyl isobutyl ketone, mesityl oxide, acetic acid, diacetone alcohol, chloroform, iodoform, bromoform, explosives, rayon, photographic films, and isoprene. Used to store acetylene gas. Widely used in the chemical process industry (CPI).

Other Designations: Dimethylformaldehyde; Dimethylketal; Dimethyl Ketone; Ketone Propane;
Pyroacetic Acid; Pyroacetic Ether; C₃H₆O; CAS No. 0067-64-1

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



NFPA

HMS

H 1 R 1

F 3 I 1

R 0 S 2

PPG* K 4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Acetone, CAS No. 0067-64-1

%

EXPOSURE LIMITS

OSHA PELs

8-Hr TWA: 750 ppm, 1800 mg/m³

STEL: 1000 ppm, 2400 mg/m³

ACGIH TLVs, 1988-89

TLV-TWA: 750 ppm, 1780 mg/m³

TVL-STEL: 1000 ppm, 2375 mg/m³

Toxicity Data*

Man, Inhalation, TD₀₁: 440 µg/m³ (6 Mins)

Man, Inhalation, TD₀₁: 10 mg/m³ (6 Hrs)

*See NIOSH, RTECS (AL3150000), for additional data with references to reproductive, mutagenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 134°F (56°C)

Melting Point: -137°F (-94°C)

Vapor Density (Air = 1): 2

Vapor Pressure: 180 Torr at 68°F (20°C)

Evaporation Rate: Faster than That of *n*-Butyl Acetate

Molecular Weight: 58 Grams/Mole

Solubility in Water (%): Complete

Specific Gravity (H₂O = 1): 0.778 at 77°F (25°C)

% Volatile by Volume: 100

Appearance and Odor: A clear, colorless, highly flammable, volatile liquid with a characteristic, pleasant, sweetish odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 1.4°F (-17°C) CC

Autoignition Temperature: 869°F (465°C)

LEL: 2.9% v/v

UEL: 12.8% v/v

Extinguishing Media: Use "alcohol" foam, dry chemical, or carbon dioxide. Use a blanketing effect to smother flames. Use water spray to reduce the rate of burning and to cool containers. Water will probably not be effective in directly extinguishing an acetone fire.

Unusual Fire or Explosion Hazards: Acetone vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

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

Stability/Polymerization: Acetone is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Acetone can react dangerously with strong oxidizing agents such as nitrates, perchlorates, permanganates, and concentrated sulfuric acid; chromic anhydride; chromyl chloride; hydrogen peroxide; hexachloromelamine; nitrosyl chloride; permono-sulfuric acid; mixtures of sulfuric acid and nitric acid; mixtures of nitric acid and acetic acid; and potassium *tert*-butoxide.

Conditions to Avoid: Do not expose acetone to sources of ignition and incompatible chemicals.

Hazardous Products of Decomposition: Carbon monoxide and carbon dioxide can be produced during acetone fires.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Acetone is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Inhalation of high concentrations of acetone vapor can cause dryness of the mouth and throat; dizziness, nausea, incoordination, slurred speech, drowsiness, and, in severe exposures, coma. Inhalation of small quantities of acetone vapor for an extended period causes irritation of the respiratory tract, coughing, and headache. Prolonged or repeated skin contact with acetone has a defatting effect causing dryness, irritation, and mild dermatitis. Under routine operating conditions the amount of acetone absorbed through the skin is small. Ingestion of acetone may cause irritation of the gastrointestinal tract and narcosis. Acetone acts primarily as a depressant to the central nervous system (CNS) when exposures are severe or prolonged. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** None reported. **FIRST AID:** **Eyes:** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin:** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Monitor the exposed person for symptoms of depression of the CNS such as incoordination and drowsiness. **Ingestion:** Unlikely.* If a small amount is ingested, dilute it slowly with 1 to 2 glasses of water or milk. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. *Note to Physician: Treatment for accidental ingestion of a small amount of acetone is unnecessary. If a large amount has been ingested, administer a charcoal slurry, either aqueous or mixed with a saline cathartic or sorbitol.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup personnel need protection against this liquid's contact with skin or eyes as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Consider saving the waste hydrochloric acid for use as a neutralizing agent during cleanup operations of basic materials.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U002

CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg), per the Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious butyl or natural rubber gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Automatic sprinkler systems for fire protection are desirable in work areas. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. 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 acetone vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store acetone in closed containers (carbon steel is recommended) in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other Precautions:** Use labeled safety cans when handling small amounts of acetone. Acetone presents a dangerous fire hazard; perform all work operations involving it carefully and in a way that will prevent exposing the liquid or its vapor to sources of ignition.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Acetone

IMO Hazard Class: 3.1

DOT Hazard Class: Flammable Liquid

IMO Label: Flammable Liquid

ID No. UN1090

IMDG Packaging Group: II

DOT Label: Flammable Liquid

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheet

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No. 350

CARBON DISULFIDE
(Revision C)
Issued: November 1977
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION

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Material: CARBON DISULFIDE

Description (Origin/Uses): Used in the manufacture of soil disinfectants, electronic vacuum tubes, rayon, and carbon tetrachloride; used also as a solvent.

Other Designations: Carbon Bisulfide; Carbon Sulfide; Dithiocarbonic Acid; CS₂; CAS No. 0075-15-0

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

HMIS		NFPA	
H	2	R	1
F	3	I	4
R	0	S	3
PPG*		K 4	
*See sect. 8			



SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

Carbon Disulfide, ca 100%

OSHA PELs (Skin*)

8-hr TWA: 4 ppm, 12 mg/m³

15-min STEL: 12 ppm, 36 mg/m³

ACGIH TLV (Skin*), 1988-89

TLV-TWA: 10 ppm, 30 mg/m³

Toxicity Data†

Human, Oral, LD₅₀: 14 mg/kg

Human, Inhalation, LC₅₀: 4000 ppm (30 min)

NIOSH RELs, 1977

10-hr TWA: 1 ppm, 3 mg/m³

15-min Ceiling: 10 ppm, 30 mg/m³

*This material can be absorbed through intact skin, and this contributes to overall exposure.

†See NIOSH, RTECS (FF6650000), for additional data with references to reproductive and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 115 °F (45 °C)

Melting Point: -170 °F (-112 °C)

Vapor Pressure: 300 Torr at 68 °F (20 °C)

Vapor Density (Air = 1): 2.6

Molecular Weight: 76 g/mol

Specific Gravity (H₂O = 1): 1.2632 at 68 °F (20 °C)

Solubility in Water (%): 220 mg CS₂/100 cc H₂O at 72 °F (22 °C)

% Volatile by Volume: 100

Appearance and Odor: A clear, colorless or faintly yellow, mobile liquid; almost odorless when pure. Technical grades of CS₂ have a strong, unpleasant odor of the contaminant hydrogen sulfide (rotten eggs); the odor threshold has been reported as 0.1 to 0.2 ppm.

Comments: The very high vapor pressure of this liquid at room temperature indicates that airborne concentrations can quickly build up to dangerous levels, from both a health effects and a fire/explosion perspective. Its properties, health effects (see sect. 6), and explosive properties (see sect. 4) make it dangerous to work with unless appropriate precautions are taken (see sect. 8).

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: -22 °F (-30 °C) CC

Autoignition Temperature: 212 °F (100 °C)

LEL: 1% v/v

UEL: 50% v/v

Extinguishing Media: Foams are more effective than water in extinguishing carbon disulfide fires. Four foams tested and ranked in order of increasing effectiveness are high-expansion, aqueous-film-forming, fluoroprotein, and protein. Cool fire-exposed containers with water spray; continue cooling them after the fire has been extinguished to prevent spontaneous reignition of the carbon disulfide. Dry chemical agents are ineffective in extinguishing carbon disulfide fires. Unusual Fire or Explosion Hazard: Carbon disulfide vapor is denser than air, and it can flow along surfaces, collect in low-lying areas, reach distant ignition sources, and flash back to its liquid source. The low flash point, wide range of explosibility, and dangerously low autoignition temperature of this material present dangerous fire and explosion risks that must be carefully considered during fire-fighting operations. Carbon disulfide vapor can be ignited by contact with an ordinary light bulb. 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

Stability/Polymerization: Carbon disulfide is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. Chemical Incompatibilities: Carbon disulfide can react dangerously with aluminum, azides, chlorine, chlorine monoxide, ethylene diamine, fluorine, nitric oxide, potassium, zinc, and oxidizing agents such as permanganates and sulfuric acid, etc. Conditions to Avoid: Do not expose this material to any source of heat or ignition or to incompatible chemicals. Hazardous Products of Decomposition: Thermal oxidative degradation of carbon disulfide can produce toxic gases and vapors such as chloroform, chlorine, hydrogen chloride, and carbon monoxide.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Carbon disulfide is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Eye contact with this liquid causes immediate, severe irritation. Absorption through the skin is particularly dangerous because it can lead to damage of the peripheral nervous system (PNS). Carbon disulfide has definite effects on the central nervous system (CNS), such as convulsions, respiratory paralysis, narcosis, and even death. Cardiovascular system problems (heart, lungs, blood) are also associated with long-term exposure to this material. Medical Conditions Aggravated by Long-Term Exposure: Persons with diseases of the CNS, CVS, gastrointestinal tract, liver, and kidneys may be at increased risk from exposure to carbon disulfide. Target Organs: Skin, eyes, respiratory system, CNS, PNS, liver, kidneys. Primary Entry: Inhalation, skin contact/absorption. (cont'd.)

SECTION 6. HEALTH HAZARD INFORMATION, continued

Acute Effects: Dizziness, nausea, vomiting, headache, euphoria, unconsciousness, and convulsions. **Chronic Effects:** Repeated exposure to carbon disulfide can cause neurotoxic effects characterized by nervousness, irritability, tremors, indigestion, headache, bizarre dreams leading to insomnia, loss of appetite, polyneuritis, and psychosis. Damage to the CNS, CVS, and eyes are also possible. Conflicting evidence of effects on the reproductive function have been cited. **FIRST AID:** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with flooding amounts of water; wash it with soap and water. **Inhalation.** Treat any substantial inhalation exposure as an emergency. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep him or her warm and at rest until medical help is available. **Ingestion.** Unlikely. Should accidental ingestion occur, have the exposed person drink 1 to 2 glasses of water to dilute the material. Do not induce vomiting unless directed to do so by an occupational physician or poison control center. Get in-plant, paramedic, or community medical help for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Inhalation exposure is potentially life threatening; direct efforts toward maintaining, supporting, or restoring adequate respiration.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: It is necessary to plan and design prior appropriate emergency-response procedures for carbon disulfide spills or leaks. Notify safety personnel, evacuate unnecessary workers, immediately extinguish all sources of ignition, and provide optimum explosion-proof ventilation, preferably at floor level. All cleanup operations must be done with nonsparking tools and equipment. Do not flush carbon disulfide to sewers or other surface waters. Flush the spilled liquid to a special retention basin where it can be collected below a layer of water for eventual disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations

Listed as RCRA Hazardous Waste No. P022 (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Reportable Quantity (RQ): 100 lb (45.4 kg), [*per CWA, §311 (b)(4) and RCRA, §3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), Threshold Planning Quantity (TPQ): 10,000 lb

Listed as a SARA Toxic Chemical* (40 CFR 372.65) [*EPA Form R may apply to your facility; see 40 CFR 372.85 for instructions]

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Wear a full face shield where splashing of carbon disulfide is possible. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, trousers, and gauntlets to prevent any contact of carbon disulfide with your skin. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne concentrations of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Carbon disulfide presents serious fire and explosion hazards (see sect. 4); these dangers are heightened by this material's physical properties (see sect. 3). Using carbon disulfide requires specific engineering controls such as an automatic monitoring-detection system for the airborne concentration of this material and a thorough inspection of all production and storage facilities to eliminate all possible sources of ignition. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store carbon disulfide in closed containers in a cool, dry, well-ventilated area (at floor level) away from all sources of heat and ignition and incompatible chemicals (see sect. 5). Protect these containers from physical damage and shield them from direct sunlight. Outside, isolated, remote, or detached storage is recommended for bulk quantities of carbon disulfide. **Special Handling/Storage:** Equip storage facilities with automatic sprinklers (test them regularly); preferably, the storage building itself should be noncombustible. In storage tanks, fill voids above the carbon disulfide with water or nitrogen gas as the tank is emptied. Tanks should be submerged in water or located above concrete basins large enough to hold all of the tanks' contents. **Engineering Controls:** Electrically ground and bond all containers and equipment used in shipping, receiving, sampling, or producing operations to prevent static sparks. Prepare safe grounding routes for lightning strikes. Electrical installations and heating facilities must be prohibited in or near storage areas. **Other Precautions:** Spark-proof tools are required for work operations. Carbon disulfide must never be transferred by means of air pressure; use pump, water, or inert gas. Use wooden measuring sticks (no spark potential) to measure the contents of carbon disulfide tanks and containers. A sustained, conscientious effort to work carefully and safely is required of all workers who handle carbon disulfide.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Carbon Disulfide or Carbon Bisulfide

DOT Hazard Class: Flammable Liquid

DOT ID No.: UN1131

DOT Label: Flammable Liquid

DOT Packaging Requirements: 49 CFR 173.121

References: 1, 6, 26, 38, 84-94, 100, 116, 118, 119, 122

IMO Shipping Name: Carbon Disulfide

IMO Hazard Class: 3.1

IMO Label: Flammable Liquid, Poison

IMPG Packaging Group: 1

Prepared by: PJ Igoe, 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. 410

CARBON TETRACHLORIDE

Revision A

Date December 1980

SECTION I. MATERIAL IDENTIFICATION			
<p>MATERIAL NAME: CARBON TETRACHLORIDE OTHER DESIGNATIONS: Tetrachlormethane, Perchlormethane, Methane Tetrachloride, CCl₄, GE Material D5B50, CAS #000 056 235 MANUFACTURER: Available from several suppliers, including: Linden Chemicals & Plastics PO Drawer J, Moundsville, WV 26041 Phone: (314) 843-1310</p>			
SECTION II. INGREDIENTS AND HAZARDS		HAZARD DATA	
Carbon Tetrachloride	ca 100	8-hr TWA 5 ppm (skin) or 30 mg/m ³ Human, oral LD ₅₀ 43 mg/kg Human, inhalation LC ₅₀ 1000 ppm TC ₅₀ 20 ppm (CNS) Hamsters and mice have developed cancer on long term feeding.	
<p>*ACGIH (1980 Intended Changes List). OSHA 8-hr TWA is 10 ppm. NIOSH has proposed a 10-hr TWA of 2 ppm. ACGIH and NIOSH recommend labeling as a suspected human carcinogen. (skin) notation indicates absorption through the skin can contribute significantly to overall exposure.</p>			
SECTION III. PHYSICAL DATA			
Boiling point at 1 atm, deg C — 76.7	Specific gravity, 25/4 C — 1.585		
Vapor pressure @ 20 C, mm Hg — ca 91	Melting point, deg C — -23		
Vapor density (Air=1) — 5.3	Volatiles, % — ca 100		
Solubility in water @ 20 C, wt % - 0.08	Molecular weight — 153.8		
<p>Appearance & Odor: A clear, colorless liquid with a characteristic sweetish odor. Odor recognition threshold (100% of test panel): 21.4 ppm in air when prepared from CS₂; 100 ppm in air when prepared from CH₄. Odor may not be objectionable at acutely toxic levels.</p>			
SECTION IV. FIRE AND EXPLOSION DATA		LOWER	UPPER
Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	
<p>Extinguishing Media: It is nonflammable. Use that which is appropriate for the surrounding fire. Use water spray to cool fire-exposed containers. When involved in a fire situation, this material will emit highly toxic and irritating fumes and gases. Metals, such as aluminum and magnesium, can react violently with carbon tetrachloride when hot or burning. Firefighters must wear self-contained breathing apparatus and full protective gear to fight fires involving this material.</p>			
SECTION V. REACTIVITY DATA			
<p>This material is stable under normal conditions of handling and use. It does not polymerize. Thermal-oxidative decomposition will produce toxic, corrosive fumes, including phosgene and hydrogen chloride. Violent reactions or explosions can occur with incompatible materials, such as barium, lithium, sodium, and potassium metal, powdered aluminum, magnesium, dimethylformamide (above 65 C), fluorine, etc. (See NFPA, "Manual of Hazardous Chemical Reactions".)</p>			

SECTION VI. HEALTH HAZARD INFORMATION	TLV 5 ppm (skin) (See Sect. II)
<p>Carbon tetrachloride is highly toxic and irritating by inhalation and ingestion (mean lethal dose is 5-10 ml). It is toxic by skin absorption. Excessive exposure may result in CNS depression and/or gastrointestinal symptoms.* It is irritating to skin and eyes. Eye contact or systemic effects can produce visual disturbances (haze, blind spots, narrowing of visual field, etc.). Skin contacts can cause defatting & dermatitis.</p> <p>Kidney & liver damage can occur from severe acute or chronic exposure. It is a suspected carcinogen in humans.</p> <p>FIRST AID: Eye Contact: Flush eyes with running water for 15 minutes, including under the eyelids. Get medical help if irritation persists or when visual disturbances occur. Skin Contact: Remove contaminated clothing promptly. Wash exposed skin with soap and water. Get medical help for repeated or gross exposures. Inhalation: Remove to fresh air. Restore and/or support breathing; have qualified person administer oxygen if needed. Get medical help. Ingestion: Contact physician for gastric lavage. (If medical help and advice is not readily available, give water to drink and induce vomiting.)</p> <p>*Also cardiac arrhythmias.</p>	
SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES	
<p>Notify safety personnel when large spills occur. Evacuate area. Provide maximum exhaust ventilation. Clean-up personnel must use protection against contact and inhalation (see Sect. VIII). Contain spill; pick up liquid for disposal. Small spills and residues can be absorbed on paper, vermiculite, etc. and allowed to evaporate in a hood. Prevent release of CCl₄ to surface water or sewers. Spills or discharges in 24 hours of 5000 lb or more (proposed RQ* is 1000 lb) must be reported to U.S. Government.</p> <p>DISPOSAL: Consider recovery and reuse, if feasible. Scrap may be burned in approved, high temperature incinerator with scrubber or it may be disposed of as hazardous waste (EPA number U211 or F00) as a spent degreasing solvent under RCRA). Follow Federal, State and Local regulations.</p> <p>*Reportable Quantity.</p>	
SECTION VIII. SPECIAL PROTECTION INFORMATION	
<p>Provide general and local exhaust ventilation to meet TLV. Exhaust hoods need 100 fpm min. face velocity. Ventilate sumps and low lying areas. Use air-supplied or self-contained respirators above TLV, with full face piece above 100 ppm.</p> <p>PVA or neoprene gloves and protective clothing needed to prevent skin contact. Wear safety goggles and/or face shield for eye protection.</p> <p>An eyewash station and chemical safety shower should be readily accessible.</p> <p>Provide preplacement and twice a year medical exams. Workers with obesity, diabetes, alcoholism or pulmonary problems should have a physician's approval before working with CCl₄. Retain medical records for 30 years after termination of employment.</p> <p>Provide training to those exposed to CCl₄ in the workplace. Monitor vapor levels in the workplace.</p>	
SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS	
<p>Store in closed containers in a cool, dry, well-ventilated, low fire-risk area. Protect containers against physical damage. Keep away from sources of heat, direct sunlight, and incompatible materials (see Sect. V). Prevent exposure of vapors to high temperature to prevent decomposition to toxic and corrosive gases and vapors. No smoking in areas where vapors may be present.</p> <p>Prevent contact with the skin or eyes. Avoid exposure to vapors. Use good personal hygiene.</p> <p>CCl₄ toxicity is markedly increased by the synergistic effects of alcohol. When possible, substitute a less hazardous solvent for CCl₄. DOT Classification - ORM-A</p>	
<p>DATA SOURCE(S) CODE: 1-12,15,16,21-26,31,37,38,41</p> <p><small>Adapted as is the subject of permission from the publisher's permission are hereby granted to the user. The user agrees to indemnify and hold the publisher harmless from all claims, damages, and expenses, including reasonable attorneys' fees, arising from the use of the information contained herein, in whole or in part, for any purpose other than that for which it was originally prepared.</small></p>	<p>APPROVALS: MIS CRD <i>J. M. Wilson</i></p> <p>Industrial Hygiene and Safety <i>JW 12-9-80</i></p> <p>MEDICAL REVIEW: 16 Dec. 1980</p>

Material Safety Data Sheet

From Genium's Reference Collection
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CHLOROFORM
 (Revision D)
 Issued: August 1979
 Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: CHLOROFORM

Description (Origin/Uses): Used as a solvent for fats, oils, rubber, alkaloids, waxes, and resins; as a cleansing agent.

Other Designations: Trichloromethane; CHCl₃; NIOSH RTECS No. FS9100000; CAS No. 0067-66-3

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

HMIS	
H 2	
F 0	R 1
R 0	I 3
PPG*	S 2
*See sect. 8	K 0



SECTION 2. INGREDIENTS AND HAZARDS

Chloroform, CAS No. 0067-66-3

%
Ca 100

EXPOSURE LIMITS

*See NIOSH, RTECS, for additional toxicity data with references to mutagenic, reproductive, tumorigenic, and irritative effects.

OSHA PEL
 Ceiling: 50 ppm, 240 mg/m³
 ACGIH TLV, 1987-88
 TLV-TWA: 10 ppm, 50 mg/m³
 NIOSH REL
 Ceiling: 2 ppm, 9.78 mg/m³
 Toxicity Data*
 Human, Oral, LD₅₀: 140 mg/kg
 Rat, Oral, LD₅₀: 908 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 142°F (61°C)
 Melting Point: -22.3°F (-63.5°C)
 Vapor Pressure: 158.4 Torr at 68°F (20°C)
 Vapor Density (Air = 1): 4.13

Water Solubility (%): 0.822 ml of CHCl₃, per 100 ml of H₂O at 68°F (20°C)
 % Volatile by Volume: 100
 Molecular Weight: 119 Grams/Mole
 Specific Gravity (H₂O = 1): 1.484 at 68°F (20°C)

Appearance and Odor: A heavy, colorless, clear, volatile liquid; characteristic, pleasant, ethereal, sweet odor (recognition threshold: 0.3 mg/m³); sweet taste.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER UPPER

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air
.	.	% by Volume

Extinguishing Media: *Chloroform does not burn. Use an agent that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

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

Chloroform is stable if kept in closed containers and protected from air and sunlight. It does not undergo hazardous polymerization; however, even when stabilized with ethanol, this material develops acidity from prolonged exposure to air and light.

Chemical Incompatibilities: This material is incompatible with strong alkalis.

Conditions to Avoid: Avoid prolonged exposure to air and light and to strong alkalis.

Hazardous Products of Decomposition: Toxic and corrosive gases like hydrochloric acid (HCl), chlorine (Cl₂), carbon monoxide (CO), and oxides of chlorine (ClO_x) can be produced during fires.

SECTION 6. HEALTH HAZARD INFORMATION

Chloroform is listed as a suspected human carcinogen by ACGIH.

Summary of Risks: Exposure to this material affects the central nervous system (anesthesia); heart (arrhythmia, ventricular tachycardia, bradycardia); liver (necrosis, hepatoma); kidney (necrosis); and it is an embryonic toxin. Fatalities are associated with cardiovascular depression and ventricular fibrillation.

Medical Conditions Aggravated by Long-Term Exposure: Ailments of the heart, liver, and kidneys may be worsened by exposure to chloroform. **Target Organs:** Liver, kidneys, heart, skin, eyes. **Primary Entry:** Skin contact, inhalation.

Acute Effects: Dizziness, mental dullness, nausea, headache, fatigue, and anesthesia. **Chronic Effects:** Possible cancer.

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 the exposed person is responsive, give him or her several glasses of milk or water to drink and induce vomiting. Repeat if large quantities were ingested.

Comments: Workers who are regularly exposed to chloroform require preplacement and periodic medical exams emphasizing kidney, liver, skin, and central nervous system functions. Carefully evaluate each exposure that produces a noticeable effect to determine the extent to which factors like alcohol or drugs have affected it.

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 of a chloroform spill or leak. Provide ventilation. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Chloroform vapor is heavier than air and will collect in low-lying areas. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.

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

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U044

CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. 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:** To prevent contact with skin, wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specific work environment. **Ventilation:** Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of chloroform 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. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area. Avoid inhalation of vapor!

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store chloroform in closed containers away from light and alkalis.

Special Handling/Storage: Protect containers from physical damage. Do not transfer chloroform through plastic or rubber hoses or pipes.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Chloroform

DOT Class: ORM-A

DOT Label: None

DOT ID No. UN1888

IMO Label: Poison

IMO Class: 6.1

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

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Occupational Health Guideline for 1,1-Dichloroethane

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_2CHCl_2
- Synonyms: Asymmetrical dichloroethane; ethylidene chloride; 1,1-ethylidene dichloride
- Appearance and odor: Colorless liquid with a chloroform-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for 1,1-dichloroethane is 100 parts of 1,1-dichloroethane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 400 milligrams of 1,1-dichloroethane per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has recommended for 1,1-dichloroethane a Threshold Limit Value of 200 ppm.

HEALTH HAZARD INFORMATION

- Routes of exposure

1,1-Dichloroethane can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

- Effects of overexposure

1. *Short-term Exposure:* Breathing 1,1-dichloroethane vapor may cause drowsiness and unconsciousness. It might also cause damage to the liver, kidneys, and lungs. Splashing the liquid in the eyes may cause irritation.

2. *Long-term Exposure:* Prolonged, confined, or repeated skin contact with 1,1-dichloroethane can produce a slight burn.

3. *Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to 1,1-dichloroethane.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to 1,1-dichloroethane at potentially hazardous levels:

1. *Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from 1,1-dichloroethane exposure.

—Skin disease: 1,1-Dichloroethane can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver disease: Although 1,1-dichloroethane is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Although 1,1-dichloroethane is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of 1,1-dichloroethane might cause exacerbation of symptoms due to its irritant properties.

2. *Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

- Summary of toxicology

1,1-Dichloroethane vapor is a narcotic. Rats exposed to 32,000 ppm for 30 minutes did not survive. The most consistent findings in animals exposed to concentrations

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

of above 8,000 ppm for up to 7 hours were pathologic changes in the kidney and liver, and at much higher concentrations, near 64,000 ppm, damage to the lungs as well. Repeated daily exposure of several species of animals to 1,000 ppm resulted in no pathologic or pathologic changes. The liquid applied to the intact or abraded skin of rabbits produced slight edema and very slight necrosis after six daily applications. Instilled in the eyes of rabbits there was immediate, moderate conjunctival irritation and swelling which subsided within a week. There have been no reported cases of human overexposure by inhalation; prolonged, confined, or repeated skin contact can produce a slight burn.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 99
2. Boiling point (760 mm Hg): 57.3 C (135 F)
3. Specific gravity (water = 1): 1.2
4. Vapor density (air = 1 at boiling point of 1,1-dichloroethane): 3.4
5. Melting point: -96.7 C (-142 F)
6. Vapor pressure at 20 C (68 F): 182 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Less than 0.1
8. Evaporation rate (butyl acetate = 1): 11.6

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with strong acids will cause formation of flammable and toxic acetaldehyde gas.

3. Hazardous decomposition products: Toxic gases and vapors (such as vinyl chloride, hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving 1,1-dichloroethane.

4. Special precautions: 1,1-Dichloroethane will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: -8.5 C (17 F) (closed cup)
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Lower: 5.9; Upper: 15.9

4. Extinguishant: Foam, dry chemical, carbon dioxide

• Warning properties

The AIHA *Hygienic Guide* reports that 1,1-dichloroethane has a distinctive, easily recognizable odor at the TLV.

1,1-Dichloroethane is not known to be an eye irritant.

MONITORING AND MEASUREMENT PROCEDURES

• General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based

on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Method

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure 1,1-dichloroethane may be used. An analytical method for 1,1-dichloroethane is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid 1,1-dichloroethane.

• Clothing wet with liquid 1,1-dichloroethane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of 1,1-dichloroethane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 1,1-dichloroethane, the person performing the operation should be informed of 1,1-dichloroethane's hazardous properties.

• Any clothing which becomes wet with liquid 1,1-dichloroethane should be removed immediately and not

reworn until the 1,1-dichloroethane is removed from the clothing.

- Employees should be provided with and required to use splash-proof safety goggles where liquid 1,1-dichloroethane may contact the eyes.

SANITATION

- Skin that becomes wet with liquid 1,1-dichloroethane should be immediately washed or showered with soap or mild detergent and water to remove any 1,1-dichloroethane.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to 1,1-dichloroethane may occur and control methods which may be effective in each case:

Operation	Controls
Use as dewaxer of mineral oils; extractant for heat-sensitive substances	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a fumigant	General dilution ventilation of work area; personal protective equipment
Use in manufacture of vinyl chloride by vapor phase cracking; use in manufacture of high vacuum rubber and silicon grease; use as a chemical intermediate	General dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If 1,1-dichloroethane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If 1,1-dichloroethane gets on the skin, promptly flush the contaminated skin using soap or mild detergent and water. If 1,1-dichloroethane soaks through the clothing, remove the clothing immediately and flush the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of 1,1-dichloroethane, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration.

Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When 1,1-dichloroethane has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

- If 1,1-dichloroethane is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. 1,1-Dichloroethane should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of 1,1-dichloroethane vapors are permitted.

• Waste disposal method:

1,1-Dichloroethane may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "1,1-Dichloroethane (Ethylidene Chloride)," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

- American Industrial Hygiene Association: "1,1-Dichloroethane (Ethylidene Chloride)," *Hygienic Guide Series*, Detroit, Michigan, 1971.

SECTION 6. HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B), by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. **SUMMARY OF RISKS:** Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors reportedly caused three fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, intoxication, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatotoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. **TARGET ORGANS:** Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. **PRIMARY ENTRY:** Inhalation, absorption through skin, oral, or eye contact. **ACUTE EFFECTS:** Skin contact causes irritation, itching, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. **CHRONIC EFFECTS:** Injuries to the liver (hepatotoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. **MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE:** Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. **FIRST AID:** Be prepared to restrain a hyperactive victim. **EYE CONTACT:** Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help. **SKIN CONTACT:** Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help. **INHALATION:** Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help. **INGESTION:** Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help. **GET MEDICAL ASSISTANCE - IN PLANT, PARAMEDIC, COMMUNITY.** Get prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. **WASTE DISPOSAL:** Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations.

Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U077
 EPA Reportable Quantity (40 CFR 117.3): 5000 lbs (2270 kgs)
 Aquatic Toxicity Rating, TLM 96: 1000 - 100 ppm

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). **GLOVES:** Wear impervious rubber gloves to prevent skin contact. **RESPIRATOR:** Use a NIOSH-approved respirator per the NIOSH Pocket Guide to Chemical Hazards (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. **OTHER:** Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. **VENTILATION:** Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 fpm (linear feet per minute). **SAFETY STATIONS:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **SPECIAL CONSIDERATIONS:** Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. **COMMENTS:** Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. **SPECIAL HANDLING/STORAGE:** Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. **ENGINEERING CONTROLS:** During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Preplan emergency response procedures.

TRANSPORTATION DATA (per 49 CFR 172.101-2):
 DOT Hazard Class: Flammable Liquid
 DOT Label: Flammable Liquid
 IMO Class: 3.2

DOT Shipping Name: Ethylene Dichloride
 DOT ID No. UN 1184
 IMO Label: Flammable Liquid, Poison

References: 1-9, 12, 19, 21, 26, 43, 47, 73, 87-102. CK

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Approvals *J.O. DeSoto*

Indust. Hygiene/Safety *JW 11-19-87*

Medical Review *Gen/Holden 11-30-87*

Material Safety Data Sheet

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No. 311

METHYL CHLOROFORM
(Revision E)
Issued: November 1975
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: METHYL CHLOROFORM

Description (Origin/Uses): Used in cold-type metal cleaning; also in cleaning plastic molds.

Other Designations: 1,1,1-Trichloroethane; CH_2Cl_2 ; CAS No. 0071-55-6

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

HMS
H 2 R 1
F 0 I -
R 1 S 2
PPG*
*See sect. 8 K 1



SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methyl Chloroform, CAS No. 0071-55-6

OSHA PELs
Hr TWA: 350 ppm, 1900 mg/m³
REL: 450 ppm, 2450 mg/m³

ACGIH TLVs, 1988-89
TLV-TWA: 350 ppm, 1900 mg/m³
TLV-STEL: 450 ppm, 2450 mg/m³

Toxicity Data**
Man, Inhalation, LC₅₀: 27 g/m³ (10 Mins)
Man, Inhalation, TC₅₀: 350 ppm
Human, Oral, TD₅₀: 670 mg/kg
Rat, Oral, LD₅₀: 10300 mg/kg

Contact your supplier for specifications, including details about inhibitors that can be added to the methyl chloroform product. See NIOSH, RTECS (KJ2975000), for additional data with references to irritative, reproductive, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 165°F (74.1°C)
Melting Point: -26.5°F (-32.5°C)
Vapor Density (Air = 1): 4.55
Vapor Pressure: 100 Torr at 68°F (20°C)

Molecular Weight: 133 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H₂O = 1): 1.3376 at 68°F (20°C)
% Volatile by Volume: Ca 100

Appearance and Odor: A colorless liquid; mild, sweetish, pleasant, etherlike odor that may be just perceptible (if unfatigued) at about 100 ppm in the air.

