

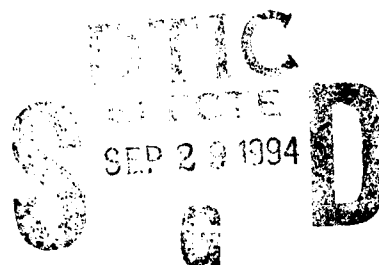
AD-A285 221



0

**United States Air Force
611th Civil Engineer
Squadron**

Elmendorf AFB, Alaska



Final

**Health and Safety Plan
Kalakaket Creek
Radio Relay Station, Alaska**



September 1994

DTIC QUALITY ASSURED 3

509 94-30943



94 9 28 000

DCN 94-640-305-03

**United States Air Force
611th Civil Engineer
Squadron**

Elmendorf AFB, Alaska

Final

**Health and Safety Plan
Kalakaket Creek
Radio Relay Station, Alaska**

**Prepared by:
Radian Corporation**

September 1994

Accession For	
NTIS	CRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
Unannounced <input type="checkbox"/>	
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	

NOTICE

This report has been prepared for the United States Air Force by Radian Corporation for the purpose of aiding implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). Since the report relates to actual or possible releases of potentially hazardous substances, its release before an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and the chemical effects on the environment and health, must be considered when evaluating the report, since subsequent facts may become known which may make this report premature or inaccurate.

Copies of this report may be purchased from:

Government agencies and their contractors registered with the Defense Technical Information Center (DTIC) should direct requests for copies of this report to: Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145.

Non-Government agencies may purchase copies of this document from: National Technical Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

DTIC QUALITY INSPECTED 3

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE 8 September 1994	3. REPORT TYPE AND DATES COVERED Final SSHP: 15 July 1994 to 30 June 1995	
4. TITLE AND SUBTITLE Health and Safety Plan, Kalakaket Creek Radio Relay Station, Alaska		5. FUNDING NUMBERS C-F41624-94-D-8049-0005	
6. AUTHOR(S) Radian Corporation			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Radian Corporation P.O. Box 201088 8501 N. Mopac Blvd. Austin, Texas 78759		8. PERFORMING ORGANIZATION REPORT NUMBER 94-640-305-03	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFCEE/ERDW 8001 Inner Circle Drive, Suite 2 Brooks AFB, Texas 78235-5328		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release. Distribution is Unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This Health and Safety Plan provides guidance for safe operations for field crew members performing activities at the Galena AFS and Campion AFS. It includes site descriptions, possible hazards, protective measures, and emergency procedures.			
14. SUBJECT TERMS Health and Safety Plan, Kalakaket Creek Radio Relay Station, Alaska		15. NUMBER OF PAGES	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

TABLE OF CONTENTS

	<u>Page</u>
1 PURPOSE, SCOPE, ORGANIZATION, AND RESPONSIBILITIES	1-1
1.1 Purpose and Scope	1-1
1.2 Organization of Document	1-1
1.3 Health and Safety Responsibilities	1-1
1.3.1 Responsibilities of Project Manager and Task Leaders	1-2
1.3.2 Responsibilities of Supervising Geologist	1-3
1.3.3 Environmental Affairs Coordinator	1-3
1.3.4 Professional Industrial Hygienist	1-3
2 SITE DESCRIPTION	2-1
2.1 Site Description	2-1
2.2 Site History	2-1
2.3 Previous Investigations	2-1
2.4 Areas of Concern Description	2-3
2.4.1 Top Camp AOCs	2-3
2.4.2 Runway AOCs	2-6
2.4.3 Other AOCs	2-6
3 FIELD ACTIVITIES AND HAZARD ANALYSIS	3-1
3.1 Field Activities	3-1
3.2 Hazard Analysis	3-1
3.2.1 Hazard Analysis—Site Reconnaissance	3-1
3.2.2 Hazard Analysis—Ground Survey	3-1
3.2.3 Hazard Analysis—Soil Sampling	3-1
3.2.4 Hazard Analysis—Decontamination Hazards	3-1
3.2.4 Hazard Analysis—Field Screening Hazards	3-2
4 HEALTH HAZARD INFORMATION	4-1
4.1 Chemical Hazards	4-1
4.1.1 Volatile Organic Compounds	4-1
4.1.2 Semivolatile Organic Compounds	4-2
4.1.3 Metals	4-3
4.1.4 Pesticides and PCBs	4-3
4.1.5 Miscellaneous	4-3
4.2 Physical Hazards	4-4
4.2.1 Cold Stress	4-4
4.2.2 Lifting Hazards	4-4
4.2.3 Slips, Trips, and Falls	4-4

TABLE OF CONTENTS (Continued)

	<u>Page</u>
4.2.4 All-terrain Vehicle Hazards	4-4
4.2.5 Electrical Hazards	4-4
4.2.6 Fire Hazards	4-5
4.3 Biological Hazards	4-5
4.4 Confined Space Entry Hazards	4-6
5 PERSONAL PROTECTIVE EQUIPMENT	5-1
5.1 Level D Protection	5-1
5.2 Level C Protection	5-1
5.3 First Aid, Emergency, and Safety Equipment	5-2
6 PERSONNEL TRAINING AND STANDARD SAFETY PROCEDURES	6-1
6.1 On-Site Safety, Health, and Emergency Response Training	6-1
6.2 Standard Safety Procedures	6-1
6.2.1 General Safety Work Practices	6-1
6.2.2 Respiratory Protection	6-2
6.2.3 Personal Hygiene Practices	6-2
7 EXPOSURE MONITORING PLAN	7-1
7.1 Air Monitoring	7-1
7.1.1 Organic Vapor Concentrations	7-1
7.1.2 Airborne Particulate Concentrations	7-1
7.2 Physical Conditions Monitoring	7-1
8 MEDICAL SURVEILLANCE	8-1
8.1 Medical Surveillance Program	8-1
8.2 Physician Reviewal	8-1
8.3 Participation Certification	8-1
9 SITE CONTROL MEASURES AND DECONTAMINATION PROCEDURES	9-1
9.1 Site Control Measures	9-1
9.1.1 Work Zone Delineation	9-1
9.1.2 Communications	9-1
9.1.3 Site Security	9-2
9.2 Decontamination Procedures	9-2
9.2.1 Personnel Decontamination	9-2
9.2.2 Equipment Decontamination	9-2

TABLE OF CONTENTS (Continued)

	<u>Page</u>
10	EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES 10-1
10.1	Emergency Phone Numbers 10-1
10.2	Clinic Information 10-1
10.3	Accident and Emergency Medical Response 10-1
10.4	Fire Emergency Procedures 10-2
10.5	Chemical Spills and Releases 10-2
10.6	Accident Prevention 10-3
11	LOGS, REPORTS, AND RECORD KEEPING 11-1
11.1	Logs 11-1
11.2	Reports 11-1
11.3	Record keeping 11-1
12	REFERENCES 12-1
	APPENDIX A: Cold Stress SOP A-1
	APPENDIX B: Material Safety Data Sheets (MSDS) B-1

LIST OF TABLES

3-1	Field Activities and Associated Hazards 3-2
5-1	Equipment Requirements for the PPE Program Levels of Protection 5-1
10-1	Emergency and Information Numbers, Galena 10-2

LIST OF FIGURES

2-1	Location of Kalakaket Creek RRS, Alaska 2-2
2-2	Location of Areas of Concern at the Top Camp, Kalakaket Creek RRS, Alaska 2-4
2-3	Location of Runway Areas of Concern, Kalakaket Creek RRS, Alaska 2-5
7-1	Air Monitoring Data Form 7-2
7-2	Air Monitoring Instrument Calibration Form 7-3

Section 1

PURPOSE, SCOPE, ORGANIZATION, AND RESPONSIBILITIES

This section describes the purpose, scope, and organization of this document and the health and safety responsibilities of personnel involved in the site investigation (SI) for Kalakaket Creek Radio Relay Station (RRS), Alaska.

1.1 Purpose and Scope

This site safety and health plan (SSHP) establishes procedures, minimum safety and health requirements, and emergency response plans for all field personnel involved in soil sampling and screening in support of the SI for Kalakaket Creek RRS Alaska. All field personnel must read and understand this SSHP and agree to implement its provisions.

1.2 Organization of Document

This SSHP includes health and safety planning for all anticipated site activities and contains the information outlined in the *Installation Restoration Program (IRP) Handbook (1993)*. This plan also meets the Occupational Safety and Health Administration (OSHA) requirements contained in 29 CFR Section 1910.120 and 29 CFR Part 1926 by including the following items:

- ▶ A description of the staff organization, qualifications, and responsibilities (section 1.0);
- ▶ Site description and contamination characterization (section 2.0);
- ▶ Field activities and hazard analysis (section 3.0);
- ▶ Health hazard information (section 4.0);
- ▶ Personal protective equipment (PPE) (section 5.0);
- ▶ Personnel training and standard operating safety procedures (section 6.0);
- ▶ Exposure monitoring plan (section 7.0);
- ▶ Cold stress monitoring procedures (Appendix A; SOP A);
- ▶ Medical surveillance (section 8.0);
- ▶ Site control measures and decontamination procedures for personnel and equipment (section 9.0);
- ▶ First aid, emergency, and safety equipment (subsection 5.3);
- ▶ Emergency response and contingency procedures (section 10.0);
- ▶ Logs, reports, and record keeping (section 11.0); and
- ▶ Material safety data sheets of chemicals used on site (Appendix C).

1.3 Health and Safety Responsibilities

Personnel responsible for implementing this SSHP are as follows:

Project Manager—Mike H. Green (overall project responsibility);

Task Leaders—Becky J. Coel and Todd A. Council (report to project manager);

Site Safety and Health Officer—Becky J. Coel (also functions as the site emergency coordinator);

Local Environmental Affairs Coordinator—S. K. Taylor (provides consultative assistance to project manager/supervising geologist/site safety and health officer); and

Professional Industrial Hygienist (PIH)—C. Herndon Williams, Ph.D., CIH (provides consultative assistance to project manager/supervising geologist/site safety and health officer).

1.3.1 Responsibilities of the Project Manager and Task Leaders

The project manager and task leaders have overall responsibility to ensure that the SSHP is implemented and the project is executed in accordance with all applicable federal, state, and local requirements and company corporate policy.

Specific safety responsibilities of the project manager and task leaders are to:

- ▶ Ensure that a detailed SSHP is available on site;
- ▶ Ensure that safety and health equipment is procured on time;
- ▶ Ensure that field personnel have the required pre- and postinvestigation medical examinations, and are properly trained in safety, health, and emergency response procedures;
- ▶ Complete the sample data sheets or equivalent;
- ▶ Coordinate the reporting of any accidents or injuries; and
- ▶ Notify the Base remedial program manager (RPM) if any problems arise that require alterations to, or deviations from, the SSHP.