Comments: Small variations in the above-noted physical properties are expected because of the various inhibitors that may be included in the methyl chloroform product.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: None Found | Autoignition Temperature: 998°F (537°C) | LEL: 8.0% v/v | UEL: 10.5% v/v

Extinguishing Media: Methyl chloroform does not burn at ordinary temperatures. High-energy sources such as an electric arc or an elevated temperature are required for ignition of this material. When the source of ignition is removed, methyl chloroform tends to stop burning. Use water spray to cool fire-exposed containers. Use water fog, carbon dioxide, dry chemical, or foam to fight fires involving this material or nearby fires. Unusual Fire or Explosion Hazards: Methyl chloroform vapor is heavier than air and may travel a considerable distance to a low-lying high-energy source of ignition and flash back to its origin. Use care in selecting equipment (see sect. 5, Comments). 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

Stability/Polymerization: Methyl chloroform is stable in closed containers during routine operations. Hazardous polymerization cannot occur. Chemical Incompatibilities: Methyl chloroform can react dangerously with acetone, nitrogen tetroxide, oxygen (gas or liquid), sodium, sodium hydroxide, and sodium-potassium alloys. Conditions to Avoid: Avoid exposure to any high-energy source of ignition or to incompatible chemicals. Hazardous Products of Decomposition: Toxic and corrosive gases such as hydrogen chloride, dichloroacetylene, phosgene, and phosgene can be produced by decomposition of methyl chloroform at high temperatures, contact with hot metals, or exposure to ultraviolet radiation. Phosgene is usually produced in very small quantities; however, the significant irritating properties of hydrogen chloride (the dominant product of decomposition) prevent significant exposure to the phosgene. Comments: This material can be hydrolyzed by water to form hydrochloric acid and acetic acid. It will react with strong caustics to form flammable or explosive materials. It attacks natural rubber. Methyl chloroform requires an inhibitor content to prevent corrosion of metals. When the inhibitor is depleted, this material can decompose rapidly by reaction with finely divided white metals such as aluminum, magnesium, or zinc. Do not use these metals in pressurized spraying equipment where methyl chloroform is involved.

SECTION 6. HEALTH HAZARD INFORMATION

Acute Toxicity: Methyl chloroform is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Methyl chloroform exhibits low oral toxicity. It can defat the exposed skin of workers and cause redness and scaling. Although methyl chloroform is low in systemic toxicity, it is an anesthetic that is capable of causing death if it is inhaled at concentrations of 14000 to 15000 ppm. Fatalities that have occurred in poorly ventilated areas such as pits or tanks are attributed to anesthesia and/or sensitization of the myocardium to epinephrine. Quick and complete recovery is reported upon prompt removal of unconscious exposed persons from the area of exposure. The TLV-TWA cited in section 2 is set to prevent initial anesthetic effects and/or objections to the

SECTION 6. HEALTH HAZARD INFORMATION, cont.

odor. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, heart, cardiovascular system, and CNS. Primary Entry: Inhalation, skin absorption. Acute Effects: Headache, lassitude, dermatitis, skin and eye irritation, cardiac arrhythmias, and depression of the CNS. Chronic Effects: None reported. FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with flooding amounts of water, then wash it with soap and water. Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Ingestion. Unlikely. Should this type of exposure occur, medical help is not readily available, and the amount swallowed was appreciable, give the exposed person milk of magnesia to drink and induce vomiting. Repeat this procedure. Aspiration hazards exist, so the decision whether or not to induce vomiting must be made carefully. If vomiting is to be induced, carry it out as quickly as possible before the ingested methyl chloroform is internally absorbed. This procedure would increase the chance of aspiration. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: The estimated lethal dose by ingestion for a man weighing 150 pounds is 0.5 to 1 pint. Do not use adrenalin or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved. Ingestion may cause spontaneous vomiting.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 5). Contain large spills and collect or absorb waste with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place liquid or absorbent waste into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U226

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). Respirator: Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. Other: Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. Suggested materials include neoprene, polyvinyl alcohol, or polyethylene. Natural rubber is not recommended. Ventilation: Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Other: Exercise care in the selection of safety and handling equipment because methyl chloroform attacks natural rubber. Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. 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 methyl chloroform vapor. Consider functions of the CVS, CNS, liver, and skin while administering preplacement and periodic medical exams.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store methyl chloroform in closed containers in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals (see sect. 5). Protect containers from physical damage. Steel is a recommended material for storage containers. Special Handling/Storage: Prevent moisture contamination of storage facilities. Monitor levels of inhibitor. Use caution in cleaning operations involving white metal fines (see sect. 5). Engineering Controls: Make sure all engineering systems (production, transportation) are of maximum, explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. Other: Personnel who regularly work with methyl chloroform should avoid drinking alcoholic beverages shortly before, during, or after exposure.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: 1,1,1-Trichloroethane

DOT Hazard Class: ORM-A

ID No. UN2831

DOT Packaging Requirements: 49 CFR 173.605

DOT Packaging Exceptions: 49 CFR 173.605

IMO Shipping Name: 1,1,1-Trichloromethane

IMO Hazard Class: 6.1

IMO Label: Saint Andrew's Cross (X)*

IMDG Packaging Group: III

*Harmful-Slow away from Foodstuffs (Materials of Class 6.1 Packaging Group III).

References: 1, 38, 84-94, 116, 117, 120, 122.

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

DIPHENYLNITROSAMINE

CAS RN: 86306

NIOSH #: JJ 9800000

mf: C₁₂H₁₀N₂O; mw: 198.24

Green crystals. mp: 144°.

SYNS:

DIPHENYLNITROSAMIN (GER-
MAN)
NCI-C02880

N-NITROSODIFENYLAMIN
(CZECH)
N-NITROSODIPHENYLAMINE

TOXICITY DATA:

3

CODEN:

eye-rbt 500 mg/24H SEV
mma-mus:lym 100 mg/L/4H
cyt-ham:fbr 30 mg/L/48H
sce-ham:fbr 100 umol/L
ori-rat TDLo:140 gm/kg/2Y-C:CAR

28ZPAK -,134,72
MUREAV 59,61,79
MUREAV 48,337,77
JNCIAM 58,1635,77
NCITR* NCI-CG-TR-
164,79

skn-mus TDLo:800 mg/kg/20W-
I:ETA

EJCAAH 16,695,80

ori-rat TD:170 gm/kg/2Y-C:CAR

NCITR* NCI-CG-TR-
164,79

ori-rat LD50:1650 mg/kg

28ZPAK -,134,72

ori-mus LD50:3850 mg/kg

GTPZAB 10,60,66

NCI Carcinogenesis Bioassay Completed; Results Positive: Rat (NCITR* NCI-CG-TR-164,79); Negative: Mouse (NCITR* NCI-CG-TR-164,79). Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.

THR: MUT data. An eye irr. An exper CARC, ETA. MOD orl.

Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction.

Disaster Hazard: Dangerous; when heated to decomp it emits highly tox fumes of NO_x; can react vigorously with oxidizing materials.

Occupational Health Guideline for Tetrachloroethylene*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $\text{CCl}_2 = \text{CCl}_2$
- Synonyms: Perchloroethylene; perchlorethylene; tetrachlorethylene; perk
- Appearance and odor: Colorless liquid with an odor like chloroform or ether.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for tetrachloroethylene is 100 parts of tetrachloroethylene per million parts of air (ppm) averaged over an eight-hour work shift, with a ceiling level of 200 ppm and a maximum acceptable peak of 300 ppm for 5 minutes in any three-hour period. NIOSH has recommended that the permissible exposure limit be reduced to 50 ppm (339 mg/m^3) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 100 ppm (678 mg/m^3) averaged over a 15-minute period. The NIOSH Criteria Document for Tetrachloroethylene should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- Routes of exposure
Tetrachloroethylene can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- Effects of overexposure
1. Short-term Exposure: Tetrachloroethylene may cause headache, nausea, drowsiness, dizziness, incoordination, and unconsciousness. It may also cause irritation of

the eyes, nose, and throat and flushing of the face and neck. In addition, it might cause liver damage with such findings as yellow jaundice and dark urine. The liver damage may become evident several weeks after the exposure.

2. Long-term Exposure: Prolonged or repeated overexposure to liquid tetrachloroethylene may cause irritation of the skin. It might also cause damage to the liver and kidneys.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to tetrachloroethylene.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to tetrachloroethylene at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the liver and the cardiovascular and neurological systems should be stressed. The skin should be examined for evidence of chronic disorders.

—Liver function tests: Tetrachloroethylene may cause liver damage. A profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has also been observed from exposure, a urinalysis should be obtained to include at minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- Summary of toxicology

Tetrachloroethylene vapor is a narcotic. Rats did not survive when exposed for longer than 12-18 minutes to 12,000 ppm; when exposed repeatedly to 470 ppm they showed liver and kidney injury. Cardiac arrhythmias

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

attributed to sensitization of the myocardium to epinephrine have been observed with certain other chlorinated hydrocarbons, but exposure of dogs to concentrations of 5000 and 10,000 ppm tetrachloroethylene did not produce this phenomenon. Four human subjects were unable to tolerate 5000 ppm in a chamber for 60 minutes. They experienced vertigo, nausea, and mental confusion during the 10 minutes following cessation of exposure. In an industrial exposure to an average concentration of 275 ppm for 3 hours, followed by 1100 ppm for 30 minutes, a worker lost consciousness; there was apparent clinical recovery 1 hour after exposure but the monitored concentration of tetrachloroethylene in the patient's expired air diminished slowly over a 2-week period. Long-term industrial exposures have been reported to cause various neuropathies, such as numbness, trembling, neuritis, and defects of memory. During the second and third post-exposure weeks, the results of liver function tests became abnormal, suggesting that acute exposure had had a significant effect upon the liver. Other instances of liver injury following industrial exposure have been reported. Other effects on humans of inhalation of various concentrations are as follows: 2000 ppm, mild narcosis within 5 minutes; 600 ppm, sensation of numbness around the mouth, dizziness, and some incoordination after 10 minutes. In human experiments, 7-hour exposures at 100 ppm resulted in mild irritation of the eyes, nose, and throat; flushing of the face and neck; headache; somnolence; and slurred speech. Exposure of the skin to the liquid for 15 minutes resulted in a progressively severe burning sensation beginning within 5 to 10 minutes; the result was marked erythema, which subsided after 1 to 2 hours. The liquid sprayed into rabbits' eyes produced immediate pain and blepharospasm; patches of epithelium were lost, but the eyes recovered completely within 3 days.

CHEMICAL AND PHYSICAL PROPERTIES

Physical data

1. Molecular weight: 165.85
2. Boiling point (760 mm Hg): 121.2 C (250 F)
3. Specific gravity (water = 1): 1.62
4. Vapor density (air = 1 at boiling point of tetrachloroethylene): 5.83
5. Melting point: -22.4 C (-8 F)
6. Vapor pressure at 20 C (68 F): 14 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.015
8. Evaporation rate (butyl acetate = 1): 2.8

Reactivity

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Tetrachloroethylene reacts with strong oxidizers and chemically active metals such as sodium, lithium, and beryllium.

Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released when tetrachloro-

ethylene decomposes.

4. Special precautions: Liquid tetrachloroethylene will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Not combustible

• Warning properties

1. Odor Threshold: Both May and Stern state that 50 ppm is the odor threshold for tetrachloroethylene.

2. Eye Irritation Level: Grant reports that "exposure to high concentrations of (tetrachloroethylene) vapor causes mild sensation of irritation to the eyes, but serious injury is not likely." The exact concentrations producing irritation are not mentioned by Grant.

Spector, however, reports that after a 20- to 30-minute exposure to 206 to 235 ppm, eye irritation occurs in humans.

Patty reports "very slight irritation of the eyes" among humans at 106 ppm.

3. Other Information: Spector reports that a 10-minute exposure to 513 to 690 ppm produces nose and throat irritation.

4. Evaluation of Warning Properties: Since the odor threshold of tetrachloroethylene is below the permissible exposure limit, and since eye irritation occurs at a concentration only twice the permissible exposure limit, its warning properties are considered to be adequate.

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of tetrachloroethylene. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Peak Above Ceiling Evaluation

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of tetrachloroethylene. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of

three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure tetrachloroethylene may be used. An analytical method for tetrachloroethylene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid tetrachloroethylene.

- Non-impervious clothing which becomes contaminated with liquid tetrachloroethylene should be removed promptly and not reworn until the tetrachloroethylene is removed from the clothing.

- Clothing wet with liquid tetrachloroethylene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of tetrachloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrachloroethylene, the person performing the operation should be informed of tetrachloroethylene's hazardous properties.

- Employees should be provided with and required to use splash-proof safety goggles where liquid tetrachloroethylene may contact the eyes.

SANITATION

- Skin that becomes contaminated with liquid tetrachloroethylene should be promptly washed or showered with soap or mild detergent and water to remove any tetrachloroethylene.

- Employees who handle liquid tetrachloroethylene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to tetrachloroethylene may occur and control methods which may be effective in each case:

Operation	Controls
Use as dry cleaning solvent; as degreasing and metal cleaning agent; in vapor degreasing of metal parts	Local exhaust ventilation; general dilution; personal protective equipment
Use as chemical intermediate in production of fluorocarbons, pesticides, and trichloroacetic acid	Process enclosure; local exhaust ventilation; general dilution ventilation
Use as scouring, sizing, desizing, solvent and greaser remover in processing and finishing of textiles	Local exhaust ventilation; general dilution; personal protective equipment
Use as general industrial solvent in rubber, textile, printing, soap, and paint remover industries	Local exhaust ventilation; general dilution; personal protective equipment
Use as extraction agent for vegetable and mineral oils and in pharmaceutical industry; as vermifuge; as laundry treatment for presoaking and as drying medium in metal and wood industries	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If tetrachloroethylene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If tetrachloroethylene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If tetrachloroethylene soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of tetrachloroethylene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When tetrachloroethylene has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If tetrachloroethylene is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

Waste disposal method:

Tetrachloroethylene may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

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• SPECIAL NOTE

Tetrachloroethylene appears on the OSHA "Candidate List" of chemicals being considered for further scientific review regarding its carcinogenicity (*Federal Register*, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980). The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 20, 1979.

RESPIRATORY PROTECTION FOR TETRACHLOROETHYLENE

Condition	Minimum Respiratory Protection* Required Above 100 ppm
Vapor Concentration	
500 ppm or less	<p>Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).</p> <p>A gas mask with a chin-style or a front- or back-mounted organic vapor canister.</p> <p>Any supplied-air respirator with a full facepiece, helmet, or hood.</p> <p>Any self-contained breathing apparatus with a full facepiece.</p>
Greater than 500 ppm or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p> <p>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</p>
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	<p>Any gas mask providing protection against organic vapors.</p> <p>Any escape self-contained breathing apparatus.</p>

*Only NIOSH-approved or MSHA-approved equipment should be used.

Material Safety Data Sheet

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No. 677

1,1,2,2-TETRACHLOROETHANE

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SECTION 1. MATERIAL IDENTIFICATION

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Material Name: 1,1,2,2-TETRACHLOROETHANE

Description (Origin/Uses): Used as a solvent primarily for cleaning and extraction procedures and as a chemical intermediate in the manufacture of trichloroethylene and tetrachloroethylene; and as an analytic reagent by textile manufacturers in polymer characterization tests.

Other Designations: Acetylene Tetrachloride; sym-Tetrachloroethane; $\text{CHCl}_2\text{CHCl}_2$; CAS No. 0079-34-5

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



Genium

HMIS		
H	2	R 1
F	0	I 4
R	0	S -
PPG*		K -
*See sect. 8		

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

1,1,2,2-Tetrachloroethane, CAS No. 0079-34-5

Ca 100

*This material can be absorbed through intact skin, which contributes to overall exposure.

**See NIOSH, RTECS (KJ8575000), for additional data with references to reproductive, tumorigenic, and irritative effects.

OSHA PEL (Skin*)
8-Hr TWA: 1 ppm, 7 mg/m³
ACGIH TLV (Skin*), 1988-89
TLV-TWA: 1 ppm, 7 mg/m³
Toxicity Data**
Human, Oral, TD₀₁: 30 mg/kg
Human, Inhalation, TC₀₁: 1000 mg/m³ (30 Mins)
Rat, Oral, LD₅₀: 800 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 295°F (146°C)

Melting Point: -47°F (-44°C)

% Volatile by Volume: Ca 100

apor Pressure: 6 Torr at 77°F (25°C)*

Molecular Weight: 168 Grams/Mole

Solubility in Water (%): Insoluble

Specific Gravity (H₂O = 1): 1.58658 at 77°F (25°C)

Appearance and Odor: A colorless, nonflammable, heavy, mobile liquid; sweetish, suffocating, characteristic chloroform odor. The odor recognition threshold is reported to be less than 3 ppm.

*At 77°F (25°C) the concentration of 1,1,2,2-tetrachloroethane in saturated air is approximately 7900 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*

Autoignition Temperature*

LEL*

UEL*

Extinguishing Media: *1,1,2,2-Tetrachloroethane does not burn. Use extinguishing agents that will put out the surrounding fire. Unusual Fire or Explosion Hazards: None reported. Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode to protect against the effects of the nearby fire.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: 1,1,2,2-Tetrachloroethane is stable in closed containers during routine operations at room temperature.

Hazardous polymerization cannot occur. Chemical Incompatibilities: Hazardous reactions between 1,1,2,2-tetrachloroethane and 2,4-dinitrophenyl disulfide, nitrogen tetroxide, chemically active metals such as potassium; and strong caustics such as potassium hydroxide, sodium, sodium-potassium alloy, hot iron, aluminum, and zinc in the presence of steam are reported. Conditions to Avoid: Prevent exposure to the incompatible chemicals listed above. Contact with water causes appreciable hydrolysis that will degrade and decompose this liquid. Hazardous Products of Decomposition: Thermal-oxidative degradation of 1,1,2,2-tetrachloroethane can produce highly toxic gases such as carbon monoxide (CO) and oxides of chlorine (ClO₂).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: NIOSH lists 1,1,2,2-tetrachloroethane as a carcinogen.

Summary of Risks: 1,1,2,2-Tetrachloroethane is absorbed through intact skin in significant amounts; one human fatality has been attributed to this route of exposure. This liquid is considered to be one of the most toxic of the common chlorinated hydrocarbons, particularly with respect to the liver. Severely acute exposure causes depression of the central nervous system (CNS), which can cause death within 12 hours. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, respiratory system.

NS, gastrointestinal system, liver, and kidneys. Primary Entry: Inhalation, skin contact/absorption. Acute Effects: The initial symptoms of exposure are lacrimation, salivation, and irritation of the nose and throat; continued exposure can lead to nausea, vomiting, and narcosis. Also, low blood pressure and cardiac rhythm abnormalities; respiratory depression; nausea, vomiting, burns of the esophagus, and diarrhea; and anesthesia with dizziness leading to loss of consciousness and coma; plus possible transient liver and kidney changes. Chronic Effects: The two sets of manifestations are (1) malaise, drowsiness, decreased appetite, then nausea and retching, a bad taste in the throat, constipation, headache, pale stools, jaundice, and dark urine, as well as mental confusion, stupor, and coma; and (2) hand

SECTION 6. HEALTH HAZARD INFORMATION, cont.

more, sensation of deafness, numbness in hands and feet, a decrease in reflexes, headache, and nausea. **FIRST AID:** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse contaminated areas with flooding amounts of water, then wash it with soap and water. Inhalation. Remove the exposed person to fresh air, and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep the exposed person warm and at rest until medical help is available. Ingestion. Unlikely. Should this type of exposure occur, give the exposed person 3 ounces of water to drink and induce vomiting, then repeat this procedure. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: Workers exposed to this liquid should be evaluated with a full battery of tests for the liver, kidneys, and CNS systems, as well as the blood.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, and provide adequate ventilation. Cleanup personnel must be properly clothed and equipped to protect the skin and eyes against any contact with the liquid as well as inhalation of its vapor (see sect. 8). Accumulate the spilled 1,1,2,2-tetrachloroethane and pump it into suitable containers for disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

SHA Designations

Classified as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

PA Designations (40 CFR 302.4)

CRA Waste No. U209

ERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a); and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of this liquid is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per minimum reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with this liquid. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench stations, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. 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 1,1,2,2-tetrachloroethane vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store 1,1,2,2-tetrachloroethane in closed, airtight containers in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). **Special Handling/Storage:** Provide storage areas with adequate ventilation to prevent concentrations of the vapor from building up beyond the occupational exposure limits cited in section 2.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetrachloroethane

DOT Hazard Class: ORM-A

ID No. UN1702

DOT Packaging Requirements: 49 CFR 173.620

DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: 1,1,2,2-Tetrachloroethane

IMO Hazard Class: 6.1

IMO Label: Poison

IMDG Packaging Group: II

References: 1, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheet

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No. 312
TRICHLOROETHYLENE
(Revision E)

Issued: July 1979
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

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MATERIAL NAME: TRICHLOROETHYLENE

DESCRIPTION (Origin/Uses): Prepared from *sym*-tetrachloroethane by way of eliminating HCl by boiling with lime. Used to manufacture organic chemicals, pharmaceuticals; in degreasing and dry cleaning; and as a solvent for fats, waxes, rubbers, oils, paints, varnishes, ethers, and cellulose esters.



OTHER DESIGNATIONS: Ethylene Trichloride; TCE; Trichloroethene; 1,1,2-Trichloroethylene; C₂HCl₃; NIOSH RTECS #KX4550000; CAS #0079-01-6

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640;
Telephone: (517) 636-1000; (800) 258-CHEM

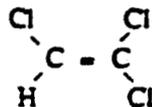
HMIS
H 2
F 1
R 1
PPE*
* See sect. 8

R 1
I 3
S 1
K 0

COMMENTS: Trichloroethylene is a toxic solvent and a suspected occupational carcinogen.

SECTION 2. INGREDIENTS AND HAZARDS

Trichloroethylene, CAS #0079-01-6; NIOSH RTECS #KX4550000



- The TLV-TWA is set to control subjective complaints such as headache, fatigue, and irritability.
- The TLV-STEL is set to prevent incoordination and other beginning anesthetic effects from TCE. These levels should provide a wide margin of safety in preventing liver injury.
- The OSHA PEL is 300 ppm for 5 minutes in any 2 hours.

%

100

HAZARD DATA

ACGIH Values 1987-88
TLV-TWA*: 50 ppm, 270 mg/m³
TLV-STEL**: 200 ppm, 1080 mg/m³
OSHA PEL 1986***
8-Hr TWA: 100 ppm
Ceiling: 200 ppm
NIOSH REL 1986
10-Hr TWA: 25 ppm
TOXICITY DATA
Human, Oral, LD₅₀: 7 g/kg
Human, Inhalation, TC_{Lo}: 6900 mg/m³ (10 Min)
Human, Inhalation, TC_{Lo}: 160 ppm/83 Min
Human, Inhalation, TD_{Lo}: 812 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point ... 188.6°F (87°C)
Vapor Pressure ... 58 Torr at 68°F (20°C)
Solubility ... Insoluble
Vapor Density (Air = 1) ... 4.53

Evaporation Rate ... Not Listed
Specific Gravity ... 1.4649 at 68°F (20°C)
Melting Point ... -120.64°F (-84.8°C)
Molecular Weight ... 131.40 Grams/Mole

Appearance and odor: Colorless, nonflammable mobile liquid; sweetish odor like chloroform.

COMMENTS: TCE is highly soluble in lipids. A high vapor pressure at room temperature provides the potential for TCE vapors to contaminate use areas.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER UPPER

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Listed	770°F (410°C)	% by Volume	8%	10.5%

EXTINGUISHING MEDIA: TCE has no flash point in a conventional closed tester at room temperature, but it is moderately flammable at higher temperatures. Use dry chemical, carbon dioxide, alcohol foam, or other extinguishing agents suitable for the surrounding fire.

OSHA Flammability Class (29 CFR 1910.106): Not Regulated

UNUSUAL FIRE/EXPLOSION HAZARDS: During fire conditions TCE emits highly toxic and irritating fumes, including hydrochloric acid and phosgene. **SPECIAL FIRE-FIGHTING PROCEDURES:** Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode. At TCE vapor levels of 300-1000 ppm, fire fighters who lack the proper respiratory equipment may experience incoordination and impaired judgment.

DOT Flammability Class (49 CFR 173.115): Not Regulated

SECTION 5. REACTIVITY DATA

Trichloroethylene is stable. Hazardous polymerization can occur under certain circumstances (see Conditions to Avoid and Comments, below).

CHEMICAL INCOMPATIBILITIES include magnesium or aluminum powder, NaOH, KOH, or other strong alkaline materials. Reactions with alkaline materials may lead to the formation of dangerous explosive mixtures of chloroacetylenes.

CONDITIONS TO AVOID: When TCE is heated (as in the case with vapor degreasers) or exposed to sunlight, it requires extra attention against oxidation, degradation, and polymerization. It is slowly decomposed by light when moist.

PRODUCTS OF HAZARDOUS DECOMPOSITION include hydrochloric acid and phosgene under certain conditions at elevated temperatures.

COMMENTS: TCE is stable under normal handling and storage conditions, and hazardous polymerization is not expected to occur. However, failure of the stabilizer at elevated temperatures or other extreme conditions may allow polymerization to take place.

SECTION 6. HEALTH HAZARD INFORMATION

Trichloroethylene is listed as a carcinogen by the NTP, IARC, and OSHA. NIOSH recommends that trichloroethylene be treated as an occupational carcinogen. IARC carcinogenic results are animal suspect, animal positive, and human indefinite. **SUMMARY OF RISKS:** Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepato cellular carcinomas have been detected in mice during tests conducted by the National Cancer Institute (Chem & Eng News 54 (April 5, 1976):4). Organ systems affected by overexposure to TCE are the central nervous system (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesication, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. When combined with alcohol intake, toxic effects are increased and may cause a red, blotchy facial and upper body rash commonly called "degreaser's flush." Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Toxic effects from testing of TCE on humans include hallucination, distorted perception, somnolence (general depressed activity), and jaundice. **TARGET ORGANS:** Respiratory system, central nervous system, heart, liver, kidneys, and skin. **PRIMARY ENTRY:** Ingestion, inhalation, skin contact. **ACUTE EFFECTS:** Headache, vertigo, visual disturbance, tremors, nausea, vomiting, dermatitis, dizziness, drowsiness, and irritation to the eyes, nose, and throat. **CHRONIC EFFECTS:** None Reported. **MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE:** Diseases of the liver, kidneys, lungs, and central nervous system. **FIRST AID: EYE CONTACT:** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help. **SKIN CONTACT:** Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help. **INHALATION:** Remove victim to fresh air; restore and/or support his breathing as needed. Do not give adrenaline to the victim. Get medical help. **INGESTION:** Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. A professional decision regarding whether or not to induce vomiting is required. Do not give adrenaline to the victim. Get medical help. **GET MEDICAL ASSISTANCE - IN PLANT, PARAMEDIC, COMMUNITY.** Get prompt medical assistance for further treatment, observation, and support after first aid.

COMMENTS: Workers' responses to TCE vary significantly because of many factors, including age, health status, nutrition, and intake of alcohol, caffeine, and medicines. Do not use these substances before, during, or after exposure to TCE. If a worker displays any of the symptoms of exposure to TCE, thoroughly investigate all the possible contributing factors to determine, if possible, how much the work environment levels of TCE are responsible.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Inform safety personnel of any trichloroethylene spill or leak and evacuate the area for large spills. Cleanup personnel must use respiratory and liquid contact protection. Adequate ventilation must be provided. Confine the spilled TCE to as small an area as possible. Do not allow it to run off to sewers or open waterways. Pick up spilled TCE with a vacuum cleaner or an absorbent such as vermiculite.

DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill.

Trichloroethylene is designated as a hazardous substance by the EPA (40 CFR 116A).

Trichloroethylene is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U228

EPA Reportable Quantity (40 CFR 117.3): 1000 lbs (454 kgs)

Aquatic Toxicity Rating, TLM 96: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Follow the eye and face protection guidelines of 29 CFR 1910.133. **GLOVES:** Wear impervious gloves. **RESPIRATOR:** Use a NIOSH-approved respirator per the NIOSH Guide to Chemical Hazards (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of TCE requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. **WARNING:** Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. **OTHER EQUIPMENT:** Wear rubber boots, aprons, and other suitable body protection appropriate to the existing work environment. **VENTILATION:** Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne concentrations of TCE below the OSHA PEL standards cited in section 2. **SAFETY STATIONS:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. **OTHER SPECIAL MODIFICATIONS IN THE WORKPLACE:** Because of the unresolved controversy about the carcinogenic status of TCE, all existing personal protective equipment and engineering technology should be used to prevent any possibility of worker contact with this material.

COMMENTS: Practice good personal hygiene. Keep material off of your clothes and equipment. Avoid transfer of material from hands to mouth while eating, drinking, or smoking. Adhere to the sanitation requirements of 29 CFR 1910.141 and 29 CFR 1910.142.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Prevent TCE from coming into contact with strong caustics such as NaOH; KOH; chemically active metal like Ba, Li, Na, Mg, Ti; and powdered aluminum or magnesium in acidic solutions. **SPECIAL HANDLING/STORAGE:** Store this material in a cool, dry, well-ventilated area. Avoid elevated temperatures because products of toxic and corrosive decomposition from TCE may form. Monitor the level of any stabilizer component that may be added to the TCE. (Consult the technical data from the supplier to determine the specifics of any added stabilizer.) If applicable, follow the supplier's recommendation concerning proper rotation of stock, shelf-life requirements, and levels of stabilizers.

ENGINEERING CONTROLS IN THE WORKPLACE: Avoid collecting aluminum fines (very small particles) or chips in a TCE vapor degreaser. Monitor TCE stabilizer levels regularly. Only trained personnel should operate vapor degreasers.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: ORM-A	DOT ID No. UN1710	IMO Class: 6.1
IMO Label: St. Andrew's Cross (X)*	DOT Shipping Name: Trichloroethylene	DOT Label: Nooc
* Harmful - Slow away from foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).		
References: 1-9, 12, 14, 21, 73, 87-94. PI		

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Approvals: *JOR*
 Indust. Hygiene/Safety: *JOR* 11-19-87
 Medical Review: *W. H. H. H. H.*

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR VINYL CHLORIDE POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about vinyl chloride for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- Formula: C_2H_3Cl
- Structure: $CH_2=CHCl$
- Synonyms: Chloroethene, chloroethylene, monochloroethylene, chloroethylen
- Identifiers: CAS 75-01-4; RTECS KU9625000; DOT 1086, label required: "Flammable Gas"
- Appearance and odor: Colorless gas with a sweet odor

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data
 1. Molecular weight: 62.50
 2. Boiling point (at 760 mmHg): $-14^{\circ}C$ ($7^{\circ}F$)
 3. Specific gravity (water = 1): 0.9121
 4. Vapor density (air = 1 at boiling point of vinyl chloride): 2.15
 5. Melting point: $-155.7^{\circ}C$ ($-243.4^{\circ}F$)
 6. Vapor pressure at $20^{\circ}C$ ($68^{\circ}F$): 2,580 mmHg
 7. Solubility in water, g/100 g water at $24^{\circ}C$ ($75^{\circ}F$): 0.11
 8. Ionization potential: 9.995 eV
- Reactivity
 1. Incompatibilities: Atmospheric oxygen and strong oxidizers may react with vinyl chloride to produce peroxide, which can initiate a violent polymerization reaction.

2. Hazardous decomposition products: Toxic vapors and gases (e.g., hydrogen chloride and carbon monoxide) may be released in a fire involving vinyl chloride.

3. Caution: Check valves for leaks.

• Flammability

1. Flash point: $-78^{\circ}C$ ($-108^{\circ}F$) (open cup)
2. Autoignition temperature: $472^{\circ}C$ ($882^{\circ}F$)
3. Flammable limits in air, % by volume: Lower, 3.6; Upper, 33.0
4. Class IA Flammable Liquid Gas (29 CFR 1910.106), Flammability Rating 4 (NFPA)

• Warning properties

1. Odor threshold: 3,000 ppm
2. Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for vinyl chloride is 1 part of vinyl chloride per million parts of air (ppm) as a time-weighted average (TWA) concentration over an 8-hour workshift, and the ceiling concentration which shall at no time be exceeded is 5 ppm as determined in any 15-minute sampling period. The National Institute for Occupational Safety and Health (NIOSH) recommends that vinyl chloride be controlled and handled as a potential human carcinogen in the workplace, and the NIOSH recommended exposure limit (REL) is that exposure be minimized to the lowest feasible limit. The American Conference of Governmental Industrial Hygienists (ACGIH) has designated vinyl chloride as an A1 substance (suspected human carcinogen) with an assigned threshold limit value, TLV[®] of 5 ppm [10 milligrams of vinyl chloride per cubic meter of air (mg/m^3)] as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

Table 1.—Occupational exposure limits for vinyl chloride

	Exposure limits	
	ppm	mg/m ³
OSHA PEL TWA	1	—
Ceiling (15 min)	5	—
NIOSH REL (Ca)*	Lowest feasible limit	
ACGIH TLV® TWA (Ala)†	5	10

* (Ca): NIOSH recommends treating as a potential human carcinogen.