In addition, one of the task leaders will also serve as the site safety and health officer and site emergency coordinator (SSHO/SEC). The SSHO/SEC will be responsible for executing field safety, health, and emergency procedures. The responsibilities of the task leader as the SSHO/SEC are listed below:

- ▶ Contact the Galena emergency response agencies (police, fire, medical) to advise them of the field activities and to ensure accuracy of the emergency phone numbers;
- ▶ Inform the civilian medical clinic of the nature and duration of work to be performed and the potential chemical and physical hazards associated with the site activities;
- ▶ Coordinate field activities with the RPM and other appropriate Galena personnel on a regular basis;
- ▶ Locate the support facilities in an uncontaminated area;
- ▶ Implement the safety, health, and emergency response training described in section 6.0 of this plan;
- ▶ Assure that all field personnel correctly select and use PPE and apply safety practices that are appropriate for the site-specific conditions;
- ▶ Take appropriate action, as described in this SSHP, regarding accidents, fires, or other emergency situations;
- ▶ Conduct periodic safety review sessions for the on-site personnel;
- ▶ Ensure that safety equipment is properly maintained or disposed of (respirators are to be cleaned daily);
- ▶ Ensure that the field team, laboratory sample control, and analytical labs have been provided with appropriately completed sample data sheets or equivalent; and
- ▶ Initiate corrective action for observed safety violations and report unsuccessful attempts to correct a violation to the project manager.

1.3.2 Responsibilities of the Supervising Geologist

The supervising geologist will be responsible for executing the safety, health, and emergency response procedures at the work site and will report directly to the task leaders. The responsibilities of the supervising geologist are listed below:

- ▶ Monitor airborne contaminants as specified in section 7.0 of this plan;
- ▶ Take appropriate action, as described in this SSHP, regarding accidents, fires, or other emergency situations;
- ▶ Ensure that daily work schedules integrate cold stress prevention measures;
- ▶ Ensure that the field team observes the work zone and decontamination procedures as described in this plan;
- ▶ Ensure proper handling and shipping of potentially hazardous samples;
- ▶ Stop work if unsafe conditions exist.

1.3.3 Environmental Affairs Coordinator

The environmental affairs coordinator will be responsible for:

- ▶ Scheduling any necessary medical examinations;
- ▶ Performing preliminary respirator fit tests; and
- ▶ Approving the SSHP.

1.3.4 Professional Industrial Hygienist

The professional industrial hygienist will be available to:

- ▶ Consult on the level of PPE needed for protection from potential exposures;
- ▶ Advise about the use of site safety and health sampling equipment;
- ▶ Help as needed to prepare or modify the SSHP; and
- ▶ Consult with SSHO and supervising geologist in field about any problems in implementation of the SSHP.

Section 2

SITE DESCRIPTION

This section presents a brief description and history of the site, the specific location and description of the areas of concern, and a summary of the chemical contaminants suspected to be present.

2.1 Site Description

The Kalakaket Creek RRS site is located 22 miles southeast of Galena Airport in Sections 22 and 27 of Township 12 South, Range 10 East, Kateel River Meridian (Figure 2-1). Four parcels of land have been transferred to the Air Force including the area of the gravel aircraft landing strip, the gravel roadway to the RRS site, the RRS site, and the water supply pipes and pump house. The facility encompasses a total of approximately 316 acres of land.

The RRS site was constructed on the leveled top of a mountain with an elevation of 1950 ft above mean sea level (msl). Several structures were constructed on the site including, an equipment/dormitory building, a vehicle maintenance shop, a paint storage building, a pair of diesel storage tanks, a pair of water storage tanks, four tropospheric scatter antennae, and two microwave antennae. All of these structures are still standing except for the paint storage building, which was partially demolished by the 5099th Civil Engineering Operations Squadron (CEOS) in 1984. Asbestos-containing material (ACM) was detected in the buildings on site. An aboveground water line consisting of two 2-in. diameter steel pipes runs easterly approximately one mile and connects the water tanks to the water supply pump house on an unnamed tributary of Kala Creek.

The runway was constructed from graded and packed gravel and is approximately 140 ft wide by 4090 ft long. The elevation of the runway is 1650 ft above msl. A temporary diesel storage tank, temporary vehicle garage, and aircraft support building were constructed adjacent to the runway.

2.2 Site History

Kalakaket Creek RRS is one of the original 31 White Alice Communication System (WACS) sites constructed in the late 1950s. Its mission was to enable the Aircraft Control and Warning (AC&W) system sites to link with the Distant Early Warning (DEW-line) system and provide reliable communication links and networks for the relay of information to and from Elmendorf Air Force Base (AFB) and Eilson AFB. The facility became operational on 25 May 1957 and provided network links between North River RRS, Bear Creek RRS, and Tatlina RRS. Microwave links to Campion Air Force Station (AFS) and Galena Airport were added later. In 1959 Alaska Telephone Switching Station capabilities were added to the system. However, with the development of satellite communication systems, the WACS sites became obsolete and most were shut down and abandoned. Kalakaket Creek was removed from service in 1973.

In 1984 the 5099th CEOS from Elmendorf AFB performed a site cleanup and removed hazardous materials, contaminated soils, and salvageable equipment from the site. Nonhazardous debris was buried in two pits located north of the eastern end of the runway and in one pit north of the RRS. The debris buried in the pits included CO₂ fire extinguisher cylinders, building materials from the demolition of the temporary vehicle garage and air services support shed located by the runway, and 3250 cleaned crushed drums.

2.3 Previous Investigations

There has not been a significant site investigation conducted at Kalakaket Creek RRS to date. Two preliminary assessments (PAs) were conducted by Dynamac Corporation (1989) and CH2M Hill (1994). Both of these documents summarize the site cleanup actions completed by the 5099th CEOS in 1984. The 1989 PA concluded that small quantities of hazardous material were handled during the operation

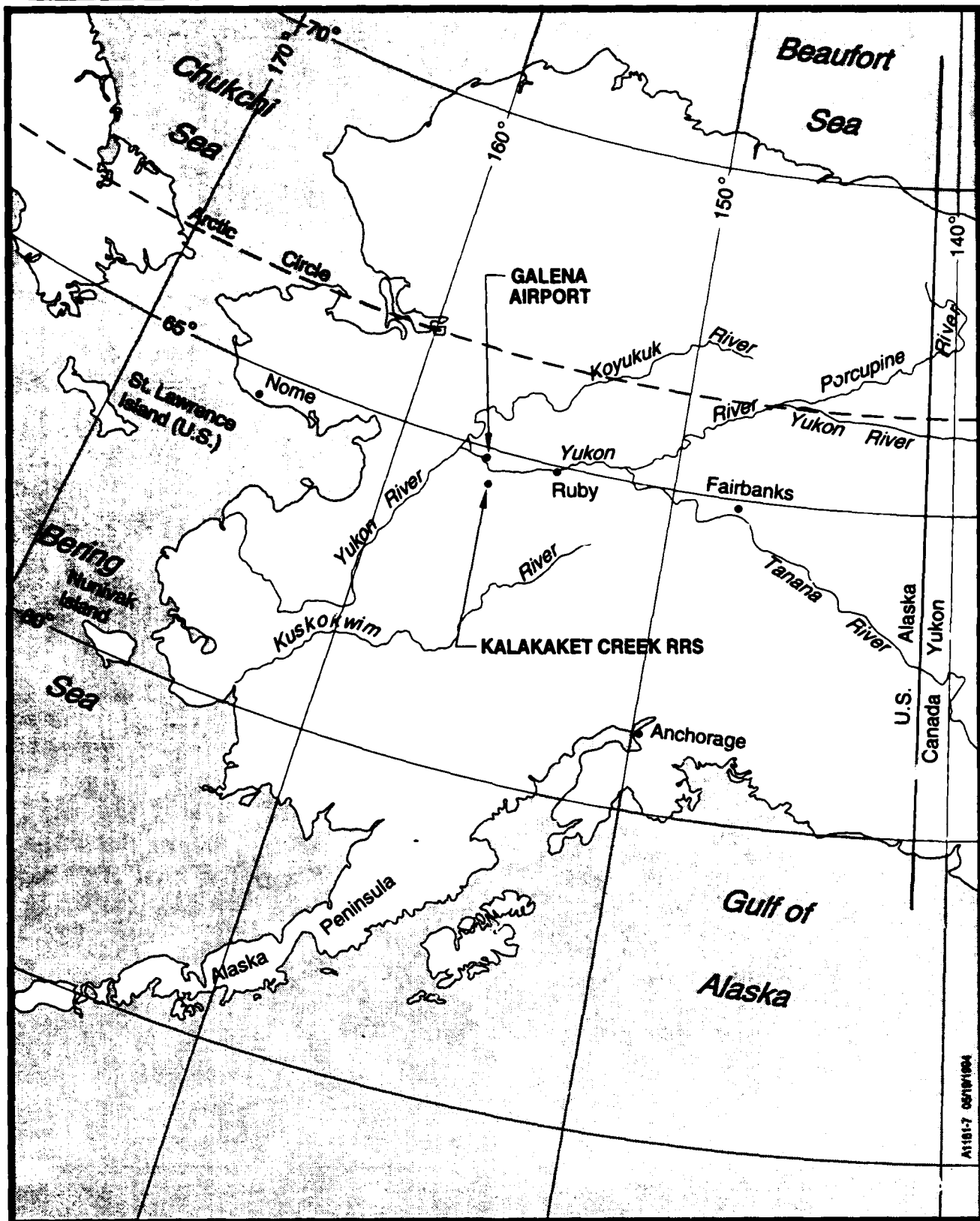


Figure 2-1. Location of Kalakaket Creek RRS, Alaska

of the facility; however, there is no visible evidence of contamination to the soils (i.e., stained soil, abandoned drums, or uncovered burial pits). Literature searches, interviews, and a site visit failed to find evidence of a landfill from the operation of the facility. All petroleum, oils, and lubricants (POL) tanks were drained and abandoned in place. The cleanup operations conducted by the 5099th removed contaminated soils, full drums, and battery banks. On the basis of these findings, the 1989 PA recommended that efforts be made to locate the landfill and determine if its contents are hazardous. The PA also suggested that the ACM be removed and disposed of properly.

The PA conducted by CH2M Hill identified potential contaminant transfer pathways but did not identify any evidence of "large fuel or hazardous-substance release." On the basis of other similar sites, however, they suggested that potential areas of concern (AOCs) that would require some field investigations include:

- ▶ Sewage outfalls;
- ▶ POL tank facilities;
- ▶ Pipeline areas; and
- ▶ Landing strips.