† (Ala): Human carcinogen with an assigned TLV.

HEALTH HAZARD INFORMATION

• Routes of exposure

Vinyl chloride may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

1. *Effects on animals:* Acute inhalation of vinyl chloride by multiple species of animals caused central nervous system depression, coma, and death; acute inhalation by dogs also caused cardiac arrhythmias. In mice, rats, and hamsters, chronic inhalation or oral administration of vinyl chloride produced cancers of the liver, kidney, central nervous system, skin, and mammary and ear duct glands.

2. *Effects on humans:* Acute exposure of workers to vinyl chloride has caused narcotic and anesthetic effects. Repeated exposure of workers to vinyl chloride has caused increased blood pressure, decreased blood platelet counts, increased liver enzyme levels, restricted blood flow, bone degeneration in the fingers, liver and spleen enlargement, nervous system disturbances, central nervous system depression, decreased respiratory function, and emphysema. Cancer of the liver has been associated with exposure of workers to vinyl chloride during the polyvinyl chloride production process. Cancers of the lung, brain, skin, nervous system, gall bladder, mouth, and pharynx have also been observed in workers with a history of exposure to vinyl chloride. An increase in fetal mortality has been reported among wives of workers who had been exposed to vinyl chloride.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to vinyl chloride can cause dizziness, light-headedness, nausea, dullness of visual and auditory responses, drowsiness, and unconsciousness. Irritation of the skin and eyes can also occur. Skin contact with the liquid can cause frostbite.

2. *Long-term (chronic):* Exposure to vinyl chloride can cause thickening of the skin, contact and allergic dermatitis, fatigue, coughing and sneezing, abdominal pain, gastrointestinal bleeding, nausea, vomiting, indigestion, diarrhea, jaundice, weight loss, anorexia, and a cold and tingling sensation of the hands and feet.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including the employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to vinyl chloride, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin, liver, kidneys, and cardiovascular, hematopoietic (blood cell forming), nervous, and respiratory systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to vinyl chloride. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include chronic diseases of the liver. The physician should obtain baseline values for serological tests of liver function and markers for infection with Hepatitis B virus.

• Periodic medical screening and/or biologic monitoring
Occupational health interviews and physical examinations

should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to vinyl chloride. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the skin, liver, kidneys, and cardiovascular, hematopoietic, nervous, and respiratory systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following test should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and ATS: standardized questionnaires and test of lung function.

• **Medical practices recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to vinyl chloride may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**

Delayed-onset SHE's include: Liver cancer (hemangiosarcoma) and "white finger" (Raynaud's syndrome, secondary to vasculitis)

MONITORING AND MEASUREMENT PROCEDURES

• **Method**

Sampling and analysis may be performed by collecting vinyl chloride vapors with tandem charcoal tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Direct-reading devices calibrated to measure vinyl chloride may also be used if available. A detailed sampling and analytical method for vinyl chloride may be found in the *NIOSH Manual of Analytical Methods* (method number 1007).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with vinyl chloride.

SANITATION

Clothing which is contaminated with vinyl chloride should be removed immediately and placed in sealed containers for

storage until it can be discarded or until provision is made for the removal of vinyl chloride from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of vinyl chloride's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with vinyl chloride should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle vinyl chloride should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to vinyl chloride may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for vinyl chloride

Operations	Controls
During the manufacture of monomer, polymer, copolymer, and terpolymer	Process enclosure, personal protective equipment
During the transfer of monomer to tank cars or polymerization reactors; during maintenance work on tanks or reactors	Local exhaust ventilation, personal protective equipment
During the cleaning of polymerization reaction tanks	Process enclosure, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures:

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to vinyl chloride, an eye-wash fountain should be

provided within the immediate work area for emergency use.

If vinyl chloride gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin exposure

Where there is any possibility of a worker's body being exposed to vinyl chloride, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If vinyl chloride gets on the skin, wash it immediately with soap and water. If vinyl chloride penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• Rescue

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If vinyl chloride is spilled or leaked, the following steps should be taken:

1. Stop the flow of gas. If the source of the leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to an area with local exhaust ventilation and repair the leak or allow the cylinder to empty.
2. Remove all ignition sources.
3. Ventilate area of spill or leak.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.

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Table 3.—Respiratory protection for vinyl chloride

Condition	Minimum respiratory protection*
Any detectable concentration	<p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode</p>
Planned or emergency entry into environments containing unknown or any detectable concentration	<p>Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode</p> <p>Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode</p>
Firefighting	<p>Any self-contained breathing apparatus with a full facepiece and operated in pressure-demand or other positive pressure mode</p>
Escape only	<p>Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted canister providing protection against the compound of concern</p> <p>Any appropriate escape-type self-contained breathing apparatus</p>

* Only NIOSH/MSHA-approved equipment should be used.

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RESPIRATORY PROTECTION FOR 1,1-DICHLOROETHANE

Condition	Minimum Respiratory Protection* Required Above 100 ppm
Vapor Concentration 1000 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
< 1000 ppm or less	A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 4000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

1,1-DICHLOROETHYLENE^{1/}

Summary

1,1-Dichloroethylene caused kidney tumors (male mice only) and leukemia in one study of mice exposed by inhalation to 1,1-dichloroethylene. The results of other studies were equivocal or negative. 1,1-Dichloroethylene is mutagenic, and has caused adverse reproductive effects when administered to rats and rabbits by inhalation. Chronic exposure causes liver damage, and acute exposure to high doses produces nervous system damage.

CAS Number: 75-35-4

Chemical Formula: CH_2CCl_2

IUPAC Name: 1,1-Dichloroethene

Important Synonyms and Trade Names; Vinylidene chloride, VDC,
1,1-dichloroethene, 1,1-DCE

Chemical and Physical Properties

Molecular Weight: 96.94

Boiling Point: 37°C

Melting Point: -122.1°C

Specific Gravity: 1.218 at 20°C

Solubility in Water: 400 g/liter at 20°C

^{1/} U.S. Environmental Protection Agency, Office of Waste Program Enforcement. September 1985. Chemical, physical, and biological properties of compounds present at hazardous waste sites. A Final Report Prepared by Clement Associates, Inc., Arlington, Virginia.

Solubility in Organics: Sparingly soluble in alcohol, ether, acetone, benzene, and chloroform

Log Octanol/Water Partition Coefficient (K_{OW}): 1.84 (Mabey et al. 1981) Estimated

Soil/Water Partition Coefficient (K_{OC}):

239	Lyman et al. (1982) Eqn 4-8 ($\log K_{OW} = 1.84$)
78	Lyman and Loretz (1987) ($\log K_{OW} = 1.84$)
65	USEPA (1986a)

Bioconcentration Factor:

20.2	Davies and Dobbs (1984) Eqn C ($\log K_{OW} = 2.18$)
26.7	Lyman et al. (1982) Eqn 5-2 ($\log K_{OW} = 2.18$)
30.9	Davies and Dobbs (1984) Eqn B ($\log K_{OW} = 2.18$)

Vapor Pressure: 500 mm Hg at 20°C
600 mm Hg at 25°C (USEPA 1986a)

Vapor Density: 3.25

Henry's Law Constant: 3.4×10^{-2} atm-m³/mole (USEPA 1986a)

Transport and Fate

Volatilization is likely to be the primary transport process for 1,1-dichloroethylene (VDC), and its subsequent photooxidation in the atmosphere by reaction with hydroxyl radicals is the predominant fate process. The half-life of 1,1-dichloroethylene in water is estimated to be between one and six days (USEPA 1984).

A range of estimated soil-water partition coefficients (K_{OC}) is reported above and indicates that sorption of 1,1-dichloroethylene to soils/sediments and dissolved organic material will occur. Pavlou (1980) estimates that sorption of volatile organic compounds will range

from low to moderate. The combined water solubility and low organic partitioning of 1,1-dichloroethylene suggests that this compound will exhibit some degree of environmental mobility.

A range of estimated bioconcentration factor (BCFs) for 1,1-dichloroethylene is also reported above. ASTM (1985) indicates that chemicals with bioconcentration factors less than approximately 100 have low potential for causing harm to wildlife and human health via biomagnification of residues up food chains. The magnitude of the concentration factors suggests that appreciable bioconcentration or biomagnification of 1,1-dichloroethylene residues is not likely to occur.

Health Effects

1,1-Dichloroethylene caused kidney tumors in male mice and leukemia in both males and females when exposed by inhalation. Equivocal results were obtained in other inhalation studies. Negative results were obtained in cancer studies with rats and mice following oral exposure or in hamsters following inhalation exposure. 1,1-Dichloroethylene has been classified according to EPA's Proposed Guidelines for Carcinogen Risk Assessment in EPA's Group C (possible human carcinogen) based on limited evidence in animals and inadequate evidence in humans (USEPA 1985).

1,1-Dichloroethylene was mutagenic in several bacterial assays. 1,1-Dichloroethylene did not appear to be teratogenic but did cause embryotoxicity and fetotoxicity when administered to pregnant rats and rabbits by inhalation. Chronic exposure to oral doses of 1,1-dichloroethylene as low as 5 mg/kg/day caused liver changes in rats. Acute exposure to high doses causes central nervous system depression. Neurotoxicity has not been associated with low-level chronic exposure. The oral LC₅₀ value for rats and mice are 1,500 and 200 mg/kg, respectively.

Toxicity to Wildlife and Domestic Animals

1,1-Dichloroethylene is not very toxic to freshwater or saltwater species, with acute LC₅₀ values generally ranging from 80 to 200 mg/liter (USEPA 1980). A chronic study in which no adverse effects were observed indicated that the acute-chronic ratio was less than 40. A 13-day study reporting an LC₅₀ of 29 mg/liter indicated that the acute-chronic ratio for 1,1-dichloroethylene is greater than 4.

No reports of the toxicity of 1,1-dichloroethylene to terrestrial wildlife or domestic animals were found in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA 1986b).

Aquatic Life (Freshwater)

The available data are not adequate for establishing criteria. However, EPA does report the lowest values known to cause toxicity in aquatic organisms.

Acute toxicity: 11,600 µg/liter

Chronic toxicity: No available data

Aquatic Life (Saltwater)

Acute toxicity: 224,000 µg/liter

Chronic toxicity: No available data

Human Health

Due to the carcinogenicity of 1,1-dichloroethylene the ambient water criterion is set at zero. However, estimates of the carcinogenic risks associated with lifetime exposure from ingestion of contaminated water and contaminated aquatic organisms are:

<u>Risk</u>	<u>Concentration</u>
10^{-5}	0.33 $\mu\text{g/liter}$
10^{-6}	0.033 $\mu\text{g/liter}$
10^{-7}	0.0033 $\mu\text{g/liter}$

National Primary Drinking Water Standard (USEPA): 0.007 mg/liter
(40 CFR Part 141)

CAG Potency Slope for Inhalation Exposure (USEPA 1989) = 1.2
(mg/kg/day)⁻¹

CAG Potency Slope for Oral Exposure (USEPA 1989) = 0.6 (mg/kg/day)⁻¹

D_T Value

The D_T value is defined as that contaminant intake rate (mg/kg/day) that should not induce an adverse effect to human health or should not pose a risk of cancer occurrence greater than a predetermined risk level.

For oral and inhalation exposures to 1,1-dichloroethylene, the D_T value is based on the USEPA Cancer Assessment Group's cancer potency slopes. The cancer potency slopes are intended to be a plausible upper bound of the potency of a carcinogen in inducing cancer at low doses. Calculation of a D_T using a cancer potency slope requires selection of an acceptable cancer risk level. A range of risk levels from 10⁻⁴

to 10^{-7} will be considered for all carcinogens, therefore a range of D_T values is presented. Derivation of the inhalation D_T value for 1,1-dichloroethylene is as follows:

$$\begin{aligned}
 D_T &= \frac{\text{Risk Level}}{\text{Potency Slope (mg/kg/day)}^{-1}} \\
 &= \frac{1 \times 10^{-4}}{1.16 \text{ (mg/kg/day)}^{-1}} \\
 &= 8.6 \times 10^{-5} \text{ mg/kg/day}
 \end{aligned}$$

For oral exposure to 1,1-dichloroethylene, the D_T value is also based on the USEPA Cancer Assessment Group's cancer potency estimate. Derivation of the oral D_T value is as follows:

$$\begin{aligned}
 D_T &= \frac{\text{Risk Level}}{\text{Potency Slope (mg/kg/day)}^{-1}} \\
 &= \frac{1 \times 10^{-4}}{0.6 \text{ (mg/kg/day)}^{-1}} \\
 &= 1.7 \times 10^{-4} \text{ mg/kg/day}
 \end{aligned}$$

The range of inhalation and oral D_T values for 1,1-dichloroethylene is presented below.

<u>Risk Level</u>	<u>Oral D_T (mg/kg/day)</u>	<u>Inhalation D_T (mg/kg/day)</u>
10^{-4}	1.7×10^{-4}	8.3×10^{-5}
10^{-5}	1.7×10^{-5}	8.3×10^{-6}
10^{-6}	1.7×10^{-6}	8.3×10^{-7}
10^{-7}	1.7×10^{-7}	8.3×10^{-8}

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MATERIAL SAFETY DATA SHEET

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NO. 414
DI(2-ETHYLHEXYL)PHTHALATE
Revision A
DATE December 1984

SECTION I. MATERIAL IDENTIFICATION			
<p>MATERIAL NAME: DI(2-ETHYLHEXYL)PHTHALATE OTHER DESIGNATIONS: DEHP, "DOP", $o-C_6H_4[COOCH_2CH(C_2H_5)C_4H_9]_2$, bis(2-Ethylhexyl)Phthalate, GE Material D5B9, ASTM D1249 Type I, CAS #000 117 817, Dioctyl Phthalate TRADE NAME & MANUFACTURER: <u>KODAFLEX DOP</u> <u>HATCOL-101</u> Eastman Chemical Products U.S. Steel Corp. W.R. Grace & Co. Coatings Chemicals Div. Chemicals Div. Hatco Chemicals Div. Kingsport, TN 37662 600 Grant Avenue Fords, NJ 08863 Phone: (800)327-8626 Pittsburgh, PA 15230 (201)738-1000 (412)433-7711</p>			
SECTION II. INGREDIENTS AND HAZARDS		HAZARD DATA	
<p>Di(2-ethylhexyl)phthalate Listed as a "suspected carcinogen" by the National Toxicology Program (NTP). (Long term, high level animal feeding tests have produced neoplasms.) National Center for Toxicological Research is currently testing (FY1984) for reproductive development toxicity.</p> <p>*Current (1984) OSHA PEL and ACGIH TLV. ACGIH STEL is 10 mg/m³ for 15 minutes exposure</p>	ca 99	<p>8-hr TWA 5 mg/m³* Man, Oral TDLo 143 mg/kg GI tract effects Rat (5-15 days Preg.) interperitoneal TDLo- 15 g/kg Teratogenic effects Rat, Oral LD₅₀ 31 g/kg</p>	
SECTION III. PHYSICAL DATA			
<p>Boiling point, 760 mm, deg C ----- ca 385 54 mm, deg C ----- 230 Vapor pressure at 200 C, mm Hg --- 1.3 Vapor density (Air=1) ----- ~13.5 Water solubility ----- Nearly insoluble (<0.01% at 20 C)</p>	<p>Specific gravity, 20/20 C ----- 0.99 Pour point, deg C ----- ca -48 Viscosity, 20 C, cps ----- 81.4 Freezing point, deg C --- below - 50 Molecular weight ----- 390.5</p>		
Appearance & Odor: Colorless to pale yellow oily liquid. Odorless to faint, mild odor.			
SECTION IV. FIRE AND EXPLOSION DATA		Lower	Upper
Flash Point and Method	Autoignition Temp	Flammability Limits in Air	
425 F (COC)	770 F	Volume % @ 474F (245C)	0.3 -
<p>Extinguishing media: Use foam, water spray, carbon dioxide or dry chemical. Water or foam may cause frothing of hot oil. Use water spray to cool fire-exposed containers of this material and to flush spills away from sensitive area. This material is a slight fire hazard when exposed to heat or flame; it presents no unusual fire hazard. Firefighters should use self-contained breathing equipment and full protective clothing.</p>			
SECTION V. REACTIVITY DATA			
<p>This is a stable material under normal storage and handling conditions. It does not undergo hazardous polymerization. It is a combustible liquid (OSHA Class III-B) and is incompatible with strong oxidizing agents. Thermal-oxidative degradation products include carbon dioxide and carbon monoxide.</p>			

SECTION VI. HEALTH HAZARD INFORMATION		TLV 5 mg/m ³ (See Sect II)
<p>The low vapor pressure of this material essentially eliminates acute inhalation hazard unless the liquid is heated or misted. The TLV has been established to prevent inhaling of excessive levels of airborne DEHP which can cause nausea and be irritating to mucous membranes and the respiratory tract. Eye contact with liquid or mist is irritating. Ingestion can cause abdominal cramps, nausea, and diarrhea. Excessive skin contact can be irritating. (Rabbit, skin, LD₅₀ 25g/kg)</p>		
FIRST AID:		
<p><u>Eye Contact:</u> Flush eyes with running water for 15 minutes, including under eyelids. Get medical help if irritation persists.</p>		
<p><u>Skin Contact:</u> Wash exposed areas well with soap and water. Get medical help if irritation persists or if large areas of the body are affected. Remove contaminated clothing promptly.</p>		
<p><u>Inhalation:</u> Remove to fresh air. Support breathing if necessary. Get medical help. Keep warm and at rest.</p>		
<p><u>Ingestion:</u> Contact physician. Stomach lavage may be needed.</p>		
SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES		
<p>Contain spill and pick up with absorbent solid, rags, or paper for disposal by burning. Prevent losses into the environment whenever possible. Do not send to sewer. (DEHP degrades in fresh water sediments under aerobic conditions; half life about 14 days. It does not degrade under anaerobic conditions. It is readily concentrated by aquatic organisms.) Clean up trace residues with water and detergent.</p>		
<p><u>DISPOSAL:</u> Scrap material can be disposed of by controlled incineration. Mix liquid scrap with a more flammable solvent and spray into incinerator's firebox. Follow Federal, State, and Local regulations.</p>		
SECTION VIII. SPECIAL PROTECTION INFORMATION		
<p>Use general ventilation, combined with local exhaust ventilation (especially when material is heated or misted) to meet the TLV requirements. For nonroutine and emergency conditions where the TLV is exceeded, use an approved air-supplied mask or organic canister respirator for protection against mist and vapors.</p>		
<p>Use rubber gloves and apron to avoid repeated or prolonged contact with liquid and safety glasses or goggles to avoid eye contact by splashing. Depending on how the material is used and conditions of use, additional body protection may be desirable.</p>		
<p>Eyewash fountain and safety showers should be available to areas of use and handling. DEHP contaminated clothing should be removed and laundered before reuse.</p>		
SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS		
<p>Store in a ventilated area away from oxidizing agents and sources of heat or ignition. Follow good hygienic practice to avoid chronic effects. Wear clean work clothing. Avoid prolonged or repeated contact with liquid and inhalation of mist or vapors. Do not eat or smoke in areas where this material is used or stored. Wash exposed skin areas after working with this material and before using restroom facilities, eating or smoking. Do not take internally.</p>		
DATA SOURCE(S) CODE: 1-12, 14, 23, 38, 47		
<small>PROPERTY OF THE MANUFACTURER. THIS INFORMATION IS FOR YOUR INFORMATION ONLY. IT IS NOT TO BE USED AS A BASIS FOR LIABILITY. THE MANUFACTURER ASSUMES NO LIABILITY FOR THE USE OF THIS INFORMATION IN ANY MANNER. THE MANUFACTURER ASSUMES NO LIABILITY FOR THE USE OF THIS INFORMATION IN ANY MANNER.</small>		APPROVALS: MIS CRD <i>J. M. McCall</i> INDUST. HYGIENE SAFETY <i>JW 12-4-84</i> MEDICAL REVIEW: December 1984

Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE
(Revision A)
Issued: August 1978
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

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



NFPA

HMIS
H 2 R 1
F 3 I 3
R 0 S 2
PPG* K 4
*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Ethyl Benzene, CAS No. 0100-41-4

Ca 100

OSHA PELs

8-Hr TWA: 100 ppm, 435 mg/m³

15-Min STEL: 125 ppm, 545 mg/m³

ACGIH TLVs, 1988-89

TLV-TWA: 100 ppm, 435 mg/m³

TLV-STEL: 125 ppm, 545 mg/m³

Toxicity Data*

Human, Inhalation, TC_{L_0} : 100 ppm (8 Hrs)

Rat, Oral, LD_{50} : 3500 mg/kg

*See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)

Melting Point: -139°F (-95°C)

Vapor Pressure: 7.1 Torr at 68°F (20°C)

Vapor Density (Air = 1): 3.7

% Volatile by Volume: Ca 100

Molecular Weight: 106 Grams/Mole

Solubility in Water (%): Slight

Specific Gravity ($H_2O = 1$): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC

Autoignition Temperature: 810°F (432.22°C)

LEL: 1% v/v

UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. Unusual Fire or Explosion Hazards: This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. 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

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. Conditions to Avoid: Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. Hazardous Products of Decomposition: Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspiring even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, respiratory system, and CNS. Primary Entry: Inhalation, skin contact. Acute Effects: Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. Chronic Effects: None reported. First Aid: Eyes. Immediately

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with plenty of water, then wash it with soap and water. Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Ingestion. Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. 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 ethyl benzene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety cans for transferring small amounts of ethyl benzene.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethyl Benzene

DOT Hazard Class: Flammable Liquid

ID No. UN1175

DOT Label: Flammable Liquid

DOT Packaging Exceptions: 49 CFR 173.118

DOT Packaging Requirements: 49 CFR 173.119

IMO Shipping Name: Ethylbenzene

IMO Hazard Class: 3.2

IMO Label: Flammable Liquid

IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheet

From Genium's Reference Collection
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No. 359
ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)
Issued: November 1978
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

23

CHEMICAL NAME: ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)
DESCRIPTION (Origin/Uses): Made from acetylene and HCl. Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums.



OTHER DESIGNATIONS: 1,2-Dichloroethane; sym-Dichloroethane; Dutch Liquid; Dutch Oil; EDC; Ethane Dichloride; Ethylene Chloride; 1,2-Ethylene Dichloride; Glycol Dichloride; C₂H₄Cl₂;
NIOSH RTECS KJ0525000; **CAS** #0107-06-2

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

MANUFACTURERS/SUPPLIERS: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000

* See Sect. 8

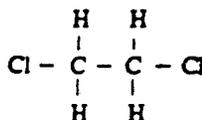
COMMENTS: Ethylene dichloride is a flammable, toxic liquid.

SECTION 2. INGREDIENTS AND HAZARDS

HAZARD DATA

Ethylene Dichloride, CAS #0107-06-2; NIOSH RTECS #KJ0525000

ACGIH Values 1987-88
TLV-TWA: 10 ppm, 40 mg/m³
OSHA PEL* 1986-87
8-Hr TWA: 50 ppm;
Ceiling: 100 ppm (15 Min.)
NIOSH REL 1986-87
10-Hr TWA: 1 ppm
Ceiling: 2 ppm (15 Min.)
Toxicity Data
Man, Inhalation, TC_{Lo}: 4000 ppm/1 Hr
Human, Oral, TD_{Lo}: 428 mg/kg
Man, Oral, TD_{Lo}: 892 mg/kg
Man, Oral, LD_{Lo}: 714 mg/kg
Rat, Oral, LD₅₀: 670 mg/kg



*The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period.
COMMENTS: Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH RTECS 1983-84 supplement, pages 865-66.

SECTION 3. PHYSICAL DATA

Boiling Point ... 182.3°F (83.5°C) Evaporation Rate (n-BuAc = 1) ... Not Listed
Vapor Pressure ... 87 Torr at 77°F (25°C) Specific Gravity ... 1.2569 at 69°F (20°C)
Water Solubility ... Soluble in about 120 Parts Water Freezing Point ... -31.9°F (-35.5°C)
Vapor Density (Air = 1) ... 3.4 Molecular Weight ... 98.96 Grams/Mole
Appearance and odor: Colorless, clear liquid. Sweet, chloroformlike odor is typical of chlorinated hydrocarbons. The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor. High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard.
COMMENTS: Ethylene dichloride is miscible with alcohol, chloroform, and ether.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER UPPER

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
See Below	775°F (413°C)	% by Volume	6.2	15.9

EXTINGUISHING MEDIA: Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride. Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers. Use a smothering effect to extinguish fires involving this material. **UNUSUAL FIRE/EXPLOSION**

HAZARDS: Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc. Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area. Ethylene dichloride burns with a smoky flame.

SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode.

COMMENTS: Flash Point and Method: 56°F (13°C) CC; 65°F (18°C) OC.

OSHA Flammability Class (29 CFR 1910.106): IB. DOT Flammability Class (49 CFR 173.115): Flammable Liquid

SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents. Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine. Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride.

CONDITIONS TO AVOID: Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there.

PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene. Phosgene is an extremely poisonous gas. Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution.

Material Safety Data Sheet

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No. 318

XYLENE (Mixed Isomers)
(Revision D)
Issued: November 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: XYLENE (Mixed Isomers)

Description (Origin/Uses): Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

Other Designations: Dimethylbenzene; Xylol; C₈H₁₀; CAS No. 1330-20-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek*

Buyers' Guide (Genium ref. 73) for a list of suppliers.

Comments: Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.



NFPA

HMIS

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

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Xylene (Mixed Isomers), CAS No. 1330-20-7*

**

IDLH*** Level: 1000 ppm

*o-Xylene, CAS No. 0095-47-6

m-Xylene, CAS No. 0108-38-3

p-Xylene, CAS No. 0106-42-3

***Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910.

****Immediately dangerous to life and health.

***** See NIOSH, RTECS (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.

OSHA PEL
8-Hr TWA: 100 ppm, 435 mg/m³
ACGIH TLVs, 1987-88
TLV-TWA: 100 ppm, 435 mg/m³
TLV-STEL: 150 ppm, 655 mg/m³

Toxicity Data****
Human, Inhalation, TC₀₁: 200 ppm
Man, Inhalation, LC₅₀: 10000 ppm/6 Hrs
Rat, Oral, LD₅₀: 4300 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 275°F to 293°F (135°C to 145°C)*

Melting Point: -13°F (-25°C)

Evaporation Rate: 0.6 Relative to BuAc = 1

Specific Gravity (H₂O = 1): 0.86

Water Solubility (%): Insoluble

Molecular Weight: 106 Grams/Mole

% Volatile by Volume: Ca 100

Vapor Pressure: 7 to 9 Torrs at 68°F (20°C)

Vapor Density (Air = 1): 3.7

Appearance and Odor: A clear liquid; aromatic hydrocarbon odor.

*Materials with wider and narrower boiling ranges are commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

81°F to 90°F (27°C to 32°C)

867°F (464°C)

% by Volume

1%

7%

Extinguishing Media: Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

Unusual Fire or Explosion Hazards: Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

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

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with strong oxidizers.

Conditions to Avoid: Avoid any exposure to sources of ignition and to strong oxidizers.

Hazardous Products of Decomposition: Carbon monoxide (CO) may be evolved during xylene fires.

SECTION 6. HEALTH HAZARD INFORMATION

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.

Summary of Risks: Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause blistering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. Medical Conditions Aggravated by Long-Term Exposure: Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. Target Organs: CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. Primary Entry: Inhalation, skin contact/absorption. Acute Effects: Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. Chronic Effects: Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.

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. Have a trained person administer oxygen. Ingestion. Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspirating very small quantities of xylene.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitalization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.

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

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U239

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use 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 OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and 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, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations.

Safety Stations: Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. 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 xylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

Special Handling/Storage: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Xylene

DOT ID No. UN1307

DOT Label: Flammable Liquid

DOT Hazard Class: Flammable Liquid

IMO Label: Flammable Liquid

IMO Class: 3.2 or 3.3

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

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Prepared by PJ Igoe, BS

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ATTACHMENT D

W-C STANDARD OPERATING PROCEDURES
FOR HEALTH AND SAFETY

OPERATING PROCEDURES NO. HS-102

102.0 HEAT STRESS

102.1 PURPOSE

The purpose of this OP is to provide general information on heat stress and the methods that can be utilized to prevent or minimize the occurrence of heat stress.

Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability. Heat stress is of particular concern while wearing impermeable protective garments, since these garments inhibit evaporative body cooling.

102.2 REQUIREMENTS

The NIOSH criteria document for heat stress recommends that environmental monitoring and other preventive measures be adopted in hot work environments. However, the provisions are not directly applicable to employees who are required to wear impermeable protective clothing. The reason for this exception is that impermeable clothing prevents the evaporation of sweat, which is one of the most important cooling mechanisms of the body. There is no recognized health standard protection for workers wearing impermeable protective clothing and respirators in hot environments.

The ACGIH has adopted a TLV for heat stress. These guides relate to work/rest regimes.

102.3 ADDITIONAL HAZARD

The use of Personal Protective Equipment of the types commonly used for hazardous waste work can place stress on the body. One common problem with the use of personal protective equipment, especially in hot environments, is heat stress. Protective clothing can cause excessive sweating and can prevent the body from properly regulating body temperature.

102.4 TYPES OF HEAT STRESS

Heat stress is the aggregate of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work. The amount and type of clothing also affect the heat stress.

Heat strain is the series of physiological responses to heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and, finally, a heat disorder may ensue. The severity of strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat disorder is a general term used to describe one or more of the following heat-related disabilities or illnesses:

- o Heat Cramps - painful intermittent spasms of the voluntary muscles following hard physical work in a hot

environment. Cramps usually occur after heavy sweating, and often begin at the end of a work shift.

- o Heat Exhaustion - profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

- o Heat Stroke - sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, which, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical care is urgently needed.

102.5 METHODS OF CONTROLLING HEAT STRESS

As many of the following control measures as are appropriate to site conditions should be utilized to aid in controlling heat stress:

- o Provide for adequate liquids to replace lost body fluids and replace water and salt lost from sweating. Encourage personnel to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

- o Replace fluids with water, commercial mixes such as Gatorade or Quick Kick, or a combination of these.

- o Establish a work regimen that will provide adequate rest periods for cooling down. This may require additional shifts of workers.

- o Wear cooling devices such as vortex tubes or cooling vests beneath protective garments.
- o Take all breaks in a cool rest area (77°F is best).
- o Remove impermeable protective garments during rest periods.
- o Do not assign other tasks to personnel during rest periods.
- o Inform personnel of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

102.6 MONITORING

102.6.1 TEMPERATURE

The heat stress of an area can be monitored by the Wet Bulb Globe Temperature Index (WBGT) technique. Where heat stress is a possibility, a heat stress monitoring device, such as the Wibget Heat Stress Monitor (Reuter Stokes) can be utilized.

The WBGT shall be compared to the Threshold Limit Values (TLV) outlined by the ACGIH TLV guides, and a work-rest regiment can be established in accordance with the WBGT. Note that 5 degrees C must be subtracted from the TLVs for heat stress listed to compensate for the wearing of impermeable protective clothing.

102.6.2 MEDICAL

In addition to the provisions of the WCC medical surveillance program, on-site medical monitoring of personnel should be performed by qualified medical personnel for projects where heat stress is a major concern. Blood pressure, pulse, body temperature (oral), and body weight loss should be taken and recorded.

Heart Rate: Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the same. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by one-third.

Oral Temperature: Use a clinical thermometer or similar device to measure the oral temperature at the end of the work period (before drinking liquids). If the oral temperature exceeds 99.6F (37.6C), shorten the next work cycle by one-third without changing the rest period. If the oral temperature still exceeds 99.6F (37.6C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment if his/her oral temperature exceeds 100.6F (38.1C).

Body Water Loss: Measure body weight on a scale accurate to ± 0.25 pounds at the beginning and end of each work day (also lunch break, if possible) to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Portable water and Gatorade or other electrolyte replacement fluid should be available. Workers should be encouraged to drink fluids during rest periods.

Physiological Monitoring: Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see Table 2). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

102.7 REFERENCES

American Conference of Governmental Industrial Hygienists,
Threshold Limit Values for Chemical Substances in the Work
Environment, 1984 - 1985.

Olishifski, J.B., Fundamentals of Industrial Hygiene, National
Safety Council, 1983.

National Institute for Occupational Safety and Health, The
Industrial Environment, Its Evaluation and Control, 1973.

/H&S2

OPERATING PROCEDURE NO. HS-203

203.0 RESPIRATOR INSPECTION, CARE, MAINTENANCE, AND STORAGE

203.1 PURPOSE

The purpose of this document is to provide guidance on the proper care and use of respiratory protective devices, to assist in adequately protecting personnel as well as complying with OSHA respiratory protection standard 1910.134. Guidance in the selection of respiratory devices is provided in OP No. HS 201.

203.2 APPLICABILITY

This procedure is applicable for use in caring for half-face and full-face respirators of either air-purifying or air supplying type. Proper care of respirators is essential for their satisfactory performance. Of importance is respirator inspection, care, maintenance, and storage.

203.3 REQUIREMENTS

OSHA requires, as part of an inspection program, that all respirators be leak checked, a determination that the complete assembly is gas tight. Follow field inspection procedures to examine the freshly cleaned, reassembled respirator.

Cleaning and Disinfecting - OSHA 1910.134 states "routinely used respirators shall be collected, cleaned and disinfected as frequently as necessary to ensure that proper protection is provided..." and that emergency use respirators "shall be cleaned and disinfected after each use."

The OSHA standard states that "replacement or repair shall be done by experienced persons with parts designed for the respirators." Besides being contrary to OSHA requirements, substitution of parts from a different brand or type of respirator invalidates approval (i.e., NIOSH, MSHA) of the device.

OSHA requires that respirators be stored to protect against:

- o Dust;
- o Sunlight;
- o Heat;
- o Extreme cold;
- o Excessive moisture;
- o Damaging chemicals; and
- o Mechanical damage.

The OSHA standard suggests that respirators be in their original cartons, however, this may provide only minimal protection from mechanical damage.

203.4 INSPECTION

203.4.1 AIR-PURIFYING RESPIRATORS

Routinely used air-purifying respirators should be checked as follows before and after each use:

1. Examine the facepiece for:

- o Excessive dirt;
- o Cracks, tears, holes or physical distortion of shape from improper storage;

- o Inflexibility of rubber facepiece (stretch and knead to restore flexibility);
- o Cracked or badly scratched lenses in full facepieces;
- o Incorrectly mounted full facepiece lenses, or broken or missing mounting clips; and
- o Cracked or broken air-purifying element holder(s), badly worn threads or missing gasket(s), if required.

2. Examine the head straps or head harness for:

- o Breaks;
- o Loss of elasticity;
- o Broken or malfunctioning buckles and attachments; and
- o Excessively worn serrations on head harness, that might permit slippage (full facepieces only).

3. Examine the exhalation valve for the following after removing its cover:

- o Foreign material, such as detergent residue, dust particles or human hair under the valve seat;
- o Cracks, tears or distortion in the valve material;
- o Improper insertion of the valve body in the facepiece;
- o Cracks, breaks, or chips in the valve body, particularly in the sealing surface;
- o Missing or defective valve cover; and
- o Improper installation of the valve in the valve body.

4. Examine the air-purifying element for:
 - o Incorrect cartridge, canister or filter for the hazard;
 - o Incorrect installation, loose connections, missing or worn gasket or cross threading in the holder;
 - o expired shelf-life date on the cartridge or canister; and
 - o Cracks or dents in the outside case of the filter, cartridge or canister, indicated by the absence of sealing material, tape, foil, etc., over the inlet.

5. If the device has a corrugated breathing tube, examine it for:
 - o Broken or missing end connectors;
 - o Missing or loose hose clamps; and
 - o Deterioration, determined by stretching the tube and looking for cracks.

6. Examine the harness of a front-or back-mounted gas mask for:
 - o Damage or wear to the canister holder, that may prevent its being held in place; and
 - o Broken harness straps for fastening.

203.4.2 ATMOSPHERE-SUPPLYING RESPIRATORS

For a routinely used atmosphere-supplying device, use the following procedures:

1. If the device is a tight-fitting facepiece, use the procedures outlined under air-purifying respirators, except those pertaining to the air-purifying elements.
2. If the device is a hood, helmet, blouse or full suit, use the following procedures:
 - o Examine the hood, blouse or full suit for rips and tears, seam integrity, etc.;
 - o Examine the protective headgear, if required, for general condition with emphasis on the suspension inside the headgear;
 - o Examine the protective face shield, if any, for cracks or breaks or impaired vision; and
 - o Make sure the protective screen is intact and secured correctly over the face shield.
3. Examine the air supply systems for:
 - o Integrity and good condition of air supply lines and hoses, including attachment and end fittings; and
 - o Correct operation and condition of all regulators, or other air flow regulators.

In addition to the above, for self-contained breathing apparatus (SCBA) units also determine that:

1. The high pressure cylinder of compressed air or oxygen is sufficiently charged for the intended use, preferably full charged.
2. On closed circuit SCBA, a fresh canister of CO₂ (carbon dioxide) sorbent is installed.
3. On open circuit SCBA, the cylinder has been recharged if less than 25 percent of the useful service time remains.

All SCBAs are required to have a warning device that indicates when the 25 percent level is reached. However, it is recommended that an open-circuit SCBA be fully charged before use.

203.4.3 RESPIRATOR DISASSEMBLY

The used respirators should be collected and deposited in a central location. They are taken to an area where the filters, cartridges or canisters are removed and discarded. Canisters should be damaged or marked to prevent accidental reuse. If facepieces are equipped with reusable dust filters, they may be cleaned with compressed air in a hood. This prevents dust from getting into the room and affecting the respirator personnel. If SCBA are used, tanks are removed and connected to an area where the SCBA regulators and low-air warning devices are tested. SCBA facepieces are cleaned like air-purifying respirator facepieces.

203.4.4 DEFECTS FOUND IN FIELD INSPECTION

If defects are found during any field inspection, two remedies are possible. If the defect is minor, repair and/or adjustment may be made on the spot. If it is major, the device should be removed from service until it can be repaired. (A spare unit should replace the unit removed from service.) Under no

circumstances should a device that is known to be defective remain in the field.

203.4.5 INSPECTION DURING CLEANING

Because respirator cleaning usually involves some disassembly, it presents a good opportunity to examine each respirator thoroughly. The procedures outlined above for a field inspection should be used. Respirators should be inspected after cleaning operations and reassembly have been accomplished.

203.5 RESPIRATOR CARE

When used routinely, respirators should be exchanged daily for cleaning and inspection. Where respirators are used only occasionally, the exchange period could be weekly or monthly. Workers maintaining their own respirators should be thoroughly briefed on cleaning and disinfecting them. Although workers may not be required to maintain their own respirators, briefing on the cleaning procedure will encourage their acceptance of a respirator by providing knowledge of what is a clean, disinfected, properly maintained device. This is particularly important where respirators are not individually assigned.

Where respirators are individually assigned (a practice to be encouraged), they should be identified to ensure that the worker always receives the same device. Identification markers must not penetrate the facepiece, block the filter, cartridge parts or exhaust valves.

When a relatively small number of respirators are used, or where workers clean their own respirators, the generally accepted procedure is washing with detergent and warm water using a brush, thoroughly rinsing in clean water, and drying in a clean

place. Precautions should be taken to prevent damage from rough handling during this procedure.

When large numbers of respirators are used, it is recommended that centralized cleaning and maintenance be performed and that specialized equipment and personnel trained in respirator maintenance be utilized.

203.5.1 CLEANING AND SANITIZING

The actual cleaning may be done in a variety of ways. A commercial dishwasher can be used. A standard domestic clothes washer may also be used if a rack is installed around the agitator to hold the facepieces in fixed positions. If the facepieces are placed loose in the washer, the agitator may damage them. A standard domestic dishwasher may be used, but it is not preferred because it does not immerse the facepieces. Any good detergent may be used followed by a disinfecting rinse or a combination disinfectant-detergent for a one step operation. Disinfection is not absolutely necessary if the respirator is reused by the same person. However, where individual issue is not practical, disinfection is strongly recommended. Reliable, effective disinfectants may be made from readily available household solutions, including:

1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately two milliliters of bleach (such as Chlorox) to one liter of water, or two tablespoons of bleach per gallon of water. A two-minute immersion disinfects the respirators.
2. Aqueous solution of iodine (50 ppm of iodine) made by adding approximately 0.8 milliliters of tincture of iodine per liter of water, or one teaspoon of tincture of

iodine per gallon of water. Again, a two-minute immersion is sufficient.

If the respirators are washed by hand, a separate disinfecting rinse may be provided. If a washing machine or dishwasher is used, the disinfectant must be added to the rinse cycle; the amount of water in the machine at that time will have to be measured to determine the correct amount of disinfectant.

To prevent damaging the rubber and plastic in the respirator facepieces, the cleaning water should not exceed 140°F, but it should not be less than 120°F to ensure adequate cleaning. In addition, if commercial or domestic dishwashers are used, the drying cycle should be eliminated, since the temperatures reached in these cycles may damage the respirators.

203.5.2 RINSING

The cleaning and disinfected respirators should be rinsed thoroughly in water (140°F maximum) to remove all traces of detergent and disinfectants. This is very important for preventing dermatitis.

203.5.3 DRYING

The respirators may be allowed to dry in room air on a clean surface. They may also be hung from a horizontal wire, like drying clothes, but care must be taken not to damage or distort the facepieces. Another method is to equip a standard steel storage cabinet with an electric heater that has a built-in circulating fan, and to replace the solid steel shelves with steel mesh.

203.5.4 REASSEMBLY AND INSPECTION

The clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area to avoid contamination. The inspection procedures have been discussed; special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking.

The respirator should be thoroughly inspected and all defects corrected. New or retested cartridges and canisters should be installed, and the completely reassembled respirator should be tested for leaks.

203.6 MAINTENANCE AND REPAIR

Maintenance personnel must be thoroughly trained. They must be aware of the limitations and never try to replace components or make repairs and adjustments beyond the manufacturer's recommendations, unless they have been specially trained by the manufacturer.

These restrictions apply primarily to maintenance of the more complicated devices, especially closed- and open-circuit SCBA, and more specifically, regulator valves and low pressures warning devices. These devices should be returned to the manufacturer or to a trained technician for adjustment or repair. there should be no major problems in repairing and maintaining most respirators, particularly the commonly used air-purifying type.

An important aspect of any maintenance program is having enough spare parts on hand. Only continual surveillance of replacement rates will determine what parts and quantities should

be kept in stock. It is desirable to have a recording system to indicate spare parts usage and the inventory on hand.

For SCBA devices, the facepiece should be combined with the tested regulator and the fully charged cylinder, and an operational check performed.

203.7 RESPIRATOR STORAGE

Damage and contamination of respirators may take place if they are stored on a workbench, or in a tool cabinet or toolbox, among heavy tools, greases and dirt. Freshly cleaned respirators should be placed in heat-sealed, ziplock, or other reusable plastic bags until reissue. They should be stored in a clean, dry location away from direct sunlight. They should be placed in a single layer with the facepiece and exhalation valve in an undistorted position to prevent rubber or plastic from taking a permanent distorted "set."

Air-purifying respirators kept ready for non-routine or emergency use should be stored in a cabinet with individual compartments. The storage cabinet should be readily accessible, and all workers should be made aware of its location, as is done for fire extinguishers. Preventing serious injury from the inhalation of a toxic substance depends entirely on how quickly workers can get to the emergency respirators.

A chest or wall-mounted case may be used for storing SCBA for use in emergencies. Again, the location of SCBA should be well-known and clearly marked. Unlike fire extinguishers, however, they should be located in an area that will predictably remain uncontaminated. Putting on a SCBA in a highly contaminated atmosphere such as might be created by massive release of a toxic material may take too long a time to perform safety in that area.

Therefore, the first reaction should be to escape to an uncontaminated area, then put on the SCBA, that should be located there, and re-enter the hazardous area for whatever task must be done. Exceptions to this rule may be encountered, and only a thorough evaluation of the process and escape routes will permit a final decision about the correct storage location for SCBA. Respirators should be stored in a plastic bag inside a rigid container.

Workers who are adequately trained should develop a respect for respirators that will be an automatic incentive to protect respirators from damage. Besides providing better assurance of adequate protection, this training will lower maintenance costs by decreasing damage.

203.8 RECORDKEEPING

Records should be maintained to document that proper care and maintenance has been performed on respiratory protection devices. Records should indicate when and what was done to each respirator, and also by whom.

203.9 REFERENCES

U.S. Department of Labor, OSHA, Safety and Health for General Industry (29 CFR Part 1910), Respiratory Protection 1910.134, U.S. Department of Labor Occupational Safety and Health Administration.

American National Standard, Practices for Respiratory Protection, ANSI Z88.2-1980, American National Standards Institute.

Birkner, L.R., Respiratory Protection A Manual and Guideline, American Industrial Hygiene Association, 1980.

OPERATING PROCEDURE No. HS-501

501.0 PERSONNEL DECONTAMINATION

501.1 GENERAL

The objective of these procedures is to minimize the risk of exposure to hazardous substances. These procedures were derived from the U.S. Environmental Protection Agency (EPA), Office of Emergency and Remedial Response's (OERR) Interim Standard Operating Safety Guides (revised September 1982). This version of the guides is in a format that is more appropriate for use in the field.

Decontamination procedures shall be communicated to employees, and implemented before any employees may enter areas on site where potential for exposure to hazardous substances exists. All employees leaving a contaminated area shall be appropriately decontaminated; all contaminated clothing and equipment leaving a contaminated area shall be appropriately disposed of or decontaminated. Decontamination procedures shall be monitored by the Site Safety and Health Officer (SSO) to determine their effectiveness. When such procedures are found to be ineffective, appropriate steps shall be taken to correct any deficiencies. Decontamination shall be performed in geographical areas that will minimize the exposure of uncontaminated employees to contaminated employees or equipment. Employees whose nonimpermeable clothing becomes wetted with hazardous substances shall immediately remove that clothing and proceed to shower. The clothing shall be disposed of or decontaminated before it is removed from the work zone.

The procedures for decontaminating personnel upon leaving the contaminated area are addressed for each of the EPA, OERR designated levels of protection, excluding Level D. Typical components of Levels B, C and D are provided in Section 7.2.2, Personal Protective Equipment Levels, of this health and safety plan. Adjustments may be required in the decontamination line configurations and procedures if ensemble components other than those specified in the health and safety plan are used.

If personnel decontamination is to be done in a manner not addressed in this SOP, those decontamination procedures must be formally established and all concerned employees briefed.

Procedures are given for complete and abbreviated amounts of decontamination for each level of protection other than Level D. Complete decontamination procedures for all levels of protection will normally consist of 17-18 steps depending upon the PPE ensemble. Each station emphasizes an important aspect of decontamination. Utilizing all 17-18 steps will ensure that contaminant removal is as complete as feasible under field conditions. Abbreviated procedures are provided for situations when complete decontamination and removal of all personal protective equipment is not necessary. Examples of such situations include having to exchange breathing air bottles, taking a work break required to minimize heat stress, and when PPE ensembles other than those specified in the health and safety plan are employed. The abbreviated procedures are not suitable for work accomplished inside the 903 Pad (IHSS No. 112) or any other area wherein radiological contamination is detected as work progresses.

Decontamination lines are site-specific since they are dependent upon the contaminant species present, the degree of contamination, the specific items of PPE worn, and the type of work activities on site. Procedures specified herein may be modified by the SSO as the need arises. All modifications must be approved by the site manager. Normally, a phosphate-free soap in potable water solution will be used as the wash medium for personnel decontamination. When the decontamination line is no longer required, contaminated wash and rinse solutions and disposable articles must be contained and disposed of.

Radiological monitoring as described in EG&G, Radiological Operating Instructions, will be conducted for personnel and equipment departing all exclusion zones established in accordance with Title 29 Code of Federal Regulations (CFR) Part 1910.120, Hazardous Waste Operations and Emergency Response.

An exclusion zone's location determines who will conduct the monitoring. EG&G Radiation Protection Technicians (RPT) will monitor all personnel and equipment departing an exclusion zone that has been established within a controlled entry area designated by EG&G to limit

exposures to radioisotopes (i.e., 903 Pad). A contractor supplied SSO or Health and Safety Technician (HST) working for the SSO and assigned to a specific field team will conduct precautionary monitoring. Precautionary monitoring is described in Appendix A of this SOP. If an SSO or HST finds contamination levels greater than 250 counts per minute (cpm), all personnel and equipment will remain at the exclusion zone until an EG&G RPT arrives and assesses the situation.

The Contractor supplied SSO/HST will be responsible for completing Form 1.2, Personnel Decontamination Record.

501.2 EQUIPMENT

The types and amounts of decontamination required are largely dependent upon the types and amounts of contaminants that also dictate the ensemble being worn. Therefore, selection of the correct decontamination procedures and equipment is based upon the level of PPE being worn. Table 1, Equipment Needed To Perform Decontamination Measures For Levels B, and C, and

Table 2, Equipment Needed to Perform Abbreviated Decontamination Measures for Levels B and C, define equipment necessary to implement procedures established by this SOP.

501.3 LOCATION OF DECONTAMINATION LINES

Decontamination facilities (excluding showers and change rooms) will be located in the Contamination Reduction Zone (CRZ), that is, the area between the Exclusion Zone (the contaminated area) and the Support Zone (the clean area) as shown in Figure 1.

501.4 CONFIGURATION OF DECONTAMINATION LINES

Decontamination procedures must provide an organized process by which levels of contamination are reduced. The decontamination process will consist of a series of procedures performed in a specific sequence. That is, outer, more heavily contaminated items (for example, outer boots and gloves) will be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (such as jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line.

Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. Entry and exit points should be conspicuously marked.

Decontamination lines for personnel wearing various levels of protection are provided in Figure 2, Decontamination Layout - Level B Protection; Figure 3, Decontamination Layout - Level C Protection; Figure 4, Abbreviated Decontamination Layout - Level B Protection; and Figure 5, Abbreviated Decontamination Layout - Level C Protection.

TABLE 1
EQUIPMENT NEEDED TO PERFORM DECONTAMINATION MEASURES
FOR LEVELS A, B, AND C

Station 1:	<ul style="list-style-type: none"> a. Various Size Containers b. Plastic Liners c. Plastic Drop Cloths 	Station 10:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools d. Boot Jack
Station 2:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Decon Solution or Detergent Water c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes 	Station 11:	<ul style="list-style-type: none"> a. Rack b. Drop Cloths c. Bench or Stools
Station 3:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) <li style="text-align: center;">OR High-Pressure Spray Unit b. Water c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes* 	Station 12:	<ul style="list-style-type: none"> a. Table
Station 4:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners 	Station 13:	<ul style="list-style-type: none"> a. Basin or Bucket b. Decon Solution c. Small Table
Station 5:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools 	Station 14:	<ul style="list-style-type: none"> a. Water b. Basin or Bucket c. Small Table
Station 6:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners 	Station 15:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners
Station 7:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Decon Solution or Detergent Water c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes* 	Station 16:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners
Station 8:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) <li style="text-align: center;">OR High-Pressure Spray Unit b. Water c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes* 	Station 17:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Radiation Monitor
Station 9:	<ul style="list-style-type: none"> a. Air Tanks or Face Masks and Cartridge Depending on Level b. Tape c. Boot Covers d. Glove 	Station 18:	<ul style="list-style-type: none"> a. Water b. Soap c. Small Table d. Basin or Bucket e. Showers f. Towels
		Station 19:	<ul style="list-style-type: none"> a. Dressing Room is Needed b. Tables c. Chairs d. Lockers e. Cloths

*Brushes will not be used to remove radiological contamination from bare skin.

TABLE 2
EQUIPMENT NEEDED TO PERFORM ABBREVIATED DECONTAMINATION
MEASURES FOR LEVELS A, B, AND C

Station 1:	<ul style="list-style-type: none"> a. Various Size Containers b. Plastic Liners c. Plastic Drop Cloths 	Station 4:	<ul style="list-style-type: none"> a. Air Tanks or Masks and Cartridges Depending Upon Level b. Tape c. Boot Covers d. Gloves
Station 2:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Decon Solution c. Rinse Water d. 2-3 Long-Handled, Soft-Bristled Scrub Brushes* 	Station 5:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools
Station 3:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools 	Station 6:	<ul style="list-style-type: none"> a. Plastic Sheets b. Basin or Bucket c. Soap and Towels d. Bench or Stools
		Station 7:	<ul style="list-style-type: none"> a. Water b. Soap c. Tables d. Wash Basin or Bucket

*Brushes will not be used to remove radiological contamination from bare skin.