The 1994 PA also recommended that the ACM be removed and properly disposed of.

2.4 Areas of Concern Description

On the basis of the findings of the previously conducted PAs, additional literature searches and interviews were conducted to locate all AOCs. Interviews were conducted with personnel who were involved in the operation of the facility during the late 1960s and who were involved in the site cleanup conducted by the 5099th CEOS. Property maps and aerial photos were located and analyzed. From the additional investigation, 11 AOCs were identified at Kalakaket Creek RRS. Seven of the AOCs are located within the RRS facility referred to as "the top camp"

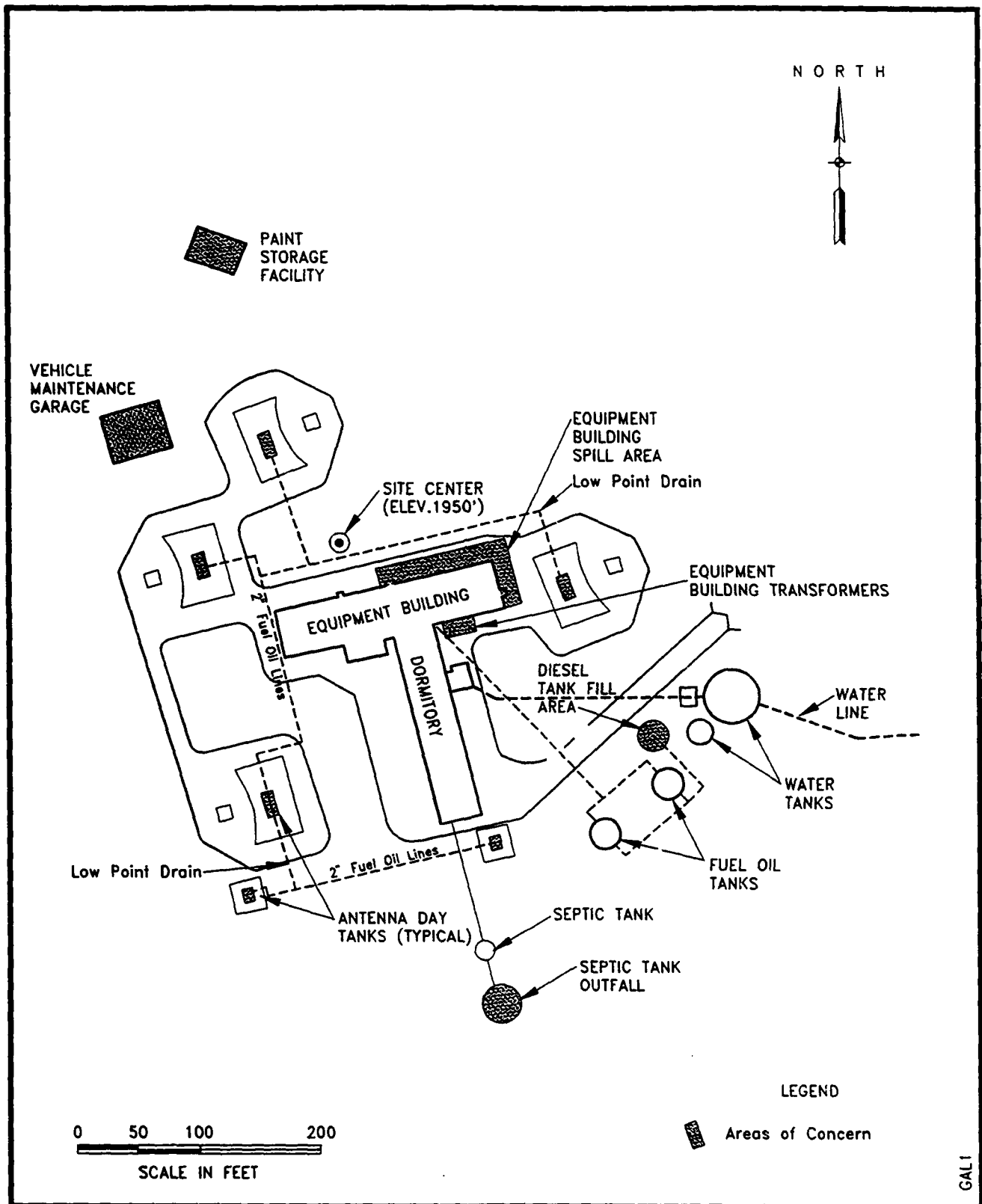
(Figure 2-2). Three of the AOCs are found along the runway and the final AOC is located at the water supply pump house located approximately 1 mile east of the RRS (Figure 2-3).

2.4.1 Top Camp AOCs

Antenna Day Tanks—Each tropospheric antenna was originally constructed with several large furnaces and blowers to keep the antenna from icing in the winter. A day tank with an approximate capacity of 500 gal. was installed below each antenna to provide fuel for the furnaces. Interviews with persons involved with the operation of the facility suggest that these furnaces were not used during the operation of the facility. Some soil staining below the tank valves was observed during the site visit. Drain pipes leading from these tanks are presumed to have been used to dewater the tanks periodically. Therefore, soils surrounding these drain pipes may contain residual POL contamination from diesel fuel.