FIGURE 1
SITE WORK ZONES

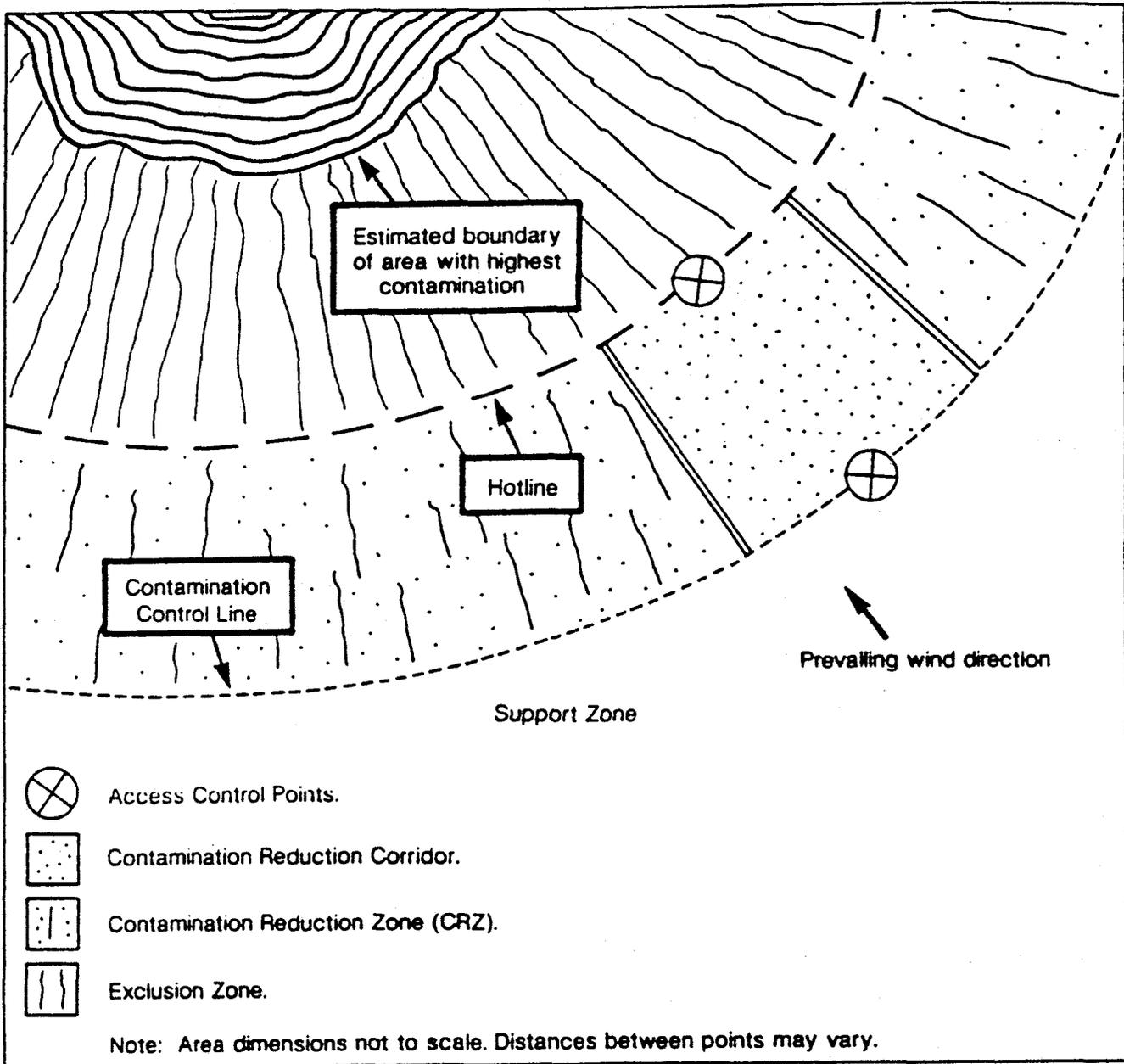


FIGURE 2
DECONTAMINATION LAYOUT
LEVEL B PROTECTION

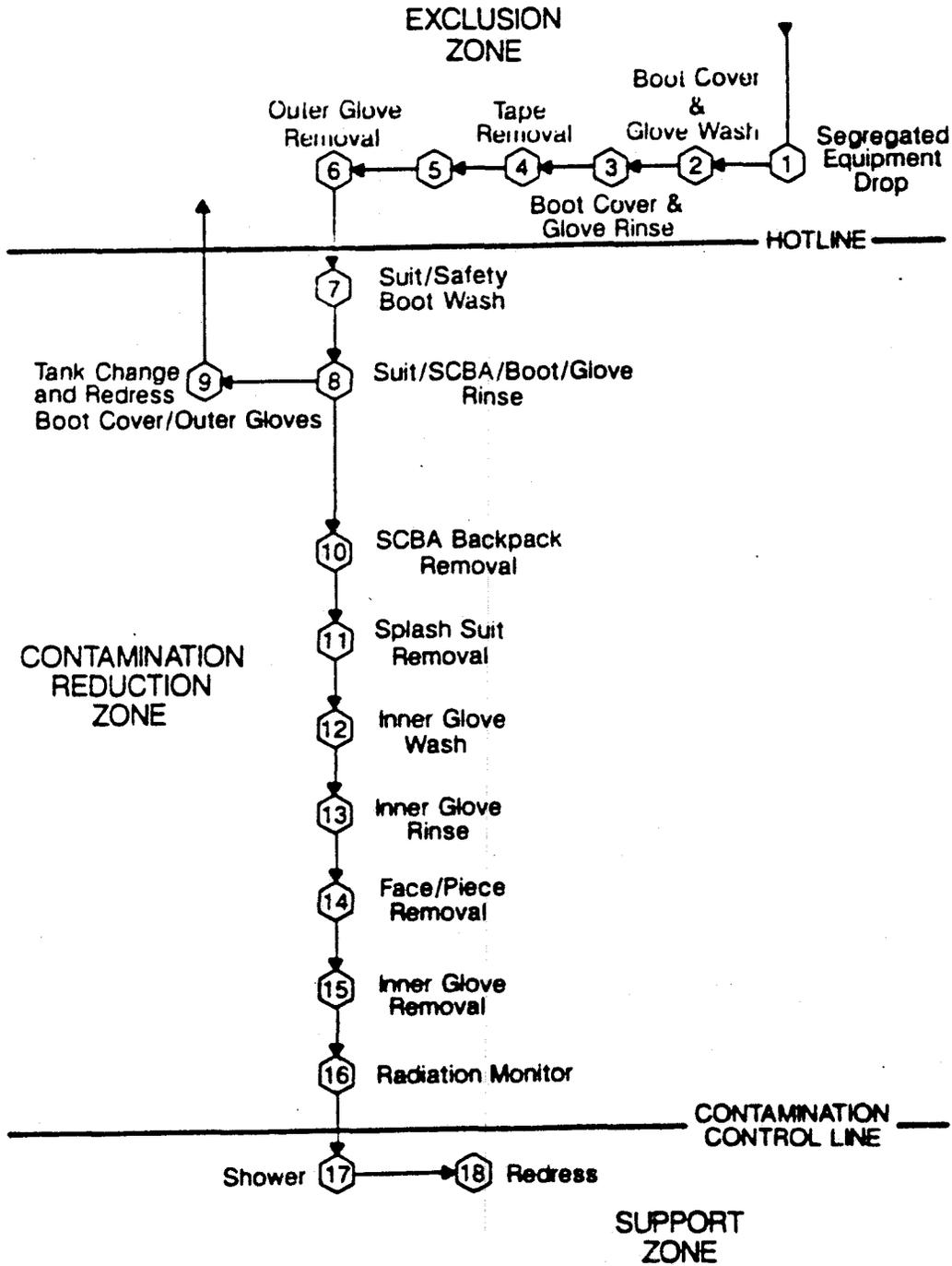


FIGURE .3

DECONTAMINATION LAYOUT
LEVEL C PROTECTION

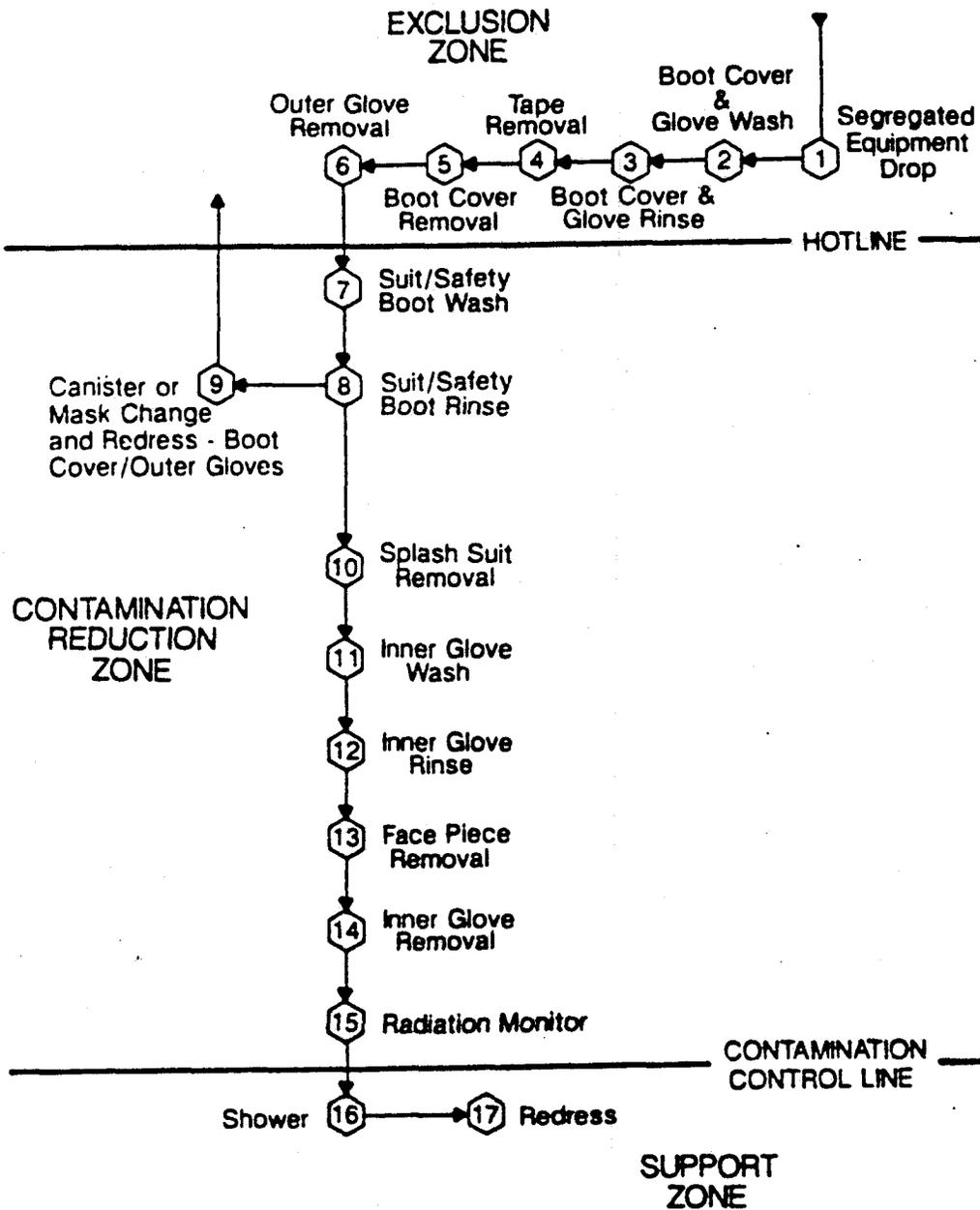


FIGURE 4

ABBREVIATED DECONTAMINATION LAYOUT
LEVEL B PROTECTION

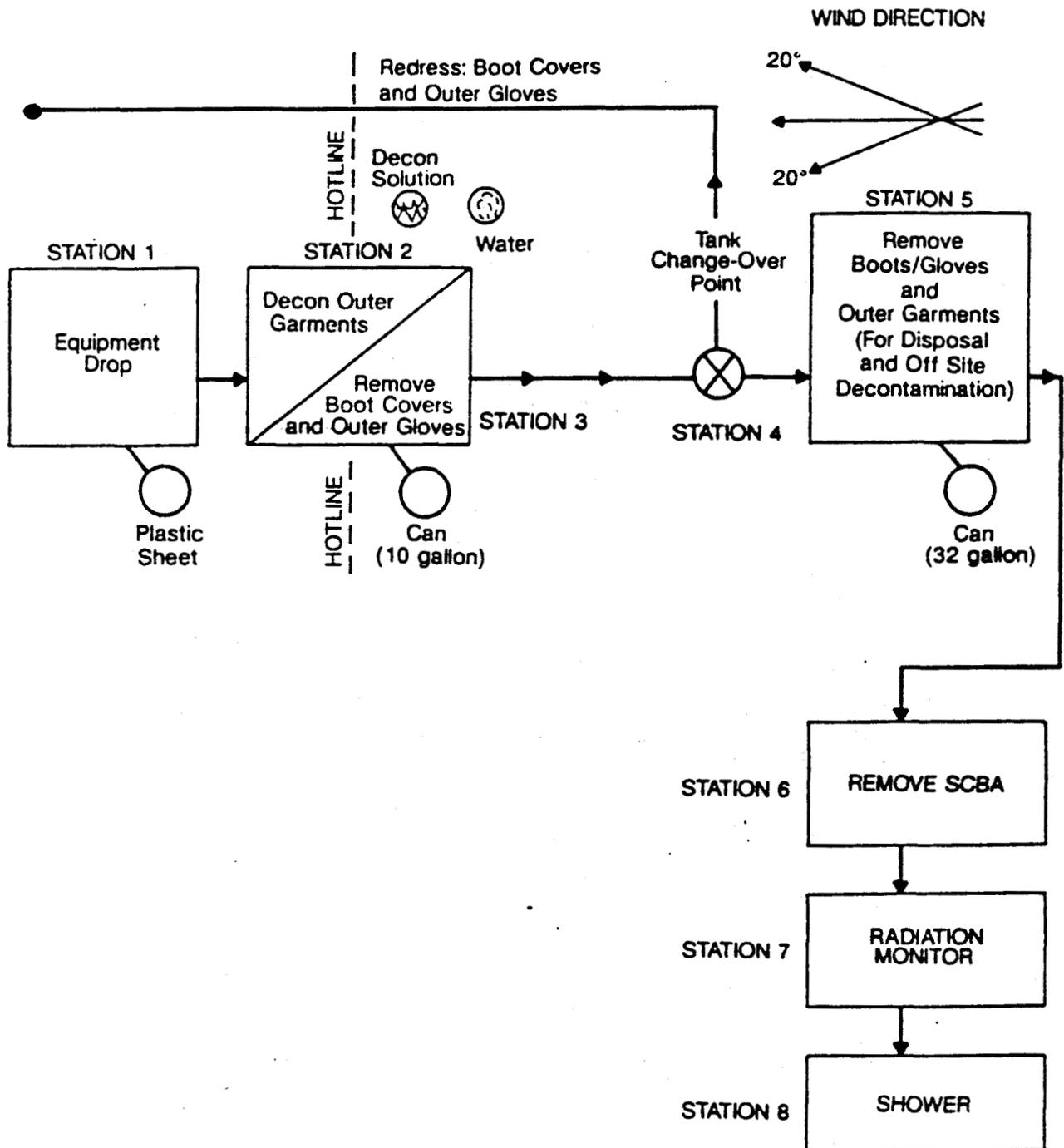
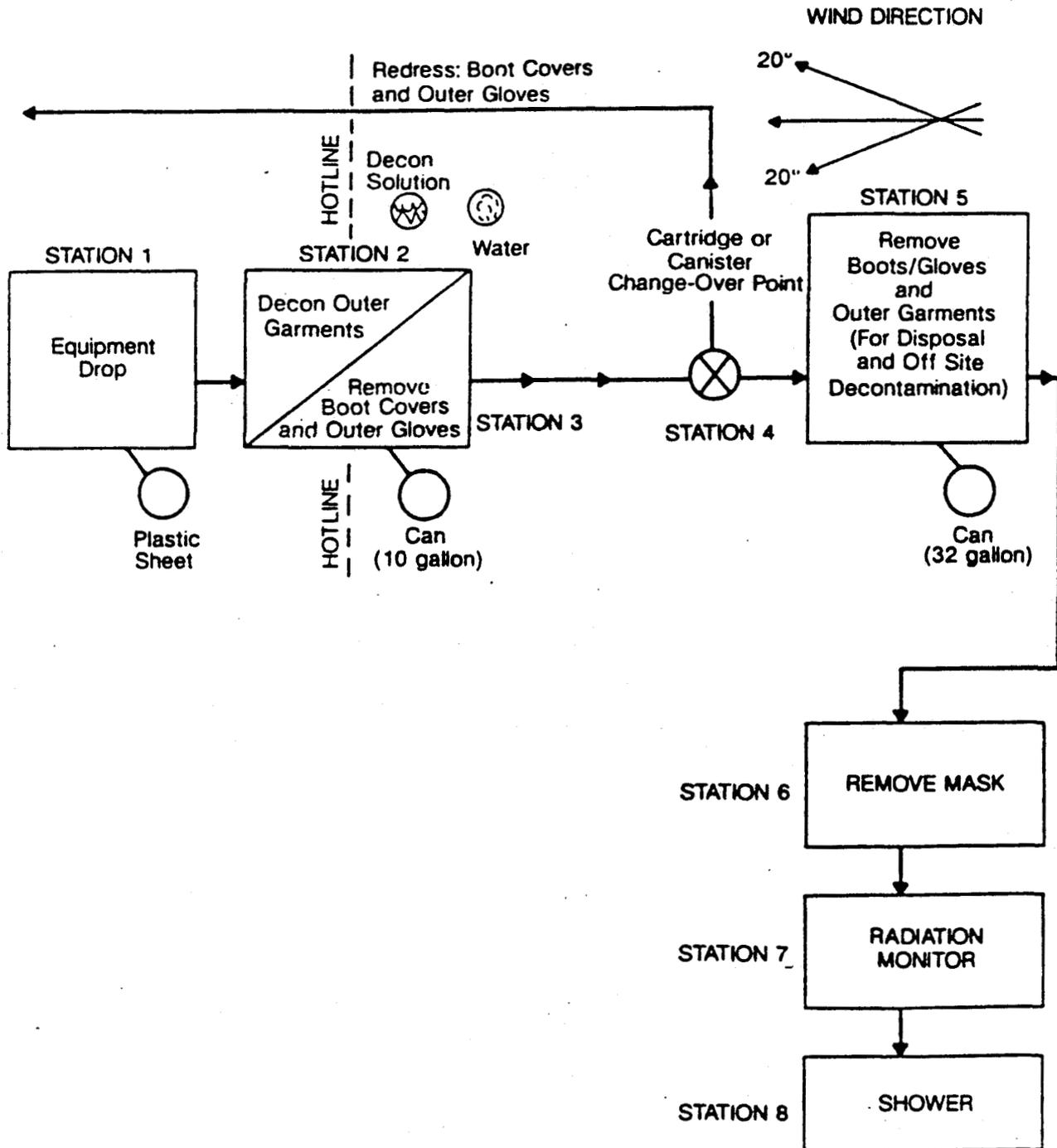


FIGURE 5

ABBREVIATED DECONTAMINATION LAYOUT
LEVEL C PROTECTION



501.5 PROCEDURES FOR PERSONNEL DECONTAMINATION

Decontamination procedures must provide an organized process by which levels of contamination are reduced. The decontamination process should consist of a series of procedures performed in a specific sequence. For example, outer, more heavily contaminated items (such as, outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (such as, jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line. The procedure (such as boot wash) to be accomplished at a given station will be clearly indicated so that a person at that station knows what is required. Decontamination procedures for various levels of protection are provided in Table 2, Procedures for Level B Decontamination; Table 3, Procedures for Level C Decontamination; Table 4, Abbreviated Procedures for Level B Decontamination; and Table 5, Abbreviated Procedures for Level C Decontamination. These procedures are for situations which warrant the maximum amount of PPE items for a given PPE level as specified in the health and safety plan. Certain operations may require a variant of the specified PPE ensembles which will require a modification in the decontamination procedures.

All equipment and fluids used for decontamination must be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment will be collected and decontaminated.

**TABLE 2
PROCEDURES FOR LEVEL B DECONTAMINATION**

Station 1:	Segregated Equipment Drop	1.	Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross contamination.
Station 2:	Boot Cover and Glove Wash	2.	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3.	Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4.	Remove tape around hoods and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5.	Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6.	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Safety Boot Wash	7.	Wash chemical-resistant splash suit, SCBA, gloves and safety boots. Scrub with long-handled scrub brush and decon solution. Wrap SCBA regulator (if belt mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloths.
Station 8:	Suit, SCBA, Boot, and Glove Rinse	8.	Rinse off decon solution using copious amounts of water.
Station 9:	Tank Change	9.	If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers put on, and joints taped. Worker returns to duty.
Station 10:	SCBA Backpack Removal	10.	While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve.
Station 11:	Splash Suit (such as saranex) Removal	11.	With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Wash	12.	Wash inner gloves with decon solution.
Station 13:	Inner Glove Rinse	13.	Rinse inner gloves with water.

**TABLE 2
(Continued)**

Station 14:	Facepiece Removal	14.	Remove facepiece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15.	Remove inner gloves and deposit in container with liner.
Station 16:	Inner Clothing Removal	16.	Remove inner clothing. Place in container with liner. Do not wear inner clothing off site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully encapsulating suit. Radiation monitoring will be done here.*
Station 17:	Field Wash	17.	Wash hands and face if shower is not available.
Station 18:	Redress	18.	Proceed to showers and put on clean clothes.

*If radiological contamination is found the SSO will provide instructions for decontamination.

**TABLE 3
PROCEDURES FOR LEVEL C DECONTAMINATION**

Station 1:	Segregated Equipment Drop	1.	Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross contamination.
Station 2:	Boot Cover and Glove Wash	2.	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3.	Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4.	Remove tape around hoods and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5.	Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6.	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7.	Wash splash suit, gloves, and safety boots. Scrub with long-handled scrub brush and decon solution.
Station 8:	Suit and Boot, and Glove Rinse	8.	Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	9.	If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers put on, and joints taped, then worker returns to duty.
Station 11:	Splash Suit (such as saranex) Removal	11.	With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 11:	Inner Glove Wash	11.	Wash inner gloves with decon solution
Station 12:	Inner Glove Rinse	12.	Rinse inner gloves with water.
Station 13:	Facepiece Removal	13.	Remove facepiece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 14:	Inner Glove Removal	14.	Remove inner gloves and deposit in lined container.

**TABLE 3
(Continued)**

Station 15:	Inner Clothing (such as tyvek) Removal	15.	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully encapsulating suit. Radiation monitoring will be done here.
Station 16:	Field Wash	16.	Wash hands and face if shower is not available.
Station 17:	Redress	17.	Proceed to shower and put on clean clothes.

*If radiological contamination is found the SSO will provide instructions for decontamination.

TABLE 4
ABBREVIATED PROCEDURES FOR LEVEL B DECONTAMINATION

Station 1:	Equipment Drop	1.	Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination.
Station 2:	Outer Garment, Boots, and Gloves chemical - Wash and Rinse	2.	Scrub outer boots, outer gloves and resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3.	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4.	If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers put on, joints taped and worker returns to duty. During hot weather operations, cool down stations may be set up within this area.
Station 5:	Boots, Gloves, and Outer Garment gloves Removal	5.	Boots, chemical-resistant splash suit, inner removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6.	SCBA backpack and facepiece are removed (avoid touching face with fingers). SCBA deposited on plastic sheets.
Station 7:	Monitor	7.	Radiation Monitor*
Station 8:	Field Wash	8.	Hands and face are thoroughly washed. Shower as soon as possible.

*If radiological contamination is found the SSO will provide instructions for decontamination.

TABLE 5
ABBREVIATED PROCEDURES FOR LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	1.	Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination.
Station 2:	Outer Garment, Boots, and Gloves splash suit Wash and Rinse	2.	Scrub outer boots, outer gloves, and with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3.	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask Change	4.	If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers put on, joints taped, and worker returns to duty. During hot weather operations, cool down stations may be set up within this area.
Station 5:	Boots, Gloves, and Outer Garment gloves Removal	5.	Boots, chemical-resistant splash suit, inner removed and deposited in separate containers lined with plastic.
Station 6:	Facepiece Removal	6.	Facepiece is removed (avoid touching face with fingers). Facepiece deposited on plastic sheet.
Station 7:	Monitor	7.	Radiation Monitor.
Station 8:	Field Wash	8.	Hands and face are thoroughly washed. Shower as soon as possible.

*If radiological contamination is found the SSO will provide instructions for decontamination.

501.6 EMERGENCY PROCEDURES

In general, emergency procedures established by the applicable health and safety plan apply.

501.6.1 Life Threatening Injuries

In an emergency, the primary concern is to prevent the loss of life or severe injury to site personnel. If immediate medical treatment is required to save a life or limb, decontamination will be delayed until the victim is stabilized. If decontamination is to be delayed, wrap the victim in blankets, plastic, or rubber to reduce contamination. Emergency response personnel should be alerted to the potential contamination.

501.6.2 Nonthreatening Injuries

If the injury does not threaten life or limb, routine decontamination procedures should be used.

501.6.3 THERMAL STRESS

If an emergency due to a heat-related illness develops, protective clothing should be removed from the victim as soon as possible to reduce the heat stress, and emergency procedures for heat stress should be implemented immediately.

501.7 DOCUMENTATION

The amount and type of documentation maintained is dependent upon type of operation in progress.

501.7.1 Routine Operations

A Personnel Decontamination Record (Form 1.2) will be completed daily by the SSO/HST for each exclusion zone established.

501.7.2 Operations That Result in Personnel or Equipment Becoming Contaminated With Radioactive Materials

An EG&G RPT will be contacted immediately if a Ludlum Model 12-1A count rate meter indicates the presence of radioactive materials in a controlled entry area designated by EG&G to limit exposures to radioisotopes. The RPT will verify the presence of radioactive materials and complete the pertinent forms as specified in EG&G ROI.

PERSONNEL DECONTAMINATION RECORD

Personnel Inside Exclusion Zone

Name	Position
_____	_____ Team Leader
_____	_____ H&S Technician
_____	_____ Driller
_____	_____ Driller's Helper
_____	_____ Air Technician
_____	_____ Other, specify

PPE Level Worn

_____ A _____ B _____ C _____ D

Assigned Task (check appropriate task)

Well Construction Well Development
 Soil Boring Surficial Soil Sampling
 Other, specify _____

Work Location

Operable Unit _____

Additional Locating Information _____

Results of Environmental Monitoring (record highest measurement noted and units)

Radiological

Instrument Used _____ Higher Measurement _____

Note: If radiological contamination is found, record the name of the RPT that responds.

APPENDIX A
PRECAUTIONARY MONITORING

1. PURPOSE

To establish personnel monitoring requirements for radioactive contamination.

2. SCOPE

This instruction defines the use of instruments for personnel contamination monitoring, criteria for personnel contamination, and management of contaminated personnel.

3. GENERAL

3.1 If a radiological occurrence involves a combination of conditions, response actions shall be taken in the following priority:

- Critical injury or illness
- Skin contamination
- Noncritical injury or illness
- Possible inhalation of radioactive material

3.2 *Emergency medical care of critically injured or ill personnel shall take precedence over radiological actions.*

3.3 Care shall be exercised in transporting contaminated personnel to minimize the spread of contamination outside of the exclusion zone. A blanket or other material will be used to cover a contaminated person that leaves the exclusion zone.

4. INSTRUCTIONS

4.1 Monitoring of personnel for contamination shall be performed in the following situations:

- Whenever leaving a Controlled Area designated by EG&G such as the 903 Pad.
- Whenever exiting a Contaminated Area as indicated by environmental monitoring conducted as field work progressed.

4.1.1 Alpha contamination monitoring shall be performed as follows:

- The Ludlum Model 12-1A Survey Meter with an Air Proportional Detector shall be used.

- The detector shall be held within $\frac{1}{4}$ inch of the body or clothing surface and moved slowly, i.e., about 1 inch per second.
- To the extent practical, clothing wrinkles shall be smoothed prior to monitoring.
- The instrument scale selector control shall be set to the range appropriate for measuring levels of contamination.
- Visual or audible instrument response shall be used to determine the presence of contamination.
- Skin or clothing shall be considered contaminated if the detectable radioactivity is greater than 250 cpm.

4.1.2 Precautionary monitoring shall consist of a whole-body survey. A whole-body survey shall be conducted front and back as the individual being surveyed stands with legs spread and arms extended out from the shoulders as the probe is moved over the following areas or articles:

- Head (pause at mouth and nose)
- Neck and shoulders
- Arms (pause at each elbow)
- Hands (pause at palm and back)
- TLD and security badge
- Respirator, exterior, interior, cartridge, and straps
- Chest and abdomen
- Back, hips, and seat of pants
- Legs (pause at each knee)
- Pant cuffs (pause)
- Shoe cover bottoms
- Shoe tops
- Shoe bottoms (pause at sole and heel)

4.1.3 An EG&G RPT and the SSO shall be contacted if greater than 250 cpm is detected after completion of the personnel decontamination procedures. The individual found to be contaminated and the individual that performed the monitoring will remain at the personnel decontamination station.

OPERATING PROCEDURE NO. HS-509

509.0 SAFETY GUIDELINES FOR DRILLING INTO SOIL AND ROCKS

509.1 PURPOSE

The purpose of this operating procedure is to provide guidelines for safe conduct of drilling operations with truck-mounted and other engine-powered, drill rigs. The procedure addresses off-road movement of drill rigs, overhead and buried utilities, use of augers, rotary and core drilling, and other drilling operations and activities.

509.2 APPLICATION

The guidelines shall be applied in all WCC/WCFS projects in which truck-mounted, or other engine-powered, drill rigs are used. The guidelines are applicable to WCC employees and WCC award rigs. For drill rigs operated by contractors, drill rig safety is the responsibility of the contractor.

509.3 RESPONSIBILITY AND AUTHORITY

Drill rig safety and maintenance is the responsibility of the drill rig operator.

509.4 SAFETY GUIDELINES

509.4.1 MOVEMENT OF DRILL RIGS

Before moving a rig, the operator must do the following:

1. To the extent practical, walk the planned route of travel and inspect it for depressions, gullies, ruts, and other obstacles.
2. Check the brakes of the truck/carrier, especially if the terrain along the route of travel is rough or sloped.
3. Discharge all passengers before moving on rough or steep terrain.
4. Engage the front axle (on 4x4, 6x6, etc. vehicles) before traversing rough or steep terrain.

Driving drill rigs along the sides of hills or embankments should be avoided; however, if side-hill travel becomes necessary, the operator must conservatively evaluate the ability of the rig to remain upright while on the hill or embankment. The possibility that the presence of drilling tools on the rig may reduce the ability of the rig to remain upright by raising the center of mass of the rig must be considered.

Logs, ditches, road curbs, and other long and horizontal obstacles should be normally approached and driven over squarely, not at an angle.

When close lateral or overhead clearance is encountered, the driver of the rig should be guided by another person on the ground.

Loads on the drill rig and truck must be properly stored while the truck is moving, and the mast must be in the fully lowered position.

After the rig has been positioned to begin drilling, all brakes and/or locks must be set before drilling begins. If the rig is positioned on a steep grade and leveling of the ground is impossible or impractical, the wheel of the transport vehicle should be blocked and other means of preventing the rig from moving or tipping over employed.

509.5 BURIED AND OVERHEAD UTILITIES

The location of overhead and buried utility lines must be determined before drilling begins, and their locations should be noted on boring plans or assignment sheets.

When overhead power lines are close by, the drill rig mast should not be raised unless the distance between the rig and the nearest power line is at least 20 feet or other distance as required by local ordinances, whichever is greater. The drill rig operator or assistant should walk completely around the rig to make sure that proper distance exists.

When the drill rig is positioned near an overhead line, the rig operator should be aware that hoist lines and power lines can be moved towards each other by wind. When necessary and approved by the PM and the utility, powerlines may be shielded, shut down, or moved by the appropriate personnel.

509.6 CLEARING THE WORK AREA

Before a drill rig is positioned to drill, the area on which the rig is to be positioned should be cleared of removable obstacles and the rig should be leveled if sloped. The cleared/leveled area should be large enough to accommodate the rig and supplies.

509.7 SAFE USE OF AUGERS

Never place hands or fingers under the bottom of an auger flight or drill rods when hoisting the augers or rods over the top of another auger or rod in the ground or other hard surfaces, such as the drill rig platform.

Never allow feet to get under the auger or drill rod while they are being hoisted.

When drill is rotating, stay clear of the drill string and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

Move auger cuttings away from the auger with a long-handled shovel or spade; never use hands or feet.

Never clean an auger attached to the drill rig unless the transmission is in neutral or the engine is off, and the auger has stopped rotating.

509.8 SAFE USE OF HAND TOOLS

OSHA regulations regarding hand tools should be observed in addition to the guidelines provided below:

1. Each tool should be used only to perform tasks for which it was originally designed.
2. Damaged tools should be repaired before use or discarded.
3. Safety goggles or glasses should be worn when using a hammer or chisel. Nearby co-workers and by-standers should be required to wear safety goggles or glasses also or to move away.
4. Tools should be kept cleaned and stored in an orderly manner when not in use.

509.9 SAFE USE OF WIRE LINE HOISTS, WIRE ROPE, AND HOISTING HARDWARE

Safety rules described in 29 CFR 1926.552 and guidelines contained in the Wire RPE User's Manual published by the American Iron and Steel Institute shall be used whenever wire line hoists, wire rope, or hoisting hardware are used.

509.10 PROTECTIVE GEAR

509.10.1 MINIMUM PROTECTIVE GEAR

Items listed below should be worn by all members of the drilling team while engaged in drilling activities.

- o Hard Hat;
- o Safety Shoes (shoes or boots with steel toes and shanks); and
- o Gloves.

509.10.2 OTHER GEAR

Items listed below should be worn when conditions warrant their use. Some of the conditions are listed after each item.

1. Safety Goggles or Glasses: Use when: (1) driving pins in and out of drive chains, (2) replacing keys in tongs, (3) handling hazardous chemicals, (4) renewing or tightening gauge glasses, (5) breaking concrete, brick, or cast iron, (6) cleaning material with chemical solutions, (7) hammering or sledging on chisels, cold cuts, or bars, (8) cutting wire lines, (9) grinding on abrasive wheels, (10) handling materials in powered or semi-powered form, (11) scraping metal surfaces, (12) sledging rock bits or core heads to tighten or loosen them, (13) hammering fittings and connections, and (14) driving and holding rivets.

2. Safety Belts and Lifelines: Safety belts and lifelines should be worn by all persons working on top of an elevated derrick beam. The lifeline should be secured at a position that will allow a person to fall no more than eight feet.

3. Life Vests: Use for work over water.

509.11 TRAFFIC SAFETY

Drilling in streets, parking lots or other areas of vehicular traffic requires definition of the work zones with cones, warning tape, etc. and compliance with local police requirements.

509.12 FIRE SAFETY

1. Fire extinguishers shall be kept on or near drill rigs for fighting small fires.
2. If methane is suspected in the area, a combustible gas instrument (CGI) shall be used to monitor the air near the borehole with all work to stop at 25 percent of the Lower Explosive Limit.
3. Work shall stop during lightning storms.

/H&S2

OPERATING PROCEDURE NO. HS-510

**510.0 SAFETY PROCEDURES FOR TRENCH CONSTRUCTION AND OTHER
EXCAVATING OPERATIONS**

510.1 PURPOSE

This procedure contains general safety requirements for excavating and trenching operations and work performed therein. The requirements are consistent with standards established by the Occupational Safety and Health Administration (OSHA) and described in 29 CFR 1926.650. The detailed OSHA standard was effective in January 1990 and should be consulted before design of a shoring system or questions regarding a sloping option.

510.2 PRIMARY RESPONSIBILITY

The WC project manager is responsible for ensuring that employees of WC and of firms contracted by WC comply with the requirements.

WC employees are responsible for not entering improper trenches or excavations.

510.3 APPLICABILITY

This procedure is applicable to all WC projects in which trenching or other excavating operations, exclusive of borings, are entered by WC personnel or personnel employed by firms under contract to WC. It is also applicable to WC projects requiring WC personnel or personnel of firms under contract to WC to enter trenches and other types of excavations.

The best approach for avoiding the detailed trenching requirements is to perform sampling and other procedures without entry into excavations. Use of a backhoe to bring up samples, use of long-handled sampling devices, and similar techniques are recommended.

510.4 REQUIREMENTS

510.4.1 PRELIMINARY REQUIREMENTS

Certain government agencies (e.g. California) require a permit to perform excavation operations.

Before digging, determine or have the client determine if underground installations, such as sewer, water, fuel, or electrical lines are to be encountered, and if so, determine the exact locations of the lines. Information can be obtained by contacting Underground Service Alert (consult local telephone directory for toll-free number), local utility companies, and the owner of the property on which excavating operations are planned.

Trees, boulders, and other surface encumbrances, located so as to pose a potential hazard to employees must be removed or made safe before the operation begins.

510.4.2 PLACEMENT OF EXCAVATED MATERIALS

Excavated materials must be placed at least two feet back from the edge of the excavation and precautions must be taken to prevent the materials from falling into the excavation.

510.4.3 WORKING IN EXCAVATIONS

510.4.3.1 SHORING AND SLOPING

Trenches in which personnel are required to work must be shored or sloped if the depth of the excavation is five (5) feet or more. When a shoring system is used, it shall consist of hydraulic shores or the equivalent, with sheathing or sheet piling as needed. Trench boxes are also permitted. OSHA uses a soil classification system to determine the allowable slopes for trenches. The shoring system must be properly designed and installed to sustain all existing and expected loads. For details on shoring and sloping, consult 29 CFR, Subpart P, Sections 1926.650 to 1926.653.

510.4.3.2 ACCESS

When work is to be performed in any excavation, safe access to the excavation must be provided by means of ladders, stairs, or ramps. Trenches four or more feet deep must have ladders spaced no less than 25 feet apart, and the ladders must extend at least three feet above grade.

510.4.3.3 HAZARDOUS ATMOSPHERES

At sites where oxygen deficiency or hazardous concentrations of flammable or toxic vapors or gases may be encountered in excavations, the atmosphere in the excavations must be tested by the project safety officer or other qualified person before work in an excavation begins and at appropriate intervals afterward.

510.4.4 INSPECTION OF EXCAVATIONS

Excavations must be observed daily by the project or site safety officer. If no safety officer has been assigned to the project, inspections must be made by the project manager or his designee. If evidence for potential cave-ins or slides is apparent, all work in the excavation must be suspended until necessary steps have been taken to safeguard employees.

510.4.5 OPERATION OF VEHICLES NEAR EXCAVATIONS

When vehicles or heavy equipment must operate near an excavation, the sides of the excavation must be shored or braced as necessary to withstand forces exerted by the superimposed load and the earth pressure. Stop logs or other types of secure barriers must be installed at the edges of the excavations.

510.4.6 BELL-BOTTOM PIER HOLES

Employees entering drilled pier holes must be protected by a casing proportioned to sustain the maximum stresses imposed by earth and water or slurry that extends the full depth of the shaft and to the bottom of the bell. A safety cage or a shoulder harness secured to a full-time tended lifeline shall be required for entry and exit.

510.4.7 BRIDGES AND WALKWAYS

Walkways or bridges with standard guardrails must be provided where employees or equipment are required or permitted to cross over excavations. Pedestrian walkways shall be of sufficient strength to permit a vertical deflection of no more than 0.5 inch when a 250-pound weight is applied to the center of the walkway.

All bridges intended for vehicular traffic must be constructed to withstand twice the load of the heaviest vehicle expected.

510.4.8 BARRICADES AND FENCES

Excavated areas must be completely guarded on all sides with barricades or fences, as appropriate. If barricades are used, they must be spaced no more than 20 feet apart and shall not be less than 35 inches high when erected. A yellow or yellow and black tape, at least 0.75 inches wide, shall be stretched between the barricades.

510.4.9 BACKFILLING

Excavated areas must be backfilled in accordance with the work plan as soon as practical after work is completed, and all associated equipment must be removed from the area.

510.5 EXCAVATIONS NEXT TO EXISTING STRUCTURES

A registered engineer will review all plans for excavations next to existing structures to avoid undermining the structures and possible collapse.

/H&S2

ATTACHMENT E

ESTIMATING AIRBORNE CONCENTRATIONS OF RADIOISOTOPES FROM SOILS

1. Mathematical Modeling

We have used the mass-loading method of estimating airborne concentrations of radioisotopes likely to be encountered from soil sources during field operations. No attempt has been made to estimate the airborne concentration of radioisotopes from liquid sources since it is extremely unlikely that liquid aerosols will be generated. Specifically, we have used the mass-loading approach as described in US Environmental Protection Agency (EPA) document Number EPA 520/1-9-90-016, *Transuranium Elements - Volume 2: Technical Basis For Remedial Actions*, dated June 1990, specifically Chapter 6, *Radiological Assessment - Rocky Flats Plant*. Pertinent sections of this chapter (hereafter simply referred to as "Chapter 6") have been extracted and are presented in this Attachment. It may be of use to review "Chapter 6" before proceeding.

The following equation (drawn from the referenced document) could be used to estimate airborne concentrations of radioisotopes that may be generated by naturally occurring resuspension processes such as surface erosion from unimproved ground surfaces.

Expected Airborne Concentration = Soil Concentration x Mass Loading x Enrichment Factor
x Area Correction

We have made three modifications in the equation. Justification for modifying the equation is couched in the "as low as reasonably achievable" (ALARA) concept for limiting personnel exposures to ionizing radiation. The expected airborne concentration value will be used as an initial indication of the need for protecting personnel and when protection is indicated the expected airborne concentration will determine the degree of protection required. The net result of all three modifications is to ensure that the estimated airborne concentration value is likely to be an overstatement of the actual airborne concentrations that will be encountered. Specific modifications to the equation and the assumptions inherent with the equation are described in the following paragraph.

The first modification was made to reflect that the resuspension process will be construction-type activities versus natural erosional processes. Empirical data described in "Chapter 6" indicates that multiplying the expected airborne concentration by 30 will yield airborne

concentrations expected to be generated by construction activities conducted in soils with the same concentration of radioisotopes.

The "Enrichment Factor" and the "Area Correction" terms have been omitted from the equation. Elimination of the enrichment factor results in the assumption that all airborne particulates are of a respirable size and that each of the airborne particles is as radioactive as all other airborne particles. Elimination of the enrichment factor results in an overestimation of the airborne concentration since, as stated in the attached extract of Chapter 6, only approximately 20 percent of the airborne particles will actually be in the respirable range and only 53 percent of the total radioactivity will be contained in that 20 percent of the airborne particles. Omission of area correction results in the assumption that the area from which particulates are being generated is of an infinite size. This results in an overestimation of the airborne concentration since the initial source of particulates will be the size of a soil auger (approximately 8 inches in diameter) and the maximum source of particulates will be some small portion of the exclusion zone (a circle with an approximately 50-foot radius).

The two assumptions that are inherent to the equation are (1) that the wind blows 100 percent of the time across the source of contamination toward the receptor, and (2) the estimated airborne concentration relates to near-surface level concentrations and does not account for a decrease in the airborne concentrations attributable to the height of the worker's breathing zone above the surface level.

Accounting for the equation modifications described above, the restated equation is as follows.

$$\text{Maximum Expected Airborne Concentration} = \text{Soil Concentration} \times \text{Mass Loading} \times 30$$

Example Problem

Given: Plutonium-239 in soil at 20,455 pCi/gm

Mass Loading of 15 $\mu\text{g}/\text{m}^3$

Maximum Expected Airborne Concentration =

$$(20,455 \text{ pCi/gm})(15 \times 10^{-6} \text{ gm}/\text{m}^3)(30) = 9.20475 \text{ pCi}/\text{m}^3$$

2. Derived Air Concentration (DAC) Guides

The DACs for the following isotopes were drawn from DOE Order 5480.11, Radiation Protection for Workers, December 21, 1988 and converted to pCi/m³ through the unit conversions shown below:

- Isotope DACs
 - Pu-239 - $6 \times 10^{-12} \mu\text{Ci}/\text{cm}^3 = 6 \text{ pCi}/\text{m}^3$
 - Am-241 - $2 \times 10^{-12} \mu\text{Ci}/\text{cm}^3 = 2 \text{ pCi}/\text{m}^3$
 - U-238 - $2 \times 10^{-11} \mu\text{Ci}/\text{cm}^3 = 20 \text{ pCi}/\text{m}^3$
 - U-233 & U-234 - $2 \times 10^{-11} \mu\text{Ci}/\text{cm}^3 = 20 \text{ pCi}/\text{m}^3$
 - Sr-89 - $6 \times 10^{-8} \mu\text{Ci}/\text{cm}^3 = 6 \times 10^4 \text{ pCi}/\text{m}^3$
 - Sr. 90 - $2 \times 10^{-9} \mu\text{Ci}/\text{cm}^3 = 2 \times 10^3 \text{ pCi}/\text{m}^3$

- Unit Conversions
 - DAC Pu-239 = $6 \times 10^{-12} \mu\text{Ci}/\text{cm}^3 = 6 \times 10^{-18} \text{ Ci}/\text{cm}^3$
 - DAC Pu-239 = $(6 \times 10^{-18} \text{ ci}/\text{cm}^3)(1 \times 10^6 \text{ cm}^3/\text{m}^3) = 6 \times 10^{-12} \text{ Ci}/\text{m}^3 = 6 \text{ pCi}/\text{M}^3$

3. Maximum Soil Activities Used

3.1 903 Pad (IHSS No. 112)

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/M ³)	DAC (pCi/M ³)
Pu-239	20,455	9.2	7
Am-241	2,273	1.02	3

3.2 903 Pad Lip site (IHSS No. 155)

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/M ³)	DAC (pCi/m ³)
Pu-239	190	0.0855	6
Am-241	0.25	0.00011	2
U-233 & U-234	0.87	0.00039	20
U-238	0.81	0.00036	20
Sr-89	1.6	0.00072	60,000
Sr-90	1.6	0.00072	2,000

3.3 All Trench Sites

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/m ³)	DAC (pCi/m ³)
Pu-239	68	0.0306	6
U-238	450	0.202	20

The amount of radioactivity/gram of soil has not been determined within all trenches. However, the radioactivity/gram has been determined in three trenches, with the highest activities found in Trench T-9 (IHSS 111.6), and those values have been assigned to all trenches for the purposes of our hazard assessment.

3.4 Reactive Metals Destruction Site (IHSS No. 140)

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/m ³)	DAC (pCi/m ³)
Pu-239	100	0.045	6
AM-241	13	0.0059	2
U-233 & U-234	3.3	0.0015	20
U-238	2.2	0.00099	20
Sr-89	1.6	0.00072	60,000
Sr-90	1.6	0.00072	2,000

3.5 Gas Detoxification Site (IHSS No. 183)

A review of the history of this IHSS does not indicate radioisotopes were disposed of here.

3.6 Mound Site (IHSS No. 113)

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/m ³)	DAC (pCi/m ³)
See Note	51	0.023	2

Note: A review of the site history indicates that a soil activity of 51 pCi/g of an unspecified radioisotope has been noted. We have calculated the maximum expected airborne activity and compared it to the most restrictive DAC (Am-241) for the isotopes found at Rocky Flats Plant.

3.7 Oil Burn Pit No. 2 (IHSS No. 153)

No radioanalytical results exist for soil boring samples for this site. However, approximately the top 5 feet of soil has been removed since the site was last used. Therefore, we do not consider this site to be a source of potential inhalation hazards from radioisotopes.

3.8 Pallet Burn Pit (IHSS No. 154)

A review of the history of this site does not indicate radioisotopes were disposed of here.

3.9 East Spray Field Center Area (IHSS No. 216.2), South Area (IHSS No. 216.3), and Outlying Areas (non-IHSS sites within OU2)

Isotopes Found	Soil Activity Used in Calculations (pCi/g)	Estimated Airborne Activity (pCi/m ³)	DAC (pCi/m ³)
Pu-239	11.34	0.005	6

Note: The maximum amount of surficial soil activity found has been assigned to all the above sites.

6. RADIOLOGICAL ASSESSMENT - ROCKY FLATS PLANT

[Reprinted With Minor Changes from Response to Comments -
EPA 520/4-78-010]

6.1 INTRODUCTION

This chapter presents an analysis of the potential hazards to individuals in the general population as a result of transuranium element contamination in the environs of the USDOE Rocky Flats Plant. It is intended primarily to serve as an illustrative example of how to carry out a comprehensive environmental assessment, and does not represent an evaluation of potential health hazards. Analysis is limited to data for the period 1970-77, when public concern about possible health hazards was greatest. The various pathways by which exposures might occur under present and projected land usages are examined and interpreted in terms of ambient levels of contamination.

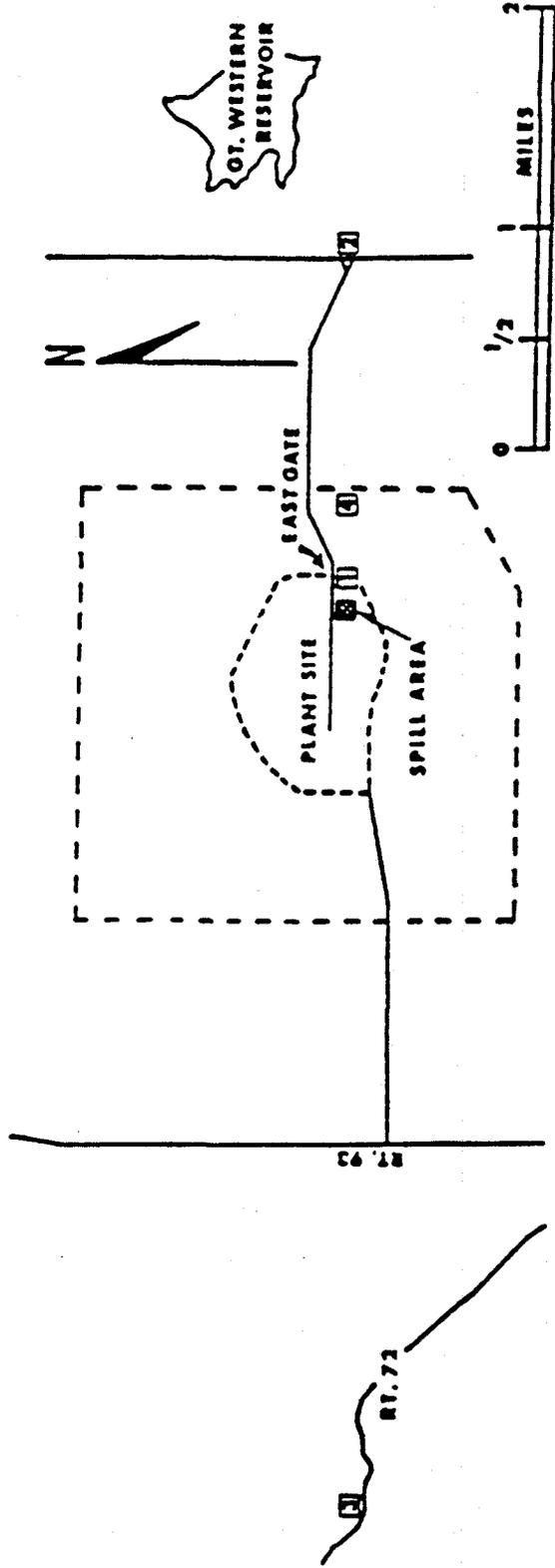
6.2 INHALATION PATHWAY

6.2.1 AMBIENT AIR CONCENTRATIONS

Under normal operating conditions, minute quantities of plutonium and other radionuclides have been released to the atmosphere from the Rocky Flats Plant. These releases originated from the plant's ventilation and filtration system. Measurements of airborne radioactivity in the vicinity of Rocky Flats and the neighboring communities are made on a continuous basis. In addition to monitoring the effluent air from production and research facilities, the Rocky Flats facility maintains a system of high-volume ambient air samplers within the plant boundary, at off-site locations in the immediate vicinity of the plant, and in several communities nearby. Altogether the system comprises 21 air samplers operating continuously within and on the perimeter of the Rocky Flats security area, and another

25 samplers located at various distances and directions from the plant. The data from this network are reported on a monthly basis to the Rocky Flats Area Office of the Department of Energy (DOE), the Division of Occupational and Radiological Health of the Colorado Department of Health, the Denver Regional Office of the EPA, the Health Departments of Boulder and Jefferson Counties, and city officials in several communities near the plant.

In addition to the surveillance network maintained by the Rocky Flats Plant, the Health and Safety Laboratory (HASL) of DOE conducted a program of continuous air sampling for plutonium at the Plant since June 1970 in response to the discovery of elevated levels of plutonium found in soils at location which were then off-site. The HASL network consisted of four sampling locations (Figure 6-1), three of which were downwind (east) from the original location of the oil drum storage site and the fourth air sampler was located off-site and upwind from the Rocky Flats Plant. Air concentration data in attocuries of Pu-239 per cubic meter of air ($\mu\text{Ci}/\text{m}^3$), as reported by this network on a monthly basis from June 1970 to March 1976, are given in Table 6-1. A significant downward trend with time in the level of plutonium in air at the stations downwind from the plant can be seen. It has been suggested by HASL that this downward trend is attributable to the weathering of the contaminated soil in the on-site vicinity of the original oil drum storage site. This weathering may be due to the movement of the plutonium from the surface down into the soil, as well as changes in the characteristics of the plutonium remaining on the surface. In addition to showing a decrease with time the data indicate a decrease in concentration with increasing distance downwind from the site of the original spill area. Based upon air and soil sampling, as well as the direction of the prevailing winds around Rocky Flats, HASL concluded in 1972 (2) that the original spill area was the primary source of plutonium in the Rocky Flats environment.



MAP OF ROCKY FLATS PLANT AND VICINITY
INDICATING CONTINUOUS AIR SAMPLING SITES (1).

FIGURE 6-1

TABLE 6-1
 MONTHLY AVERAGE AIR CONCENTRATIONS OF PU-239
 AT ROCKY FLATS PLANT
 (Attocuries /Cubic Meter)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
SITE #1												
1970	--	--	--	--	--	1990.00	1250.00	790.00	850.00	693.00	2260.00	962.00
1971	1960.00	--	7140.00 ^a	9730.00	4920.00	3800.00	2980.00	3530.00	4040.00	5770.00	5770.00	3160.00
1972	5430.00	1670.00	4610.00	1460.00	2080.00	6610.00	4720.00	1380.00	--	1620.00	498.00	1860.00
1973	1160.00	3640.00	2520.00	612.00	1780.00	3040.00	2920.00	3320.00	1050.00	2010.00	1810.00	1690.00
1974	402.00	802.00	891.00	1810.00	3060.00	5470.00	2670.00	3330.00	1120.00	407.00	580.00	643.00
1975	1260.00	1360.00	1780.00	2180.00	2190.00	1160.00	567.00	426.00	179.00	--	1220.00	655.00
1976	680.00	1240.00	864.00	--	--	--	--	--	--	--	--	--
SITE #2												
1972	--	--	--	--	--	--	98.90	55.50	119.00	609.00	48.50	45.20
1973	37.80	57.70	55.80	716.00 ^c	51.80	57.70	92.10	65.00	152.00	31.50	25.20	76.30
1974	16.80	23.20	462.00 ^c	135.00	176.00	140.00	78.70	58.10	34.20	24.00	29.20	43.70
1975	141.00	34.70	56.80	39.70	--	--	27.40	14.00	9.98	--	10.60	16.40
1976	12.20	23.10	14.40	--	--	--	--	--	--	--	--	--
SITE #3												
1972	--	--	--	--	--	--	--	--	--	21.90	18.50	25.60
1973	18.40	41.70 ^b	24.20	24.00	40.40	42.00	25.80	25.70	38.20	21.50	11.00	16.90
1974	21.70	39.10	163.00 ^c	283.00 ^c	--	--	--	--	--	--	--	--
SITE #4												
1974	--	--	--	--	1460.00	758.00	1430.00	222.00	199.00	395.00	1240.00	710.00
1975	288.00	399.00	1850.00	254.00	139.00	684.00	118.00	146.00	72.20	189.00	188.00	128.00
1976	184.00	303.00	72.60	236.00	109.00	319.00	98.20	63.10	--	--	--	--

-- NO DATA
 Errors are less than 20% except:
 a -error between 20% and 100%
 b -error greater than 100%
 c -suspect, omitted from average

The levels of airborne plutonium at the downwind edge of the buffer zone (Indiana Street) were approximately the same level as reported at the monitoring station upwind from the plant. Although these levels were about twice that expected from background radioactivity in the Rocky Flats area, the effect of the spill area upon the off-site environment has been much reduced from earlier levels.

Comparison of the HASL data for 1976 for the Indiana Street location (site 2) with the 1975 data reported by the Rocky Flats Plant (Table 6-2) for the same general area shows the two networks to agree within a factor of about 2. The values reported by HASL range between 12 to 23 aCi/m³, while Rocky Flats reported an average of 37 aCi/m³.

6.2.2 INHALATION DOSES DUE TO ON-SITE CONTAMINATION

An assessment can be made of the doses received through inhalation by individuals residing off-site at the time the measurements were made, based upon the considerable amount of air monitoring data available for the Rocky Flats Plant. In carrying out this assessment; a deliberate effort has been made to choose assumptions which are most likely to result in an overestimate of dose. These are:

- 1) Inhaled plutonium is considered to be in an insoluble form. (chemical solubility of an aerosol determines its residence time in the lung with insoluble compounds being retained the longest.)

- 2) The plutonium aerosol is assumed to have a lognormal distribution with an activity median aerodynamic diameter (AMAD) of 1 micrometer. (According to the ICRP (3) this implies that approximately 25% of the aerosol will be deposited in the pulmonary compartment of the lung. HASL (4) has reported 25% of

TABLE 6-2

PLUTONIUM IN AMBIENT AIR NEAR ROCKY FLATS PLANT (1976)
 [Air Concentration in Attocuries/Cubic Meter]
 Distances = 3 to 6 Kilometers

Station	Number of Samples Taken	Less Than Detectable	Volume (cubic meters)	Concentration	
				C maximum	C average ^a
S-31	12	1	461,547.0	0.144	<0.032 ± 96%
S-32	12	1	543,346.0	0.134	<0.035 ± 96%
S-33	12	1	531,886.0	0.097	<0.034 ± 95%
S-34	3	1	118,243.0	0.176	<0.037 ± 550%
S-35	3	0	119,322.0	0.116	0.027 ± 538%
S-36	2	0	57,286.0	0.012	0.012 ± 1734%
S-37	12	0	525,181.0	0.198	0.056 ± 93%
S-38	10	0	460,089.0	0.097	0.027 ± 108%
S-39	12	1	502,129.0	0.102	<0.026 ± 97%
S-40	12	0	486,876.0	0.198	0.054 ± 92%
S-41	12	1	472,698.0	0.136	<0.033 ± 99%
S-42	12	1	416,244.0	0.137	<0.037 ± 96%
S-43	11	1	360,818.0	0.185	<0.056 ± 105%
S-44	12	1	429,709.0	0.094	<0.029 ± 103%
Summary	137	9	5,485,374.0	0.198	-
Volume-Weighted Average					<0.037 ± 29%

a. Volume-weighted average.

the airborne activity being in the respirable range around Rocky Flats, while Sehmel (5) has reported a 20% respirable fraction.

3) The individual is considered to be exposed continuously for 10 years at the currently observed air concentration. (No further reduction in airborne activity as a result of weathering or remedial actions is assumed)

4) All plutonium was assumed to contribute to the dose, with no correction being made for ambient background levels of plutonium.

The PAID code developed by EPA (6) was used to calculate the annual dose rate. Tables 6-3 and 6-4 have been generated by the PAID code and relate years of exposure to the resultant dose rate for various organs. Values in the tables are normalized to an aerosol concentration of 1.0 femtocurie per cubic meter of air (fCi/m^3) with a $1 \mu\text{m}$ AMAD.

6.2.3 INDIANA STREET LOCATION

Indiana Street is the nearest location to the Rocky Flats Plant where an individual in the general population could live and be exposed as a result of transuranium contamination originating from the Plant. This location is in the downwind direction of the prevailing winds that blow across the Rocky Flats Plant (7) and, therefore, it represents a worst case for offsite exposure.

From Figure 6-2 it can be seen that stations 5-35, 5-36, 5-37, 5-38, and 5-39 are located along Indiana Street. The station reporting the highest annual average for 1975 was 5-37 with $0.056 \text{ fCi}/\text{m}^3$ (Table 6-2). Assuming this level to continue for the next 70 years, the 70th year dose rates to lung and bone can be calculated.

TABLE 6-3

ANNUAL DOSE RATE TO VARIOUS LUNG COMPARTMENTS
FROM CHRONIC EXPOSURE TO PLUTONIUM-239 AEROSOLS

Concentration: 1.0 fci/m³ Particle AMAD: 0.05, 1.0 and 5.0 Microns

Duration of Exposure (Years)	Pulmonary mrad/yr. x 10 ⁻¹			Tracheobronchial mrad/yr. x 10 ⁻²			Nasopharyngeal mrad/yr. x 10 ⁻⁶		
	0.05u	1.0u	5.0u	0.05u	1.0u	5.0u	0.05u	1.0u	5.0u
1	3.9	1.5	.7	2.7	1.1	6.1	.04	11.	30.
5	9.1	3.5	1.7	3.7	1.5	7.9	.04	11.	30.
10	9.8	3.8	1.8	3.8	1.6	8.1	.04	11.	30.
70	9.9	3.8	1.8	3.8	1.6	8.1	.04	11.	30.

TABLE 6-4

ANNUAL DOSE RATES TO VARIOUS ORGANS
FROM CHRONIC INHALATION OF TRANSURANIUM RADIONUCLIDES
(In Millirad/Year)

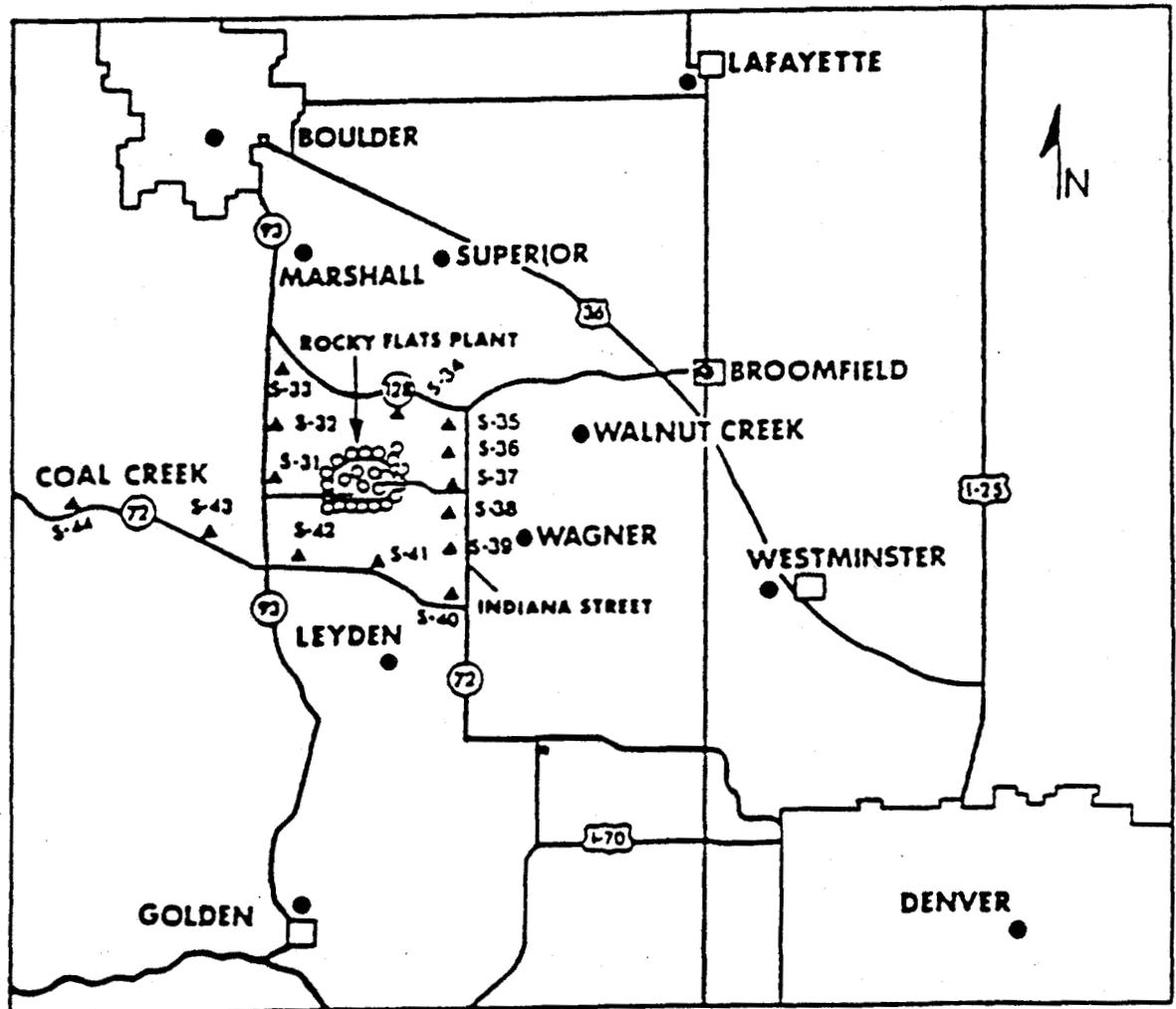
Aerosol AMAD: 1 μ m Concentration: 1 fci/m³ $f_1 = 10^{-3}$

Duration of EXPOSURE	Nuclide: Pu-239				Nuclide: Pu-241/Am-241*			
	LIVER	Skeletal	Bone Red_Marrow	Endosteal	Liver	Skeletal	Bone Red_Marrow	Endosteal
1 Year	1.0 E-3	5.0 E-4	4.8 E-4	6.6 E-3	1.4 E-6	5.0 E-7	4.6 E-7	5.8 E-6
5 Years	1.8 E-2	6.5 E-3	6.3 E-3	8.6 E-2	8.7 E-5	3.2 E-5	3.0 E-5	3.7 E-4
10 Years	3.2 E-2	1.9 E-2	1.8 E-2	2.5 E-1	4.6 E-4	1.7 E-4	1.6 E-4	2.0 E-3
15 Years	6.9 E-2	3.4 E-2	3.2 E-2	4.5 E-1	1.1 E-3	4.1 E-4	1.6 E-4	2.0 E-3
20 Years	1.3 E-1	4.9 E-2	4.7 E-2	6.5 E-1	1.8 E-3	7.1 E-4	6.6 E-4	4.8 E-3
30 Years	1.9 E-1	7.8 E-2	7.4 E-2	1.0 E-0	3.4 E-3	1.4 E-3	1.3 E-3	1.6 E-2
40 Years	2.4 E-1	1.1 E-1	1.1 E-1	1.5 E-0	5.0 E-3	2.2 E-3	2.0 E-3	2.6 E-2
50 Years	2.9 E-1	1.3 E-1	1.2 E-1	1.7 E-0	6.4 E-3	3.0 E-3	2.8 E-3	3.5 E-2
70 Years	3.6 E-1	1.7 E-1	1.6 E-1	2.3 E-0	8.0 E-3	4.4 E-3	4.1 E-3	5.1 E-2

Duration of EXPOSURE	Nuclide: Am-241				Nuclide: Cm-244/Pu-240			
	LIVER	Skeletal	Bone Red_Marrow	Endosteal	Liver	Skeletal	Bone Red_Marrow	Endosteal
1 Year	1.5 E-3	5.0 E-4	4.6 E-4	5.8 E-3	1.6 E-3	6.0 E-4	5.6 E-4	6.4 E-3
5 Years	1.9 E-2	7.0 E-3	6.3 E-3	8.1 E-2	1.8 E-2	1.6 E-2	1.5 E-2	1.7 E-2
10 Years	3.5 E-2	2.1 E-2	1.9 E-2	2.4 E-1	4.7 E-2	1.7 E-2	1.6 E-2	1.8 E-1
15 Years	9.5 E-2	3.6 E-2	3.3 E-2	4.2 E-1	7.3 E-2	2.8 E-2	2.6 E-2	3.0 E-1
20 Years	1.3 E-1	5.2 E-2	4.8 E-2	6.0 E-1	9.4 E-2	3.7 E-2	3.4 E-2	3.9 E-1
30 Years	2.0 E-1	8.2 E-2	7.5 E-2	9.5 E-1	1.3 E-1	4.9 E-2	4.5 E-2	5.2 E-1
40 Years	2.6 E-1	1.1 E-1	1.0 E-1	1.3 E-0	1.4 E-1	5.7 E-2	5.3 E-2	6.1 E-1
50 Years	3.0 E-1	1.4 E-1	1.3 E-1	1.6 E-0	1.5 E-1	6.3 E-2	5.8 E-2	6.7 E-1
70 Years	3.7 E-1	1.8 E-1	1.7 E-1	2.1 E-0	1.6 E-1	6.8 E-2	6.3 E-2	7.3 E-1

*Alpha dose only - 70th year bone dose rates: liver = 0.11 urad; bone = 0.049 urad.

LOCATION OF OFF-SITE AMBIENT AIR SAMPLERS (8).



LEGEND

- ON-SITE AIR SAMPLERS
- ▲ AIR SAMPLERS, 3 TO 6 KILOMETERS (2 TO 4 MILES) DISTANCE
- COMMUNITY AIR SAMPLERS

FIGURE 6-2

As shown in Table 6-3, an air concentration of 1.0 fCi/m^3 for $1 \mu\text{m}$ AMAD aerosols of Pu-239 would produce a 70th year dose rate to the pulmonary compartment of 0.38 mrad/yr ; therefore, proportionally, a concentration of 0.056 fCi/m^2 (5-37) will produce a 70th yr dose rate of 0.02 mrad/yr . The bone dose rate associated with this level of Pu-239 according to Table 6-4 will be 0.009 mrad/yr in the 70th year.

Data on the air concentration of Am-241 have been reported by HASL (7) for the years 1970 through 1974. These data show the americium levels, measured at the perimeter fence of the Plant, to be approximately 11% of the Pu-239 levels. HASL projected that the Am-241 activity level will reach its maximum value arising from the decay of Pu-241 in the year 2033 at which time it will amount to 18% of the Pu-239 activity. For the calculation of the dose rate from Am-241, it is assumed that Am-241 is at the maximum of 18% of the Pu-239. The 70th year dose rate corresponding to a concentration of 1 fCi/m^3 of Am-241 is 0.4 mrad/yr ; proportionally, an air concentration of $0.18 \times 0.056 \text{ fCi/m}^3$ would produce 0.004 mrad/yr to the pulmonary compartment. The associated bone dose would be approximately 0.002 mrad/yr .

Based upon these calculations, the total pulmonary dose rate after 70 years of exposure for an individual living along Indiana Street would be 0.024 mrad/yr , while the associated bone dose would be 0.01 mrad/yr . Individuals living further away from the Rocky Flats Plant should receive even lower doses than these due to the lower air concentrations reported for the nearby communities.

6.2.4 INHALATION DOSES DUE TO OFF-SITE CONTAMINATION

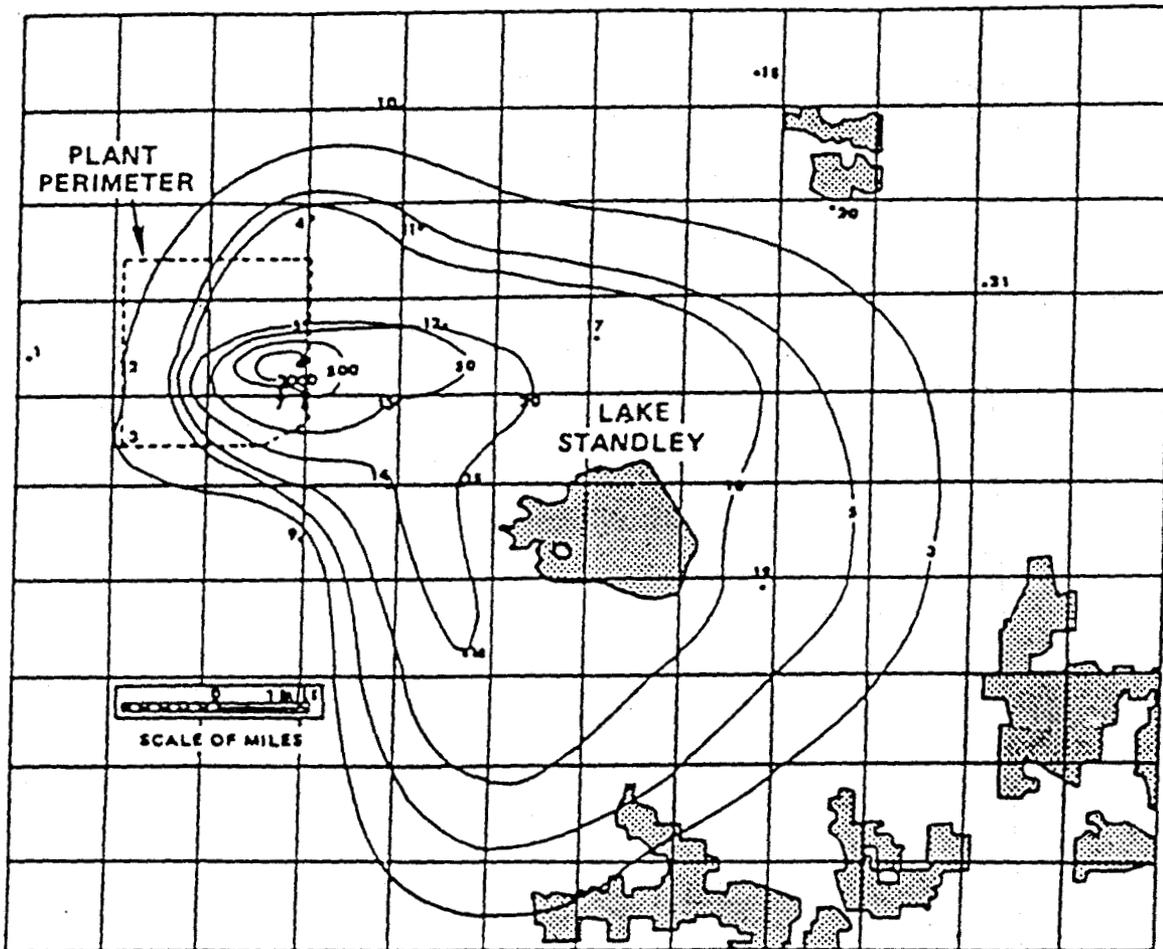
A complete assessment of the inhalation pathway for the Rocky Flats vicinity must consider the potential hazard from the low levels of contaminated soil which already exist off-site.

Questions have been raised as to the effect of this material in producing localized exposures which are not necessarily reflected in the data obtained through the air monitoring network around Rocky Flats. These inhalation exposures can arise through various mechanisms including: wind resuspension of contaminated soil, vehicular and mechanical disturbances of soil, accumulation and resuspension of dust within the home, as well as the resuspension of contaminated soil attached to clothing. The following analysis will attempt to investigate these exposure mechanisms and assess their potential impact.

6.2.5 WIND RESUSPENSION

Figure 6-3 shows the off-site soil contamination contours reported by HASL in 1970 (2). Soil sampling programs in 1975 (8) showed that these contours had not changed significantly from the 1970 report. The highest off-site contour shown by the HASL data was 0.05 uCi/m^2 . These contours were developed based upon an inventory sample to a depth of 20 centimeters. What is important in assessing the resuspension of soil, however, is only the material existing near the surface. Based upon the HASL soil depth profiles, Anspaugh (9) stated that approximately 20% of the total activity is contained within the first centimeter. Therefore, the highest contour value of 0.05 uCi/m^2 would correspond to 0.01 uCi/m^2 when corrected for a 1 cm. depth. On a mass basis, 0.01 uCi/m^2 is equivalent to approximately 2 disintegrations per minute per gram of soil, i.e., 2 DPM/gm. The offsite area bounded by this contour is approximately two square kilometers and soil within that area would be projected to be at or above 2 DPM/gm. Beyond this area, off-site soil will generally be below this value.

This review uses the mass loading approach as an indicator of the general resuspension by wind over large land areas. Because of technical shortcomings identified with the mass



ROCKY FLATS
 PLUTONIUM-239 CONTOURS mCi/km²

FIGURE 6-3

loading approach (10), the concept has been modified by an area correction factor to correct for small areas of contamination and with an enrichment factor to reflect a nonuniform distribution of radioactivity with soil particle size. This latter modification is particularly important because transuranium activity associated with soil particles within the respirable range is a greater hazard than it would be if associated with the larger particle sizes.

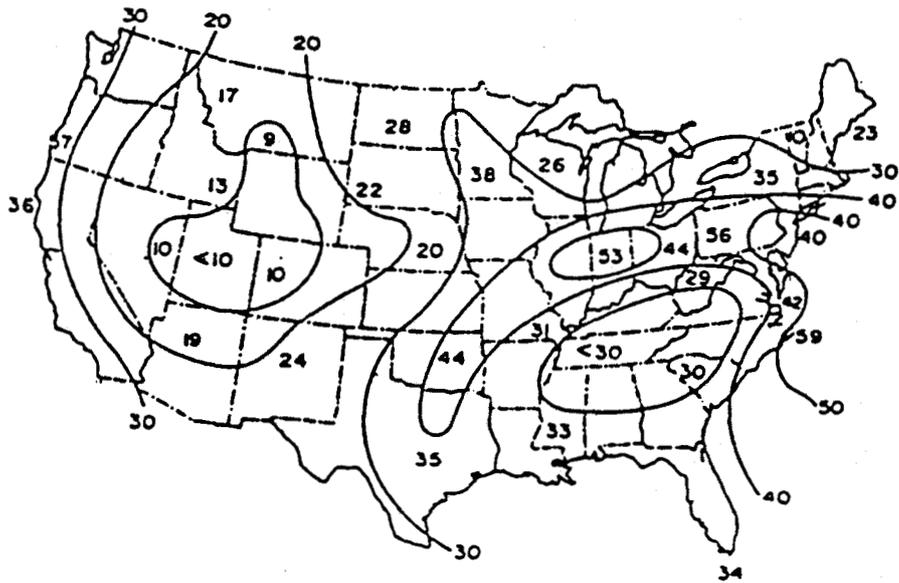
The mass loading approach assumes the loading of the air with particulates to be an index of resuspension and derives the airborne concentration of a specific radionuclide by a comparison with its concentration on the adjacent surface (11). Specifically,

$$\text{Air Concentration (fCi/m}^3\text{)} = \frac{\text{Soil Concentration (uCi/m}^2\text{)}}{\text{x Mass Loading (ug/m}^3\text{)} \text{ x U.C.}}$$

where U.C. is the units conversion factor based upon the depth of sampling and the soil density.