Vehicle Maintenance Garage (VMG)—A 2000-ft² garage, located in the northern portion of the top camp, was used for vehicle storage and maintenance. There appear to be no floor drains in the concrete floors of the facility. However, waste oils and other liquids may have been poured onto the ground in the areas around the doors of the facility. Soil staining was observed next to the building by the front garage door. An oil furnace that is located in the southwest corner of the building may have been supplied by an underground storage tank (UST). Typically, soils around a VMG facility may contain contamination from fuels, chlorinated solvents, antifreeze, and metals.

Paint Storage Building—A 640-ft² storage facility located to the east of the VMG was used for the temporary storage of paints, thinners, and other small containers of chemicals during the operation of the facility. The building has been partially demolished and no walls are standing. Soils surrounding this facility may contain contamination from paints, thinners, POL, polychlorinated biphenyls (PCBs), or solvents.



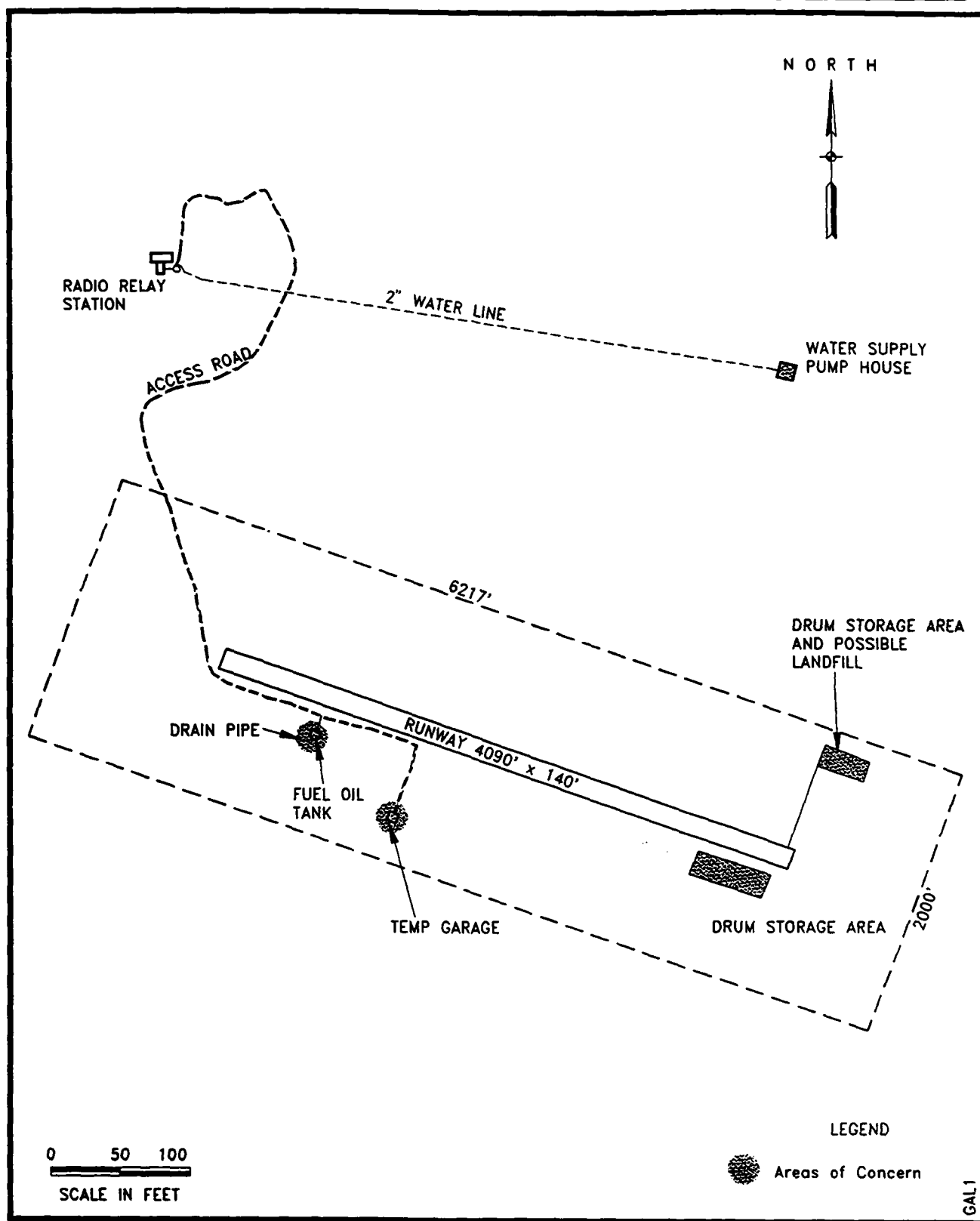


Figure 2-3. Location of Runway Areas of Concern, Kalakaket Creek RRS, Alaska

Equipment Building—Large diesel generators were used to provide power for the radio relay site. Standard maintenance practices may have resulted in the spill/release of waste oil and solvents around the building. Typically, waste liquids are poured on the ground close to the building doors. Some soil staining and vegetative stress were noted in the area around the eastern door to the facility. The soils around this building may be contaminated with oils, solvents, PCBs, and metals.

Equipment Building Transformers—PCB-contaminated soils were removed from the area surrounding the concrete transformer pad on the southeast side of the equipment building during the 1984 cleanup activities. All soils with total PCBs greater than 50 ppm were reportedly removed from the site (CH2M Hill, 1994). However, there is still a potential for soils near the transformer pad to contain PCBs.