Airborne particulate mass loading is one of the criteria for clean air standards and measurements are widely available for urban and nonurban locations through the National Air Surveillance Network (NASN). The data recorded at nonurban stations are a better indicator of the levels of resuspended material than are urban measurements. In general, annual mean mass concentrations of airborne particulate material at the nonurban stations range from 5-50 micrograms per cubic meter (Figure 6-4); the mean arithmetic average for 1966 of all 30 nonurban NASN stations was 38 ug/m³ (11). From Figure 6-4 an estimate can be made of the average mass loading for the general area in which Rocky Flats is located. It would appear that 15 ug/m is reasonably representative of this area on an annual basis.

Simple application of the mass loading approach without consideration of the activity distribution as a function of



ANNUAL MEAN MASS CONCENTRATIONS ($\mu\text{g}/\text{m}^3$) OF AIRBORNE PARTICLES FROM NON-URBAN STATIONS OF THE U.S. NATIONAL AIR SAMPLING NETWORK. 1964 - 1965

FIGURE 6-4

particle size is not appropriate, however, since that would imply a uniform distribution of activity with particle size as well as a uniform resuspension of all particle sizes. This has not been found to be the case at Rocky Flats (12) or at other plutonium contaminated sites (13).

In addition, an important consideration in assessing the potential exposure due to contaminated soil is the amount of activity associated with particles within the respirable size range. Johnson (14) has suggested that sampling of only those particles in a soil sample which are within the inhalable size range (generally $< 10 \mu\text{m}$) would give the best measure of risk to the public health around Rocky Flats. However, the weight fraction of particles in the less than $10 \mu\text{m}$ range is small in most soils, and sampling, separation, and analysis techniques are correspondingly more difficult and inaccurate. There is also considerable evidence that some of the larger particles really consist of aggregates and are relatively easily broken down into smaller ones, so that an instantaneous measurement of a single size range may not give a good picture of long-term trends. Also a substantial contribution to other possible pathways (e.g. ingestion) may be via larger particle sizes and measurement of the contribution of only the inhalable fraction would not provide all the information that is required.

6.2.5.1 ENRICHMENT FACTOR

The "Enrichment Factor" is intended to 1) give a mathematical view of the different fractions of the total radioactivity associated with particles of different size ranges, and 2) address the problem of the nonuniform resuspension of particle sizes.

The inhalable fraction of the soil is weighted by considering the relative distribution of activity and soil mass

as a function of particle size for representative samples of soil. To accomplish this, the sample of contaminated soil is segregated into "n" size increments and the activity and mass contained within each size increment is determined. The factor g_i is then defined as the ratio of the fraction of the total activity contained within an increment "i" to the fraction of the total mass contained within that increment. A value greater than 1 for g_i implies an enrichment of activity in relation to mass, while a value less than 1 indicates a dilution of the activity with respect to mass.

The nonuniform resuspension of particle sizes is also considered by measuring the mass loading as a function of particle size. The fraction of the airborne mass contained within each size increment "i" is then calculated and designated as f_i . The factors of f_i and g_i are then incorporated into the mass loading formulation for each size increment as follows:

$$\text{Air Conc}_i = \text{Air Mass Loading} \times f_i \times \text{Soil Conc} \times g_i$$

Summation over all the size increments results in the total air concentration:

$$\text{Air Conc} = \text{Air Mass Loading} \times \text{Soil Conc} \times \sum f_i g_i$$

The term $\sum f_i g_i$ weights the contribution of plutonium from each soil size fraction to the total resuspended material, thereby taking into account both the nonuniform resuspension of particles sizes as well as the nonhomogeneous distribution of activity with particle size.

Data on the distribution of plutonium with soil particle size has been obtained (12) for the vicinity around Rocky Flats (Table 6-5). The ratio, g_i has been calculated for each size increment and indicates an enrichment of activity to mass associated with soil particles within the respirable size range. To obtain f_i , the data obtained by Chepil (15) for fields

TABLE 6-5

EXPERIMENTAL DATA FOR WEIGHT AND ACTIVITY FRACTIONS
 FOR SOILS IN THE ENVIRONS OF THE ROCKY FLATS PLANT
 [Sampling and Analysis by US Environmental Protection Agency]

Sample	Size Increment (μ m)	Wgt. Fract	Act. Fract	$\frac{B_1}{f_1}$	$\frac{f_1}{f_1}$	$\frac{f_1}{f_1}$
RF 1A	2000-105	.62	.07	.12	-	
	105-10	.18	.40	2.21	.7	
	<10	.20	.53	2.65	.3	2.34
RF 1B	2000-105	.63	.39	.63	-	
	105-10	.17	.06	.34	.7	
	<10	.20	.55	2.74	.3	1.06
RF 1C	2000-105	.64	.43	.68	-	
	105-10	.16	.07	.46	.7	
	<10	.20	.49	2.47	.3	1.06
RF 2A	2000-105	.46	.13	.28	-	
	105-10	.34	.37	1.10	.7	
	<10	.20	.50	2.48	.3	1.51
					av.	1.49

undergoing wind erosion in Colorado and Kansas were used. The results of his findings have been conveniently plotted by Slinn (16) and reproduced as Figure 6-5. Comparison of Chepil's data with another study substantiates the applicability to the Rocky Flats situation. Chepil found 30% of the airborne mass to be below 10 μm versus a study by Willeke (17) in an area outside Denver where approximately 33% of the measured airborne mass was below 10 μm . Values for f_1 used in this analysis are included in Table 6-5.

6.2.5.2 CORRECTION FOR AREA SIZE

Use of the mass loading approach implies that the air concentration is at equilibrium with the ground surface, i.e., a steady state situation exists in which the amount of material coming up from the surface is balanced by the rate at which material is depositing back onto the surface. In the strictest sense this limit can only be achieved for source areas approaching infinite dimensions. For sources of finite dimensions, a correction must be applied for area size.

Although many techniques are presently under development to calculate the air concentration arising from an area source, no generally accepted method has yet been identified. Usually, these approaches make use of a standard diffusion equation, modified to handle area sources. One such equation is the Sutton-Chamberlain diffusion equation:

$$\frac{X}{Q_A} = \frac{1}{V_d} \left[\exp\left(-\frac{4 V_d D_1^{N_2}}{\pi^{1/2} C_2 n u}\right) - \exp\left(-\frac{4 V_d D_2^{N_2}}{\pi^{1/2} C_2 n u}\right) \right]$$

where X is the air concentration, Ci/m

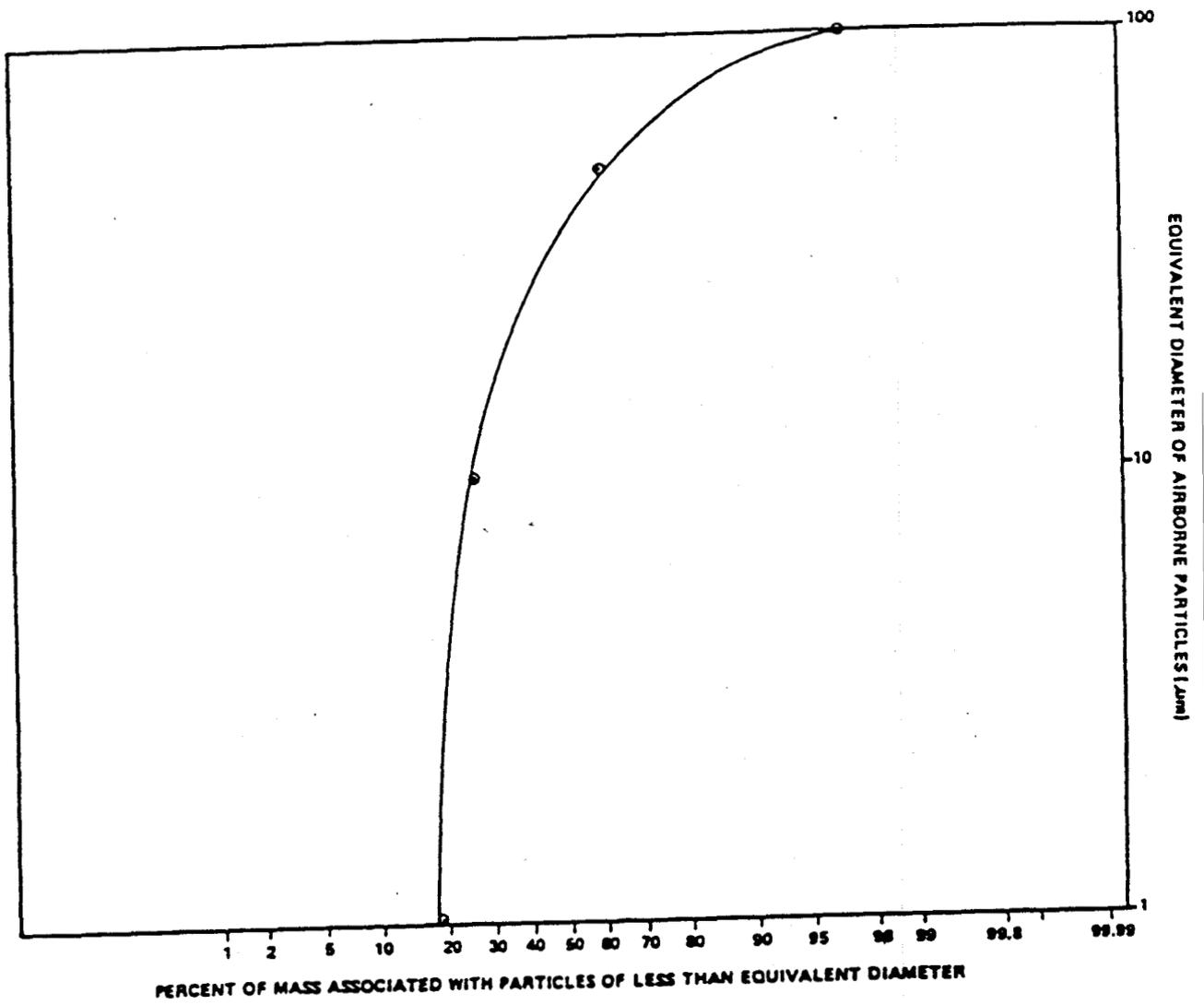
Q is the amount of activity resuspended per unit area, per unit time, $\text{Ci}/\text{m}^2 \text{ sec}$

V_d is the particle deposition velocity, m/sec

D_1 and D_2 are the distances from the receptor to the nearest and furthest edges respectively of the source area

u is average wind speed, m/sec

C_2 and n are Sutton parameters for meteorological conditions.



PERCENT OF MASS ASSOCIATED WITH PARTICLES OF LESS THAN EQUIVALENT DIAMETER
 PARTICLE SIZE DISTRIBUTION OF RESUSPENDED SOIL

FIGURE 6-5

For source areas approaching infinite depth, $D_2 \rightarrow \infty$ and the above equation becomes

$$\frac{X}{Q_A} = \frac{1}{V_d}$$

Therefore, the correction term to be applied for areas of finite size is

$$1 - \exp\left(-\frac{4 V_d D_2^{n/2}}{\pi^{1/2} C_2 n u}\right)$$

The area under consideration in this analysis has been described earlier. It is bounded by Indiana Street and the 0.05 Ci/m² isopleth (Figure 6-3) with a width in the downwind direction of approximately 1 kilometer. This is the most highly contaminated off-site area and includes sites of projected residential development. The meteorology for the Rocky Flats area has been described (8) to have neutral stability at least 50% of the time with a mean wind speed of 4.2 m/sec in 1975. Healy (18) has suggested values for the parameters required for the situation of neutral stability: $C_2 = 0.1$ and $n = 0.25$, while the ratio V_d/u , which depends upon the surface roughness, ranges between 0.003 and 0.008 for grassland. A value of 0.005 will be assumed. Therefore, the correction factor for the area under consideration is 0.66.

6.2.6 AVERAGE AIR CONCENTRATION DUE TO WIND RESUSPENSION

The average soil concentration for the area is not known, but it would be somewhere between 0.05 uCi/m² and the next higher isopleth of 0.5 uCi/m². For calculational purposes, 0.25 uCi/m² will be assumed or approximately 10 DPM/g (based upon 20% of the radioactivity within the first centimeter). By using the parameters developed in the previous sections for the Rocky Flats

area, one can estimate the average air concentration due to wind resuspension:

$$\text{Air Conc} = \text{Mass Loading} \times \text{Soil Conc} \times \text{Enrichment Factor} \\ \times \text{Area Correction Factor}$$

$$\text{Air Concentration} = 15 \text{ ug/m}^3 \times 10 \text{ DPM/g} \times 10^{-6} \text{ g/ug} \\ \times \text{Ci}/2.22 \times 10^{12} \text{ DPM} \\ = 0.066 \text{ fCi/m}^3$$

This calculated value of 0.066 fCi/m agrees within a factor of 2 with the data obtained for the sampling stations along Indiana Street.

Inherent in the above calculation were some conservative assumptions. First of all, the wind was assumed to be blowing 100% of the time across the contaminated area in the direction of the receptor. In reality, the reported (8) wind rose for Rocky Flats indicates that the wind blows from the westerly direction only about 50% of the time; the remaining time it will be blowing from the direction of less contaminated land and, therefore, less radioactivity would be available for resuspension. Second, in deriving the area correction factor the effect of breathing height was ignored with the ground level concentration being calculated. This is a conservative assumption since the airborne concentration will decrease as a function of the height above the ground. Although such refinements may be incorporated in the calculation, the results represent a conservative approach to deriving the dose rates to potentially exposed persons.

6.2.7 RESUSPENSION OF SOIL BY MECHANICAL DISTURBANCES

The use of land contaminated with transuranium elements in the vicinity of Rocky Flats for agricultural or building purposes can result in localized resuspension and presents a potential inhalation hazard to individuals in the immediate vicinity of the

operation. In the vicinity of Rocky Flats, there is some farming of wheat and the raising of corn for livestock feed. Future development of the land for residential purposes is also being advocated. Although only a limited amount of experimental data are currently available to base an assessment of the inhalation hazard from such activities, some conclusions and recommendations can be made.

In assessing the agricultural situation, data obtained by Milham (19) have been utilized. In that study, a field contaminated with plutonium near the Savannah River Facility was subjected to various plowing and seeding activities associated with planting wheat. The increase in the airborne activity above that from normal wind resuspension was monitored at the location of the tractor operator and at the downwind edge of the field during the various activities. An average increase of a factor of 30 was observed in the level of resuspended plutonium at the location of the tractor operator and an increase of a factor of 5 at the edge of the field. Based upon these observations, the average air concentration for the year can be calculated for these two locations, assuming that the field is cultivated 30 days of the year for 8 hours per day. Again the area under consideration will be that area of highest off-site contamination described earlier with an average soil contamination level of 10 DPM/g. In the previous discussion of wind resuspension, this level of soil activity produced an air concentration of 0.066 fCi/m³. From Milham's data, this activity level would increase to 2.0 fCi/m³ at the location of the tractor operator and to 0.33 fCi/m³ at the edge of the field during the agricultural operations. The annual average concentration at the tractor location is then:

$$2 \text{ fCi/m}^3 \times 8/24 \text{ hr} \times 30/360 \text{ d} + 0.33 \text{ fCi/m}^3 \times 330/360 \text{ d} \\ + 0.066 \text{ fCi/m}^3 \times 16/24 \text{ hr} \times 30/360 \text{ d} = 0.07 \text{ fCi/m}^3$$

When these annual Pu-239 concentrations are compared to the value of 2.6 fCi/m³ which was calculated by the PAID code to correspond with a dose rate of 1 mrad/year to the lung, one can conclude that agricultural operations in the area of Rocky Flats would produce activity levels well below levels of concern. In addition, after the first plowing cycle, the surface concentration should be diluted by mixing with soil from below the surface and subsequent plowings would produce air concentration lower than that of the first year.

One can also make projections for building activities based upon the agricultural situation examined above. There does not appear to be any reason why building activities, such as excavation and grading, should produce higher instantaneous air concentrations than those observed during agricultural plowing and, therefore, should not present a more restrictive situation.

6.2.8 RESUSPENSION OF DUST WITHIN THE HOME

The total amount of soil continuously in the home is not known but an assumption of 10 g/m³ has been made (20). This amounts to about 3 lbs of soil in a modest 1500 square foot house. Because the floors are harder and smoother than outside surfaces, the resuspension from these surfaces will be higher. Resuspension factors of 10⁻⁶/m have been used in the past to predict exposures in the work place and studies of PuO₂ deposited on indoor surfaces have been consistent with such a value (21).

The following exposure situation is postulated: the individual is exposed to contaminated dust in the home for 24 hrs/day, 7 days/week, for 70 years. The dust in the home has the same activity/gram as outside soil and has an areal distribution within the home of 10 g/m². The air concentration resulting from resuspended dust at 10 DPM/g would be:

$$10 \text{ DPM/g} \times \text{Ci}/2.22 \times 10^{12} \text{ DPM} \times 10 \text{ g/m}^2 \times 10^{-6} / \text{m} = 0.045 \text{ fCi/m}^3$$

ATTACHMENT F

ESTIMATING AIRBORNE CONCENTRATIONS
OF VOLATILE AND SEMIVOLATILE ORGANIC
COMPOUNDS FROM GROUNDWATER

1. Raoult's Law was used to calculate the maximum airborne concentration of the nine nonradioactive compounds found in groundwater at concentrations greater than potential chemical-specific applicable or relevant and appropriate requirements (ARARs) (extracted from Table 2-12, Phase II RFI/RIFS Work Plan (Alluvial)).

Raoult's Law

$$\text{Mole Fraction} = \frac{\frac{\text{Mass}}{\text{MW}_c}}{\left[\left(\frac{\text{Mass}}{\text{MW}_c} \right) + \left(\frac{1 - \text{Mass}}{\text{MW}_w} \right) \right]}$$

Mass (in grams)	=	(mg/l of contaminant)(1 x 10 ⁻⁶)
MW _c	=	molecular weight of contaminant
MW _w	=	molecular weight of water
p (mmHg)	=	(V _c)(mole fraction)
V _c	=	Vapor pressure of contaminant at temperature of fluids in question

$$\text{ppm of contaminant in air above fluid surface} = \left(\frac{P}{P_a} \right) (1 \times 10^6)$$

P_a = air pressure in mmHg

2. Example Problem

Given:

$$\begin{aligned} & \cdot \quad 1100 \mu\text{g/l of carbon tetrachloride, therefore Mass} = (1100 \times 10^{-3} \text{ mg/l})(1 \times 10^{-6}) \\ & \quad = 1.1 \times 10^{-6} \text{ gm/gm} \end{aligned}$$

- $MW_c = 153.8$
- $MW_w = 18$
- $V_c = 91 \text{ mmHg at } 20^\circ \text{ C}$
- $P_a = 700 \text{ mmHg}$

$$\text{Mole Fraction} = \frac{\left(\frac{1.1 \times 10^{-6}}{153.8} \right)}{\left(\frac{1.1 \times 10^{-6}}{153.8} \right) + \left(\frac{1 - 1.1 \times 10^{-6}}{18} \right)} = 1.287388 \times 10^{-7}$$

$$P = (91)(1.287388 \times 10^{-7}) = 1.1715123 \times 10^{-5}$$

$$\text{ppm} = \left(\frac{1.1715123 \times 10^{-5}}{700} \right) (1 \times 10^6) = 1.673604 \times 10^{-2} = 0.017 \text{ ppm of } \text{C}$$

Carbon tetrachloride

3. The following compounds (extracted from Table 2-12, Phase II RFI/RI Work Plan (Alluvial)) have been found in groundwater at concentrations greater than potential chemical-specific ARARs. The estimated airborne concentration is based upon Raoult's Law, and the 8-hour time-weighted average (TWA) permissible exposure limits (PELs) have been drawn from Occupational Safety and Health Administration's 1989 amended PELs.

Compound	Maximum Concentration In Groundwater $\mu\text{g}/\ell$	Estimated Airborne Concentration (ppm)	8-hr TWA PEL (ppm)
Carbon Tetrachloride (CAS-56-23-25)	1,100	0.034	2
Vinyl Chloride (CAS 75-01-4)	520	0.55	1
1,1-Dichloroethane (CAS 75-34-3)	59	0.0028	100
Chloroform (CAS 67-66-3)	330	0.011	2

Compound	Maximum Concentration In Groundwater $\mu\text{g}/\text{l}$	Estimated Airborne Concentration (ppm)	8-hr TWA PEL (ppm)
1,1-Dichloroethene (synonym: Vinylidene Chloride) (CAS 75-35-4)	32	0.004	1
Tetrachloroethene (synonym: Perchloroethylene) (CAS 127-18-4)	33,000	0.072	25
1,1,1-Trichloroethane (synonym: Methyl Chloroform) (CAS 71-55-6)	63	0.0012	350
1,1,2,2-Tetrachloroethane (CAS 79-34-5)	45,000	0.04	1
Trichloroethene (synonym: Trichloroethylene) (CAS 79-01-6)	49,000	0.56	50

4. Nonradioactive Organic Substances that have been found in soils within OU2.

The following is a summary of organic substances found in soils. No attempt has been made to estimate airborne concentrations that might be generated by these substances. An organic vapor meter (OVM) will be used during all intrusive activities to detect airborne concentrations of these substances; action levels have been established.

4.1 903 Pad (IHSS No. 112) and 903 Pad Lip Site (IHSS No. 155) Excluding IHSS Sites Within the 902 Pad Lip site

Soils from beneath the 903 Pad and Lip Site have not been analyzed for nonradioactive contamination.

4.2 Trench T-2 (IHSS No. 109), Reactive Metal Destruction Site (IHSS No. 110), and the Gas Detoxification Site (IHSS No. 183)

Compound	Concentration in Soil ($\mu\text{g}/\text{kg}$)
Trichloroethene (synonym: Trichloroethylene) (CAS 79-01-6)	17,000
Tetrachloroethene (synonym: Perchloroethylene) (CAS 127-18-4)	10,000
1,1,1-Trichloroethane (synonym: Methyl Chloroform) (CAS 71-55-6)	250

bis (2 ethylhexyl) phthalate (synonym: Di (2 ethylhexyl) phthalate) (CAS 117-81-7)	3,400
Ethyl Benzene (CAS 100-41-4)	780
Total Xylenes (CAS 1330-20-7)	3,300
Carbon Disulfide (CAS 75-15-0)	58

4.3 Mound Site (IHSS No. 113), Oil Burn Pit (IHSS No. 153), and Trench T-1 (IHSS No. 108)

Organic contaminants have not been found.

4.4 Pallet Burn Site (IHSS No. 154)

Compound	Concentration in Soil ($\mu\text{g}/\text{kg}$)
bis (2 ethylhexyl) phthalate (synonym: Di (2ethylhexyl) phthalate) (CAS 117-81-7)	580
Acetone (CAS 67-64-1)	170
Tetrachloroethene (synonym: Perchloroethylene) (CAS 127-18-4)	20

4.5 Trenches North of Central Ave.; Trench T-3 (IHSS No. 110), Trench T-4 (IHSS No. 111.1), Trench T-10 (IHSS No. 111.7), and Trench 11 (No. 111.8)

Compound	Concentration in Soil ($\mu\text{g}/\text{kg}$)
1,1,1-Trichloroethane (synonym: Methyl Chloroform) (CAS 71-55-6)	190
Nitrosodiphenylamine (synonym: Diphenylnitrosamine) (CAS 86-30-6)	100

- 4.6 Trenches and East Spray Fields South of Central Avenue; Trench T-5 (IHSS No. 111.2), Trench T-6 (IHSS No. 111.3), Trench T-7 (IHSS No. 111.4), Trench T-8 (IHSS No. 111.5), and Trench T-9 (IHSS No. 111.6)

Compound	Concentration in Soil ($\mu\text{g}/\text{kg}$)
1,2-Dichloroethane (synonym: Ethylene Dichloride) (CAS 107-06-2)	100
Trichloroethene (synonym: Trichloroethylene) (CAS 79-01-6)	150
Tetrachloroethene (synonym: Perchloroethylene) (CAS 127-18-4)	62

ATTACHMENT G
MEDICAL SURVEILLANCE REQUIREMENTS

3.0 MEDICAL SURVEILLANCE

Medical surveillance is a major component of the WC health and safety program. It was established to monitor and promote the health of employees engaged in projects which have the potential for exposure to hazardous substances.

Medical surveillance provides a clinical base of information useful in evaluating employee's fitness to work at hazardous waste sites, to identify anomalies in a person's medical history that may be related to potential impaired health, to evaluate a person's capability to use respiratory protection equipment, and to identify illnesses that may be related to chemical exposure while on the job. This base of medical information includes personnel health history, exposure history, physical examination results, laboratory analyses, and results of screening and special tests. Medical examinations include:

- o Past Medical History - on entry to the program, information concerning past occupational exposures and personal as well as family history of disease.
- o Present Medical Profile - all pertinent medical information regarding present state of health and during each year of field work in hazardous material projects.
- o Exposure History - information concerning the cumulative duration of time spent on potentially hazardous sites, the primary toxic substances, and the levels of protection employed by each site.
- o Laboratory Analyses - hematology, liver and kidney function tests, and urinalysis.

- o Hearing test.
- o Vision test.
- o Pulmonary function test.
- o Electrocardiogram.
- o X-ray.
- o Physical examination.
- o Special Tests - medical information concerning the effects of exposure to specific contaminants.

3.1 OBJECTIVES

The objectives of the medical surveillance component of the health and safety program are:

- o Protect the health of employees assigned to work on hazardous material projects.
- o Pre-assignment screening of employee's health to determine present status and to identify existing problems that may be aggravated by chemical exposures or physical stress.
- o Monitoring employee health for early signs of work-related illness and employee suitability for further field or laboratory assignments on sites containing potentially hazardous substances.

- o Evaluation and care of individuals with work-related illnesses or injuries.
- o Satisfy the requirements of OSHA Part 1910.134 regarding respiratory protection and OSHA 1910.120 for hazardous waste workers.

3.2 RESPONSIBILITIES OF WC OPERATING UNITS

Each operating unit, through its HSO, must comply with the medical surveillance provisions of the health and safety program. It is the responsibility of the operating unit manager to assure that the following activities are punctually and thoroughly conducted.

- o Arrange for health monitoring services by a qualified local physician or medical organization, preferably with occupational health expertise. The physician must be willing to perform all physician-related tasks described in the WC medical surveillance program.
- o Identify personnel within the operating unit required to enter the program.
- o Inform participants of the specific arrangements for scheduling and receiving medical examinations.
- o Comply with the examining and/or the reviewing physician's recommendations regarding work restrictions and attending to all work-related illnesses.
- o Document and report work/exposure histories for all employees engaged in field activities.

3.3 REQUIREMENTS

Under Part 1910.120, OSHA requires medical surveillance for personnel involved in hazardous waste operations. OSHA states that persons should not be assigned to tasks unless it has been determined that they are physically able to perform the work and use the equipment.

The OSHA program has two essential components: routine health care and emergency treatment. Routine health care and maintenance shall consist of at least:

1. Pre-employment medical examinations to establish the individual's state of health, baseline physiological data, and ability to wear personal protective equipment. The frequency and type of examination to be conducted thereafter should be determined by medical personnel knowledgeable in the area of occupational medicine.
2. Arrangements to provide special medical examinations, care, and counseling in case of known or suspected exposures to toxic substances. Any special tests performed depend on the chemical substance in which the individual has been exposed.

The site safety plan must address emergency medical care and treatment of personnel, including possible exposures to toxic substances and injuries due to physical hazards. The following items should be considered in emergency care provisions.

- o The name, address, and telephone number of the nearest medical treatment facility should be conspicuously posted. A map and/or directions for locating the

facility, plus the travel time, should be readily available.

- o The facility's ability to provide care and treatment of personnel exposed or suspected of being exposed to toxic (or otherwise hazardous) substances should be ascertained. If the facility lacks toxicological capability, arrangements should be made for consultant services.
- o All administration arrangements for accepting patients should be made in advance with the facility.
- o Arrangements should be made to quickly obtain ambulance, emergency, fire, and police services. Telephone numbers and procedures for obtaining these services should be conspicuously posted.
- o Emergency showers, eye wash fountains, and first aid equipment should be readily available on-site. Personnel should have first aid and medical emergency training.
- o Provisions should be made for rapid identification of the substance to which the worker has been exposed (if this has not previously been done). This information must be provided to medical personnel.

3.4 MEDICAL EXAMINATIONS

3.4.1 INITIAL BASELINE EXAMINATION

All applicable employees shall be given a baseline examination before being assigned to work at sites containing

potentially hazardous substances. The purpose of the baseline examination is pre-assignment screening.

3.4.2 ROUTINE EXAMINATIONS

All personnel who have taken the initial baseline examination and have received clearance by the examining and/or reviewing physician to participate in field or laboratory activities shall be re-examined on an annual or biennial basis. Generally, employees with less than 100 hours of annual hazardous waste field work will have biennial examinations. Employees with greater than 100 hours hazardous waste field work will have annual examinations. The reviewing physician will have final authority in regard to examination frequency.

3.4.3 EXIT EXAMINATION

An exit examination shall be given to any employee whose employment with WC has included hazardous materials work and who has been a participant in medical surveillance. The exit examination may be waived if the most recent examination was in the past six months.

3.4.4 SPECIAL TESTING

Special testing may be required on certain projects due to the potential for exposure to specific substances. This may also be necessary where the potential for heat or cold stress exists. The need for special testing will be assessed on a project-by-project basis. Examples of special testing conditions include sites containing asbestos, arsenic, or lead where specific OSHA medical requirements for these compounds are in effect.

3.5 EXAMINATION PROTOCOLS

The protocols presented in Table 3-1 apply to baseline, annual, and exit examinations. A detailed health/work history questionnaire is provided before baseline and routine examinations. The protocols may be expanded by the reviewing or examining physician after consultation with WC.

3.6 PHYSICIAN'S REPORTS

Examining physicians will use information provided by the employee in the questionnaire, the examination results, and the results of laboratory tests to determine if any work restrictions or occupational health problems appear to be present. The examining physician will provide the results of the examination to the WC reviewing physician for final evaluation of employee suitability for work at hazardous material sites. The reviewing physician's conclusions shall supercede those of the examining physician. A physician's report on the examination will be sent directly to the employee with a separate letter stating ability to work at hazardous waste sites sent to WC.

Employer reports received by WC shall be reviewed by the HSO and kept in the Operating Unit's health and safety file. Physician recommendations regarding limitations must be followed.

3.7 EMPLOYEE MEDICAL SURVEILLANCE PROGRAM

The employee medical surveillance program (EMSP) is a computerized database which stores and processes employee medical surveillance information such as medical examination results, exposure history, training and respirator fit testing data. The purpose of EMSP is to facilitate record documentation, the reviewing physician's evaluation of the medical surveillance data,

and administration of the WC Health and Safety Program. Administrative and quality control features include: profile reports on employee eligibility for site work, medical examination scheduling reports, training requirement notices, and listing of qualified staff by operating unit and firmwide.

3.8 REVIEWING PHYSICIAN

Dr. Peter Greaney of Anaheim, California has been retained to provide medical oversight to the WC medical surveillance program. The reviewing physician receives copies of all medical questionnaires, examinations, and laboratory testing results, reviews the opinions of examining physicians, and determines an employee's fitness for work at hazardous material sites. The physician also provides advice and assistance regarding site specific medical monitoring needs and programs.

3.9 CONFIDENTIALITY

Employee medical records are confidential and available for review only by the examining and/or reviewing physicians and their medical personnel.

Each employee can obtain information on his/her health by asking the examining physician for the information at the time of, or after, an examination. The employee may also request release of records or information, and/or designate a representative, in a letter to the physician. The request must contain the full name and address of the representative and indicate the records to be released. Medical information about an employee will not be made available to anyone without authorization from the individual concerned.

3.10 FINANCIAL RESPONSIBILITY

The costs of baseline, routine, special, and exit examinations will be paid to the examining physician by WC operating units. The cost of examinations and tests that the employee voluntarily takes on recommendations by the examining or reviewing physician shall be borne by the employee unless the examinations/tests are related to the employee ability to work or to diagnose a work-related illness. The cost of the reviewing physician and the EMSP data base will be paid by Corporate Health and Safety.