Diesel Tank Fill Area—Two 3000-barrel diesel aboveground storage tanks are located in the southeast portion of the top camp. These tanks were filled from trucks that ferried the diesel from a temporary storage tank located adjacent to the runway. The tanks were periodically dewatered at a valve and standpipe located north of the tanks. Diesel fuel may have been released to the ground during this process.

Septic Tank Outfall—Wastewater generated at the facility flowed into a heated septic tank south of the facility. The effluent from the tank was released onto the ground from a heated discharge pipe. Sink drains in the facility may have been used to dispose of small quantities of waste liquids other than water. Therefore, the area may be contaminated with solvents, POLs, pesticides, or other liquid wastes.

2.4.2 Runway AOCs

Drum Storage Areas (DSA)—Two areas of past drum storage have been identified at the eastern end of the runway. All drums have been removed from the site and the southern DSA is being taken over by the growth of alders and willows. PCB-contaminated soil was removed from the southern DSA in 1984; soil staining is common at the northern DSA. Soils may be contaminated with POL, PCBs, solvents, metals, or pesticides.

Temporary Garage—A temporary garage located south of the runway was used mainly for the storage of vehicles and possibly refueling activities in the winter. Only the building foundation remains at the site. The concrete floor has no visible floor drains and staining is not common. Fuel contamination may have occurred to the soils surrounding this facility.

Temporary Diesel Tank—A 1000-barrel diesel aboveground storage tank is located south of the runway. The tank was filled from off-loading planes and was later pumped into trucks that ferried the diesel to the 3000-barrel tanks at the top camp. The tank was periodically dewatered at a valve and standpipe located south of the tank. Diesel fuel may have been released to the ground during this process.

2.4.3 Other AOCs

Water Pump House—Potable water was supplied to the top camp by pumping surface water from an unnamed tributary of Kala Creek located approximately 1 mile east of the site. Diesel pumps were used to fill the two 200,000-gal. storage tanks that provided enough water to last through the long winter. A diesel day tank may be present at the pump house; therefore, spills of fuel oils that contaminated the soil may have occurred.

Section 3

FIELD ACTIVITIES AND HAZARD ANALYSIS

This section briefly describes the field activities that will occur during the SI and the hazards associated with each field activity.

3.1 Field Activities

Site activities to be conducted during the SI are briefly described below. More detailed descriptions are provided in the field sampling plan.

- ▶ **Site Reconnaissance:** A site reconnaissance will be conducted at each site to visually assess the site for entrance and egress, obvious signs of spill or contamination, buried debris, and so on.
- ▶ **Field Screening:** Samples collected in the field will be analyzed in the field using immunoassay test kits and a portable infrared total petroleum hydrocarbon analyzer.
- ▶ **Soil Sampling:** Soil samples will be collected with hand augers, trowels, or shovels.
- ▶ **Ground Survey:** A ground survey will be conducted to establish sampling grids, provide topographic information (where required), locate structures, and survey all surface soil sampling locations.

3.2 Hazard Analysis

The field activities planned for this project pose potential health and safety hazards for field team members. The following subsections describe the hazards associated with the field activities. These hazards are summarized in Table 3-1. Detailed chemical, physical, and biological hazards information is provided in section 4.0, "Health Hazard Information."

3.2.1 Hazard Analysis—Site Reconnaissance

Since site reconnaissance does not typically include the use of mechanical devices, and no soils are

disturbed, no chemical hazards are expected. Physical hazards include exposure to extreme outside temperatures, biological hazards, and slipping, tripping, and falling.

3.2.2 Hazard Analysis—Ground Survey

As with the site reconnaissance, no chemical hazards are expected. Exposure to extreme outside temperatures, biological hazards, and lifting, slipping, tripping and falling are the expected physical hazards.

3.2.3 Hazard Analysis—Soil Sampling

Soil samples will be collected with a hand auger, trowel, or shovel. During sampling operations, field personnel may be exposed to chemical hazards, some physical hazards, and biological hazards. These hazards are discussed below.

Chemical Hazards—Chemical hazards may result from inhalation and/or dermal exposures to chemical contamination that may be present in soils.

Physical Hazards—Exposure to physical hazards associated with the site sampling include exposure to extreme temperatures (cold), slips, trips, and falls, and lifting of heavy equipment and supplies. Physical hazards related to the operation of all-terrain vehicles (ATVs) also exist.

Biological Hazards—Biological hazards may be encountered at the remote site. Both brown and black bears are known to frequent the area.

3.2.4 Hazard Analysis — Decontamination Hazards

The equipment decontamination activities potentially expose field team members to chemical hazards. The chemical hazards include chemical contaminants present in the surface soils and the chemicals used to decontaminate the equipment. Physical hazards include cold stress, lifting, tripping, slipping, and falling.

Table 3-1
Field Activities and Associated Hazards

Activity	Mechanical	Electrical	Fire	Cold Stress	Chemical	Biological	Lifting, Slips, Trips, and Falls
Site Reconnaissance				X		X	X
Ground Survey				X		X	X
Soil Sampling	X		X	X	X	X	X
Sample Handling/ Field Screening					X		X
Decontamination Activities	X	X	X	X	X	X	X

3.2.5 Hazard Analysis—Field Screening Hazards

The analysis of samples in the field potentially exposes field team members to chemical

hazards. These hazards include exposure to chemical contaminants in the soil samples as well as to the reagents used to conduct the analyses.