TABLE 3-1

MEDICAL EXAMINATION PROTOCOL

Test	Testing Frequency			Remarks
	Baseline	Routine	Other	
1. Cardiogram	X		X	Preplacement Every 3 years for less than or equal to 40 years old. Every examina- tion for more than 40 years old.
2. Chest X-Ray	X		X	Preplacement Every 3 years for less than or equal to 40 years old. Every 2 years for more than or equal to 40 years old to less than or equal to 55 years old. Every exam for more than 55 years old.
3. Audiogram	X	X		
4. Blood Chemistry Panel	X	X		

Required:

Glucose
 Sodium
 Potassium
 Chloride
 BUN
 Creatinine
 Uric Acid
 Phosphate
 Calcium
 Cholesterol
 Triglycerides
 Total Protein
 Albumin

TABLE 3-1
(continued)

Test	Testing Frequency			Remarks
	Baseline	Routine	Other	
4. Blood Chemistry Panel Required: (continued)				
Globulin				
Total Bilirubin				
Direct Bilirubin				
Alk. Phosphatase				
G-Glutamyl Transpep.				
Transaminase, SGO				
Transaminase, SGP				
LDH				
Iron				
Optional:				
Magnesium				
Albumin/Globulin Ratio				
BUN/Creatinine Ratio				
CBC Count (Hemogram)	X	X		
WDC				
RBC				
HGB				
HCT				
MCV				
MCH				
MCHC				
Differential White Count		X		
Seg				
Band				
Lymph				
Mono				
Eosin				
Baso				
Platelets				
Platelets Count				
Reticulocyte Count				
6. Serum Iron and Total Iron Binding Capacity (TIBC)	X			

TABLE 3-1
(continued)

Test	Testing Frequency			Remarks
	Baseline	Routine	Other	
7. Urinalysis	X	X		
Appearance				
Color				
pH				
Ketones				
Direct Bilirubin				
Total Bilirubin				
Glucose				
Blood				
Urobilinogen				
L. Esterase				
WDC				
RBC				
Casts				
Mucus				
Bacteria				
Eiptherlial				
Crystals				
Yeast				
MCG/DL				
8. Morphology (Present, Absent, Unknown)	X	X		
Anisocytosid				
Poikilocytosis				
Hypochromia				
Polychromasia				
Basophilic Stippling				

TABLE 3-1
(continued)

Test	Testing Frequency			Remarks
	Baseline	Routine	Other	
9. Treadmill			X	*Only if: o Abnormal EKG (except sinus bradycardia, unless an otherwise healthy person); or o History of angina; or o History of myocardio infarction (MI); or o History of cardiac surgery.
10. Vision Test (R&L) Near-Corrected and Uncorrected Far-Corrected and Uncorrected Peripheral (Visual Field) Color Depth Perception	X	X		
11. Height and Weight	X	X		
12. Blood Pressure	X	X		
13. Pulse (resting)	X	X		
14. Temperature (oral) Fahrenheit	X	X		
15. Pulmonary Function Test	X	X		

ATTACHMENT H
WC ACCIDENT/INCIDENT FORM

OPERATING PROCEDURE NO. HS-502

502.1 INCIDENT REPORTS

All health and safety incidents that occur during field and laboratory activities associated with investigations and remediation of sites containing hazardous materials must be reported to management.

502.2 DEFINITIONS

A health and safety incident is any event listed below:

- o Illness resulting from chemical exposure or unknown causes.
- o Physical injury, including those that do not require medical attention.
- o Fire, explosions, and flashes resulting from activities performed by WCC and its subcontractors.
- o Property damage resulting from activities performed by WCC and its subcontractors.
- o Vehicular accidents occurring on-site or while travelling to and from sites.
- o Infractions of safety rules and requirements.
- o Unexpected chemical exposures (indicated by irritation of eyes, nose, throat, or skin).

502.3 REPORTING PROCEDURES

502.3.1 REPORTING FORMAT

Incident reports shall be prepared by completing Form HS-502. This form may be obtained from any WCC health and safety officer.

502.3.2 RESPONSIBLE PARTY

Reports of incidents occurring in the field shall be prepared by the site safety officer or, in the absence of the site safety officer, the supervising field engineer, witness, or injured/exposed individual.

502.3.3 FILING

A report must be submitted to the health and safety officer of the business unit to which the project manager belongs within 24 hours of each incident involving medical treatment. In turn, the health and safety officer must distribute copies of the report to the corporate health and safety administrator and the corporate health and safety officer. When an injury or illness is reported, the business unit health and safety officer must deliver a copy of the report to the individual in charge of personnel affairs so that a Worker's Compensation Insurance Report can be filed if necessary. Reports must be received by personnel within 48 hours of each qualifying incident.

/H&S2

ATTACHMENT I
EMERGENCY ALERT SIGNALS

EMERGENCY ALARMS

WARNING	SOUND	INSTRUCTIONS
FIRE ALARM	BELL	EVACUATE AREA
CIVIL DEFENSE WARNING ALARM	HIGH FREQUENCY PITCH STEADY TONE	FOLLOW PUBLIC ADDRESS INSTRUCTION & BLDG ANNOUNCEMENTS
CIVIL DEFENSE ATTACK ALARM	WAILING SIREN	FOLLOW PUBLIC ADDRESS INSTRUCTIONS
CRITICALITY ALARM	WAILING TONE	EVACUATE BLDG & ASSEMBLE IN EVACUATION AREA
GLOVEBOX OVERHEAT ALARM	WAVERING TONE	FOLLOW BLDG INSTRUCTION VENTILATION SHUTS OFF
SAM ALARM	WAVERING TONE	FOLLOW BLDG INSTRUCTIONS VENTILATION SHUTS OFF
GENERAL FIRE ALARM IN PLUTONIUM/URANIUM PROCESSING PLANT	WAVERING TONE	EVACUATE AREA

DRAFT

ATTACHMENT J

**INTERIM PLAN FOR PREVENTION OF
CONTAMINANT DISPERSION**

INTERIM PLAN FOR PREVENTION OF CONTAMINANT DISPERSION

OBJECTIVE

The objective of this Interim Plan for Prevention of Contaminant Dispersion (IPPCD) is to establish procedural requirements to mitigate potential hazards, on an interim basis, to persons located offsite as a result of contact with emissions resulting from intrusive remedial investigation activities.

SCOPE

Procedural requirements identified herein are applicable to certain intrusive actions taken at the 16 Operable Units (OUs) as part of the RFI/RI activities described in the Interagency Agreement (IAG). Intrusive activities which fall within the scope of this IPPCD are those with the potential for producing appreciable quantities of suspended particulate, primarily through mechanical actions. Intrusive activities potentially susceptible to producing appreciable quantities of suspended particulate include:

- Monitoring well and soil/rock borehole installation
- Excavations such as trenching and test-pitting using powered equipment

Additionally, heavy vehicular traffic associated with intrusive RFI/RI activities shall be considered susceptible to producing appreciable quantities of suspended particulate. By contrast, activities such as surface soil sampling with hand implements are not considered susceptible to producing appreciable quantities of suspended particulate.

Procedural requirements identified herein must be evaluated on a case-by-case basis to determine their potential impact on other IAG objectives. For example, it is possible that applying certain dispersion techniques, such as wetting, could compromise sample integrity and limit the usefulness of the data for which the sampling was intended.

The procedural requirements identified in the IPPCD shall remain in effect until the final PPCD is approved or until modifications are substantiated, approved, and documented in the Site Specific Health and Safety Plan (SSH&SP).

RESPONSIBILITY

The EG&G RFI/RI Project Manager (PM) shall be responsible for assuring that activities conducted at his/her OU are performed in accordance with the requirements identified herein.

The Remedial Projects Division (RPD) Manager will be responsible for follow-up and auditing the PM.

PROCEDURAL REQUIREMENTS

A pre-startup activity review shall be conducted by the PM and the Activity Field Supervisor to evaluate the potential for particulate emissions to create hazardous conditions. If the activity is being performed by non-EG&G personnel, the subcontractor's Activity Field Supervisor shall participate in the review.

The pre-startup activity review involving intrusive activities where there is a significant potential for producing appreciable quantities of suspended particulate shall be documented by completion of a Radiological/H&S Work Permit (HSP 6.05) and an Excavation Permit (HSP 6.01). HSP's 6.05 and 6.01 are attached.

If the review establishes that there is a significant potential for producing appreciable quantities of suspended particulates that could create hazardous conditions, the specific procedural requirements identified below shall govern the activity.

SPECIFIC REQUIREMENTS

Activities where there is a significant potential for producing appreciable quantities of suspended particulates shall not be conducted when the following conditions exist:

- Sustained wind speeds above 15 miles per hour (mph) as measured by a site-located anemometer. Sustained winds above 15 mph exist when the 15-minute average wind-speed exceeds 15 mph for two consecutive 15-minute periods.
- Soil moisture content less than 15% in areas where major excavation or scraping is planned as measured with a Soiltest "Speedy Moisture Tester" or an equivalent instrument.

- In the special case of excavations, the top 6" of soil will be moved (i.e., scraped) and placed in a low pile and covered with a tarp or other suitable covering to prevent resuspension of particulates. The width of the scraped zone shall be wide enough to accommodate the expected volume of soil from the excavation, without coming into contact with unexcavated adjacent surface soil.

Air quality monitoring requirements for activities where there is a significant potential for producing appreciable quantities of suspended particulate include the following:

- Site perimeter and community Radiological Ambient Air Monitoring Program (RAAMP) monitoring.
- Local monitoring of Respirable Suspended Particulate (RSP) at individual activity worksites shall be conducted using a TSI "Piezobalance" Model 3500 Respirable Aerosol Mass Monitor, real-time instrument. Local RSP measurements will be used to guide the PM's evaluation of the potential hazards associated with activity related emissions. The threshold RSP concentration for curtailing intrusive activities will be 6.0 milligrams/cubic meter (mg/m³).
- Additional worker health and safety monitoring as required by the SSH&SP.

Additional requirements that govern activities where there is a significant potential for producing appreciable quantities of suspended particulates that could create hazardous conditions include the following:

- Excavate soils that are not promptly backfilled shall be covered with a tarp or similar cover to prevent resuspension of particulates.
- Vehicular traffic will be minimized to the extent practicable.
- Vehicular traffic shall not exceed 5 mph.
- Roadways will be watered as necessary.
- Access paths leading to activity sites that are not on roadway will be watered to prevent the generation of particulates from vehicular traffic during access and egress.

Activity specific requirements will be evaluated periodically to determine their effectiveness at preventing dispersion of contaminants. Modifications to these requirements will be documented in the SSH&SP.

ATTACHMENT K
NIOSH METHOD 1007

VINYL CHLORIDE

FORMULA: CH₂=CHCl; C₂H₃ClMETHOD: 1007
ISSUED: 2/15/84

M.W.: 62.50

OSHA: 1 ppm; C 5 ppm
NIOSH: minimum measurable
ACGIH: 5 ppm (human carcinogen) [1]
(1 ppm = 2.56 mg/m³ @ NTP)

PROPERTIES: BP -14 °C; vapor density 2.2 (air = 1)

SYNONYMS: chloroethylene; chloroethene; CAS #75-01-4.

SAMPLING	MEASUREMENT
SAMPLER: SOLID SORBENT TUBE (2 tandem tubes, each with 150 mg activated coconut charcoal)	! TECHNIQUE: GAS CHROMATOGRAPHY, FID ! ! ANALYTE: vinyl chloride !
FLOW RATE: 0.05 L/min	! DESCRIPTION: 1 mL carbon disulfide; 30 min !
VOL-MIN: 0.7 L -MAX: 5 L	! INJECTION ALIQUOT: 5 µL !
SHIPMENT: separate primary and backup tubes and cap each	! COLUMN: stainless steel, 6.1 m x 3.2 mm, 10% SE-30 on 80/100 mesh Chromosorb W (AW-DMCS) !
SAMPLE STABILITY: 10 days @ 25 °C	! CARRIER GAS: He, 40 mL/min !
BLANKS: 2 to 10 field blanks per set	! TEMPERATURE-INJECTOR: 230 °C ! -DETECTOR: 230 °C ! -COLUMN: 60 °C !
<hr/> ACCURACY <hr/>	! CALIBRATION: solutions of vinyl chloride in CS ₂ !
RANGE STUDIED: 1 to 64 mg/m ³ [2]	! RANGE: 0.002 to 0.2 mg per sample [2] !
BIAS: -6% of calculated concentration [2]	! ESTIMATED LOD: 0.00004 mg per sample [2] !
OVERALL PRECISION (s _p): 0.06 [2]	! PRECISION (s _p): not determined !
<hr/> APPLICABILITY: The working range is 0.4 to 40 mg/m ³ (0.16 to 16 ppm) for a 5-L air sample. The method is applicable to 15-min samples at concentrations of 1 ppm or higher. <hr/>	
INTERFERENCES: Other than the possibility of loss of sample upon storage of two weeks or more at room temperature, none have been noted. <hr/>	
OTHER METHODS: This is a revision of P&CAM 178 [3]. <hr/>	

7. Transfer the charcoal from the front and back tubes to separate vials. Discard the glass wool and foam plugs. Seal the vials with septum caps immediately.
8. Allow to stand for 30 min, with occasional agitation. Analyze the sample within the next 30-min period.

CALIBRATION AND QUALITY CONTROL:

9. Calibrate with at least five working standards covering the range 0.0002 to 0.2 mg per sample.
 - a. Add known amounts of calibration stock solution to CS₂ in 10-ml volumetric flasks and dilute to the marks, using serial dilution as appropriate.
NOTE: Working standards can be stored at -20 °C for at least three days.
 - b. Analyze together with samples and blanks (steps 12 and 13).
 - c. Prepare calibration graphs of peak area vs. quantity (mg) of vinyl chloride per tube and peak area vs. quantity (ng) per injection.
10. Determine desorption efficiency (DE) at least once for each lot of charcoal used in the calibration range (step 9). Prepare three tubes at each of five levels plus three media blanks.
 - a. Prepare three atmospheres of vinyl chloride in air by injecting 0.01, 0.08, and 0.2 ml vinyl chloride gas into 10 L air in Tedlar bags. The resulting concentrations are approximately 2.6, 21 and 52 mg/m³.
 - b. Following steps 1 through 4, sample these atmospheres according to the following scheme:

Concentration in Bag (mg/m ³)	Volume Sampled (L)	Quantity of Vinyl Chloride (mg)
2.6	0.8	0.002
	2.2	0.006
21	0.8	0.017
	2.2	0.046
52	2.5	0.13

Obtain three samples at each level.

- c. Desorb (steps 6 through 8) and analyze together with working standards (steps 12 and 13). No vinyl chloride should be found on the back tubes.
- d. Analyze the atmospheres in the bags (steps 12 and 13) using 1-ml gas samples. Read from the calibration graph the quantity (ng) per injection, which for a 1-ml injection of gas is numerically equal to the concentration in mg/m³.
- e. Calculate DE from the mass (mg) of vinyl chloride on the front tube (M_f), the average blank (B), the concentration of vinyl chloride in the synthetic atmospheres (C_s, mg/m³), and the volume of air sampled (V, L):

$$DE = \frac{(M_f - B) \cdot 10^3}{(C_s)(V)}$$

- f. Prepare a graph of DE vs. mass found (M_f - B).
11. Analyze three quality control blind spikes and three analyst spikes to ensure that the calibration graph and DE graph are in control.

ATTACHMENT L

**ORGANIZATIONAL STRUCTURE OF ROCKY FLATS
PLANT HEALTH AND SAFETY ACTIVITIES**

CHAPTER 2
ORGANIZATIONAL STRUCTURE

2.1 Plant Organization

Environmental restoration activities at the Rocky Flats Plant (RFP) are directed by the Associate General Manager for Environmental Restoration (ER) and Waste Management (see Figure 2-1). ER Program Activities (CERCLA and RCRA response actions) involve the following ER Divisions:

- o Remediation Programs Division (RPD)
- o Environmental Monitoring and Assessment Division (EMAD)
- o National Environmental Policy Act Division (NEPA)
- o Clean Water Action Division (CWAD)
- o Clean Air and Environmental Reporting (CAER)

(See Figure 2-2 for the organizational structure of the Environmental Restoration Department.)

Health and Safety (H&S) activities at the RFP are under the direction of the Associate General Manager for Support Operations (see Figure 2-3). ER Program Activities receive support from the following H&S divisions:

- o Radiological Operations
- o Occupational Safety
- o Health and Safety Area Engineering
- o Industrial Hygiene
- o Radiological Engineering
- o Occupational Health

Facilities Engineering (FE) and Facilities Project Management (FPM) also provide support to the ER program activities. FE's role is to provide engineering designs, oversight, and management of design projects. The Project Engineer (PE) from FE directs all project design activity, ensures the user's technical requirements are met, ensures conformance with plant design standards and obtains design concurrence from RFP technical support groups (e.g., Facilities Quality Engineering, Design Verification Engineering, Fire Protection Engineering, Plant Electrical and Plant Utilities Engineering, Operations, Maintenance and Utilities Management, etc.). FPM administers the implementation of engineering designs through Construction Management (CM). CM, a branch within FPM, is responsible for assisting ER with obtaining approval for work permits for land use and work activities, and for managing/coordinating general construction contractors and their quality of work. A Construction Coordinator, identified by CM, is responsible for coordinating with various departments within the RFP to obtain permits, escorts and access justification in addition to other supporting functions, as needed by Subcontractors.

Appendix IV contains a list of RFP departments or divisions that are mentioned in this Plan along with available phone numbers and contacts.

2.2 Responsibilities of Individuals

2.2.1 Division Managers

Environmental Restoration and Health & Safety division managers are responsible for managing programs and supervising project managers in the implementation of ER and H&S activities.

2.2.2 Environmental Restoration Health and Safety Officer (Dennis Smith)

The Environmental Restoration Health and Safety Officer (ERHSO) is responsible for managing and implementing the ER Health and Safety Program. Environmental Restoration is responsible

for project planning, contracting, and managing ER projects, therefore, the ER HSO will ensure the a Site-specific Health and Safety Plan is written for each Operable Unit; ensure that subcontractors prepare site- or task-specific health and safety plans for approval; and provide support to project managers in the area of environmental health and safety through his/her expertise and that of the environmental support divisions.

2.2.3 Remediation Programs Site Project Manager (Brook Wilson)

The RP Site Project Manager is the direct line supervisor responsible for project work on a designated ER site. He/she reports directly to the RPD Manager. The RP Site Project Manager has overall control and responsibility for the management of the project, including enforcement of health and safety requirements. The Project Manager is the single-point-of-contact for implementing ER's needs and requirements through the Project Administrator.

2.2.4 Health & Safety Liaison Officer (Dina Sassone)

The H&S Liaison Officer is assigned from the Occupational Safety Division to the Environmental Restoration Division to serve as the central point-of-contact for supporting the ER Program for all operational health and safety needs. The H&S Liaison Officer reports to the Occupational Safety Division Manager and interacts directly with the ER Site Project Managers and the ER Health and Safety Officer. He/she also supervises the EG&G Site Health and Safety Coordinators. The H & S Liaison Officer has the following responsibilities:

- o Coordinates health and safety activities with the ER H&S Officer and the ER Site Project Managers
- o Implements the HSPP by providing and supervising EG&G Site Health and Safety Coordinators at each designated ER site
- o Prepares EG&G Health and Safety Plans (HSPs)

- o **Coordinates approval of Site-specific (Task-Specific) Health and Safety Plans prepared by Subcontractors and their lower-tier subcontractors with all health and safety disciplines**
- o **Performs periodic health and safety audits and inspections of the subcontractor health and safety programs, and program documentation**

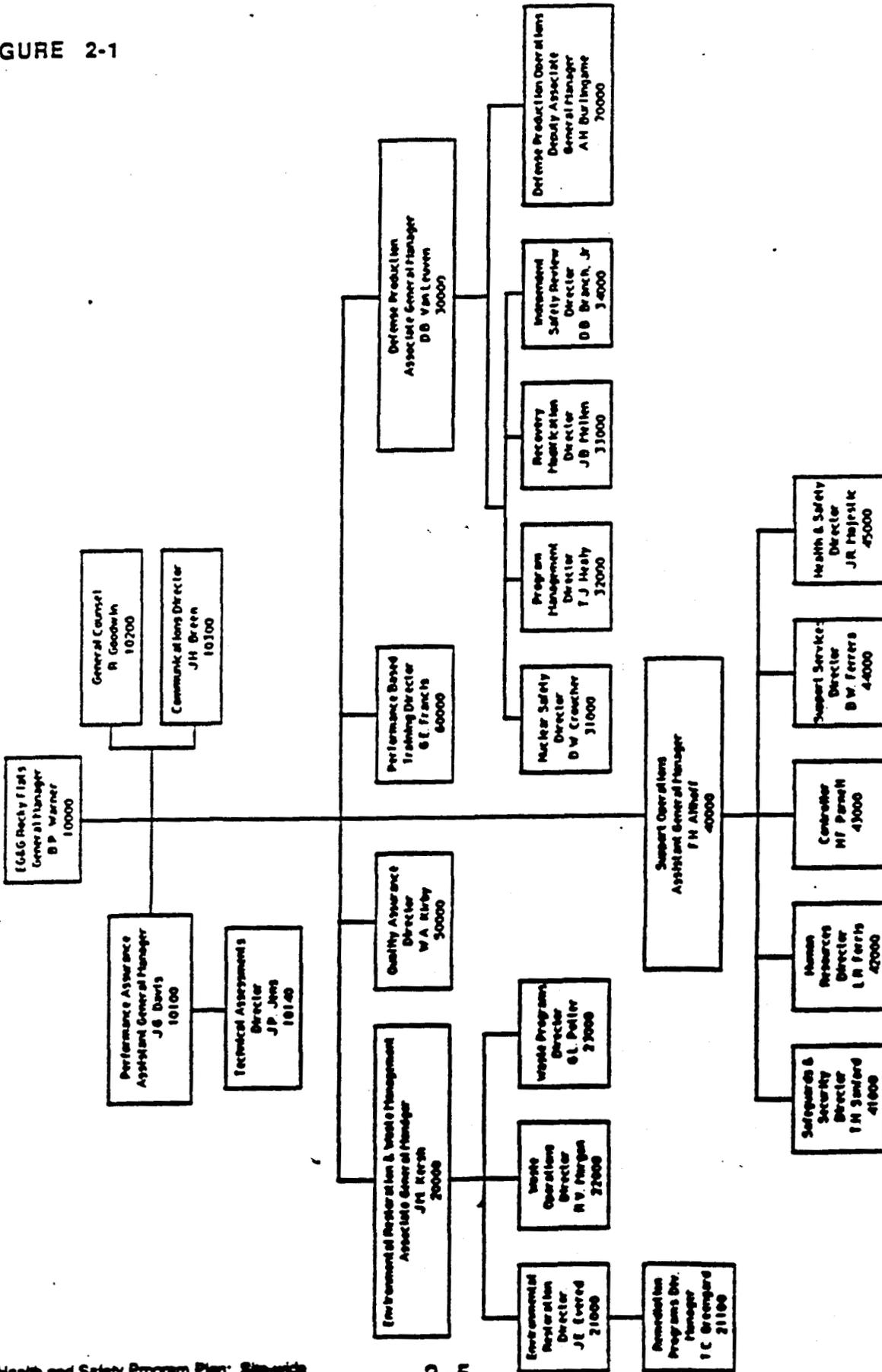
2.2.5 Site Health and Safety Coordinator (Brian Fielding)

A Site Health and Safety Coordinator (SHSC) will be assigned from the Health and Safety Department by the Health & Safety Liaison Officer to oversee Health and Safety Plan implementation at each Operable Unit. The SHSC will report to the H&S Liaison Officer and will keep the RP Site Project Manager informed of health and safety related activities on the site. The SHSC has the following responsibilities:

- o **Oversees EG&G and subcontractor work to ensure that the requirements and principles of this HSPP and the Site Specific HSPs are followed.**
- o **Performs audits for proper and appropriate use of PPE, monitoring and decontamination procedures, access control and required documentation.**
- o **Alerts the ER Site Project Manager and the H&S Liaison Officer of health and safety violations at the ER remedial project work site.**
- o **Coordinates with appropriate health and safety divisions to provide for radiation monitoring, medical surveillance, emergency response, industrial hygiene support and H&S engineering support.**
- o **Provides on-site health and safety support at all times for tasks performed by EG&G employees beyond project management and oversight.**

FIGURE 2-1

EG&G ROCKY FLATS ORGANIZATION



2-5

FIGURE 2-2

ENVIRONMENTAL RESTORATION

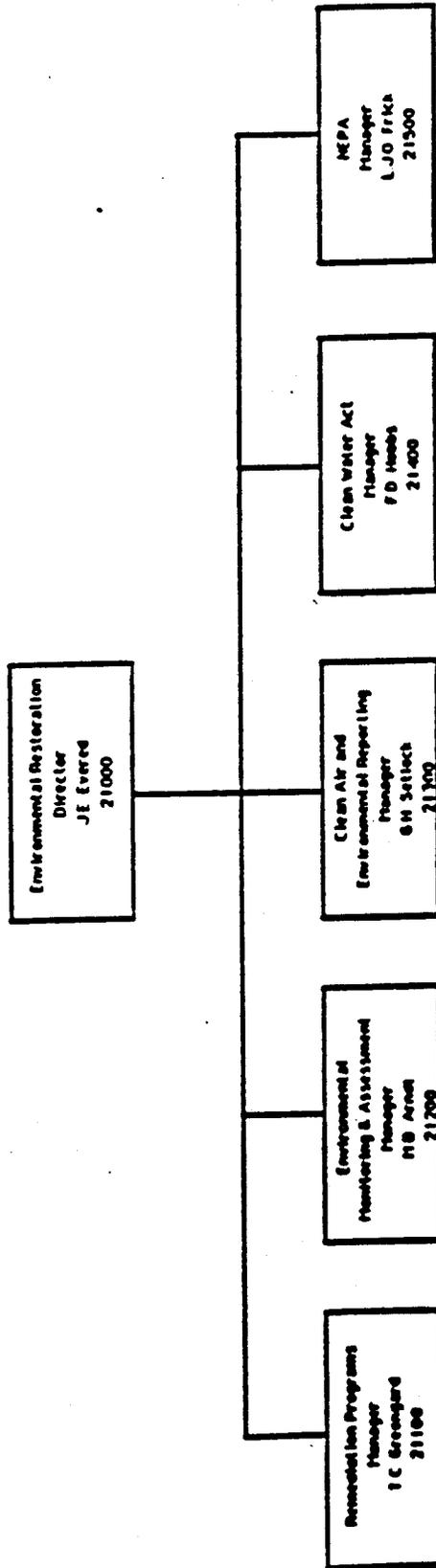
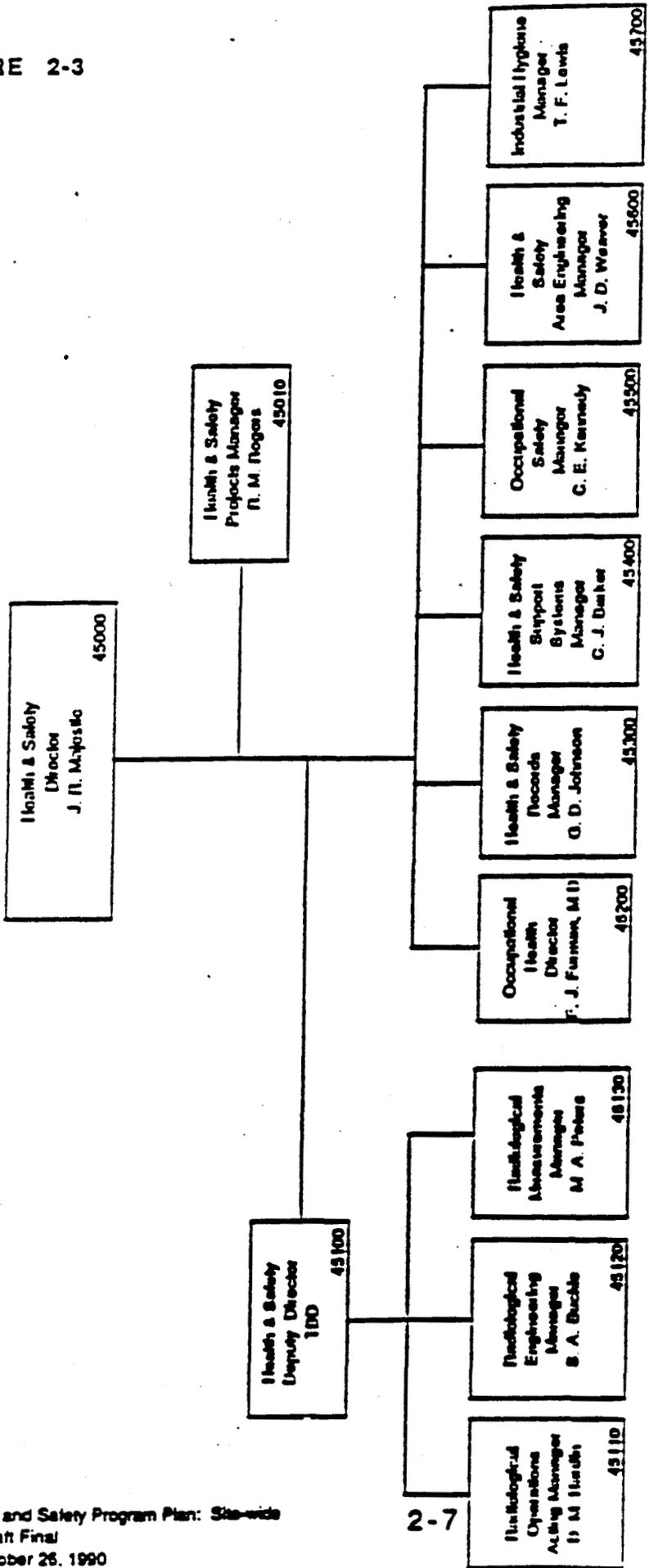


FIGURE 2-3

HEALTH AND SAFETY



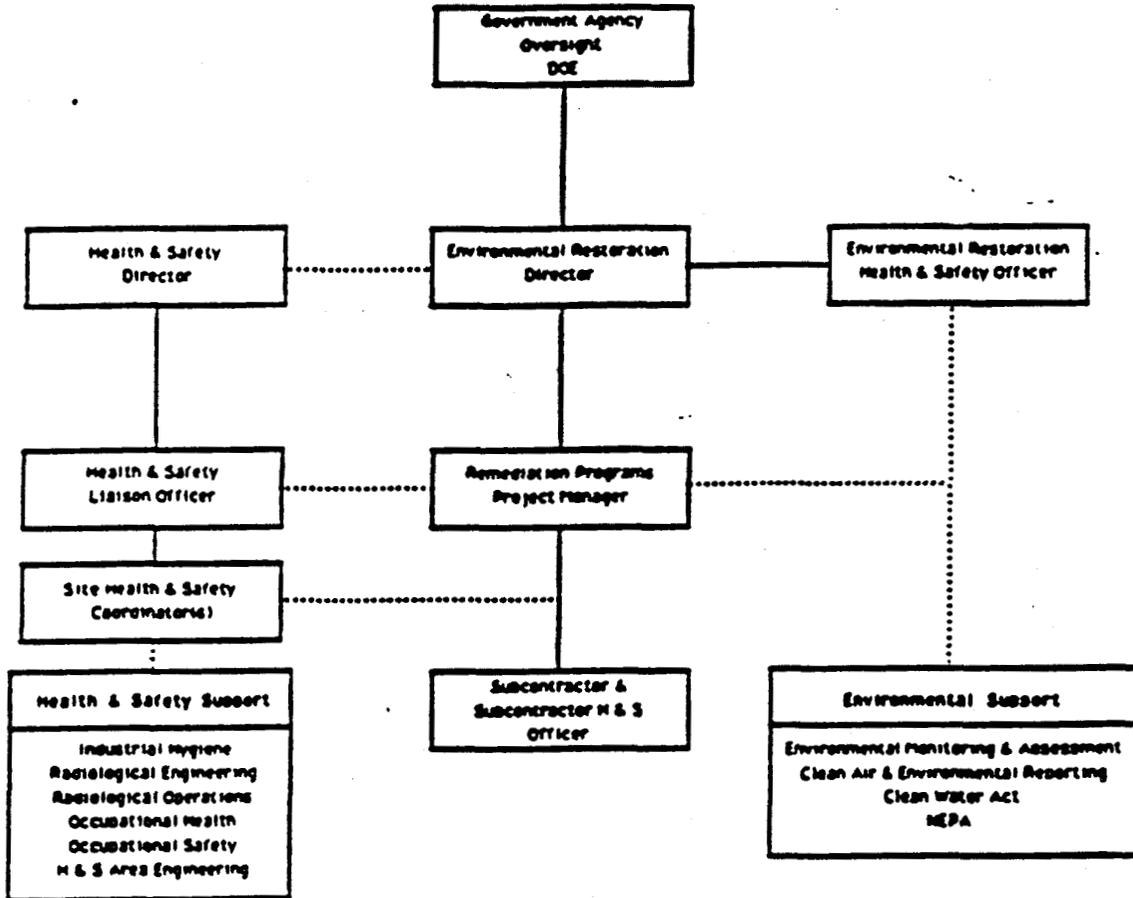
2-7

EG&G ROCKY FLATS
Organization
DE-AC04-90DP62349

Health and Safety
CH/III 45000
April 9, 1990

FIGURE 2-4

RP PROJECT ORGANIZATIONAL CHART



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