Section 4

HEALTH HAZARD INFORMATION

Chemical hazard information is listed below for potentially hazardous chemicals that employees may be exposed to at the work sites. This hazard information includes the potentially hazardous chemicals used by the employees while performing sampling activities, and those identified during previously conducted PAs. Also, potential physical, biological, and confined space entry hazards are discussed in this section.

4.1 Chemical Hazards

Exposure to chemicals through inhalation, ingestion, or skin contact may result in health hazards to workers. Chemical hazards should be avoided when possible. Included here are the OSHA permissible exposure limits (PELs) for a time-weighted average (TWA) of 8 hours. This is the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week, which shall not be exceeded. These values are the OSHA final rule limits as listed in the 29 CFR Part 1910.1000. The American Conference of Governmental Industrial Hygienists (ACGIH)-adopted Threshold Limit Value-Time Weighted Average (TLV-TWA) concentration for a normal 8-hour workday and 40-hour workweek is also included here when the value is more stringent than the OSHA-PEL.

The following is a summary of potential hazards of the compounds that may be encountered during this investigation.

4.1.1 Volatile Organic Compounds

Acetone—Prolonged or repeated exposure to acetone may cause erythema and dryness. Inhalation may produce headache, fatigue, excitement, bronchial irritation, and, in large amounts, narcosis. The TLV-TWA is 750 ppm.

Benzene—Symptoms of exposure include irritation to the eyes, nose, and respiratory systems; giddiness, headache, nausea, fatigue, anorexia,

dermatitis, and abdominal pain. Benzene is also a human carcinogen. The PEL is 1 ppm.

Chlorobenzene—Chlorobenzene exposure may cause eye, nose, and skin irritation. Ingestion may lead to drowsiness and incoordination. Chronic exposure could result in liver damage. The PEL is 75 ppm.

1,2-Dichlorobenzene—Exposure to this chemical affects the liver, kidneys, skin, and eyes. Inhalation results in eye and nose irritations and liver damage. Absorptions through the skin may result in kidney and skin damage; ingestion may cause internal blistering. The PEL is 50 ppm.

1,4-Dichlorobenzene—Symptoms of exposure include head and eye irritations, swelling, profuse rhinitis, anorexia, nausea, vomiting, weight loss, jaundice, and cirrhosis. Target organs include the liver, respiratory systems, eyes, kidneys, and skin. The PEL is 75 ppm.

1,1-Dichloroethane—There is no reliable information on what levels of 1,1-dichloroethane may cause effects in humans. Exposure to this chemical may cause central nervous system depression, skin irritation, drowsiness, and liver and kidney damage. The PEL is 100 ppm.

Ethylbenzene—This substance irritates the eyes, skin, mucous membranes, and, in high concentrations, is narcotic. The PEL is 100 ppm.

Freon 113—Freon 113 will be used in the analytical procedure used to measure the total petroleum hydrocarbons (TPH) concentrations in soils and groundwater. Exposure to Freon 113 may occur through inhalation, ingestion, or skin contact. The OSHA-PEL is 1000 ppm. Refer to material safety data sheets (MSDS) presented in Appendix B. A ventilation system will be provided in the laboratory to minimize inhalation of these vapors during the

analytical procedures. Also, nitrile gloves and eye protection will be worn when Freon is being used.

Hexane—Hexane will be used to decontaminate sampling equipment in the field. The only effect observed with low airborne concentrations of hexane is mild irritation of the eyes and skin. Acute narcosis may occur at high inhaled concentrations, resulting in slight nausea, headache, and dizziness. Contact with mucous membranes and skin contact may result in irritation and dermatitis. A serious chronic systemic effect from inhalation, ingestion, and/or absorption is a peripheral neuropathy (disease of cranial and spinal nerves from where they exit the brain to their terminations in peripheral structures). The PEL is 50 ppm. See the MSDS in Appendix B of this SSHP.

Methanol—Methanol will be used to decontaminate sampling equipment in the field. Mild poisoning is characterized by fatigue, nausea, headache, and delayed visual blurring. Moderate intoxication results in severe depression. Temporary or permanent blindness may follow in two to six days. In severe poisoning, symptoms progress to rapid, shallow respiration, cyanosis, coma, hypotension, dilated pupils, and visual disturbance. Death may result from respiratory failure. The TLV-TWA is 200 ppm.

Methylene Chloride—Methylene chloride is a U.S. Environmental Protection Agency (USEPA) Group B2 carcinogen, which classifies the compound as having sufficient evidence of carcinogenicity in animals but insufficient evidence of carcinogenicity in humans. Routes of entry are inhalation, ingestion, and skin and eye contact. It is irritating to the eyes and skin, and is a mild narcotic. Symptoms of exposure include fatigue, headache, giddiness, stupor, irritability, numbness, and tingling in the limbs. The ACGIH classifies methylene chloride as a suspected human carcinogen. The TLV-TWA is 50 ppm.

Tetrachloroethene—Exposure to tetrachloroethene can cause irritation to the eyes, nose, and throat; nausea, flushed face and neck, vertigo,

dizziness, and headache. It is a suspected carcinogen. The PEL is 25 ppm.

1,1,2,2-Tetrachloroethane—1,1,2,2-tetrachloroethane is a powerful narcotic and may cause liver poisoning. Exposure may cause nausea, vomiting, diarrhea, headache, stupor, and renal damage leading to anuria and azotemia. The PEL is 1 ppm.

Toluene—Toluene can cause loss of coordination, memory lapses, anorexia, and, at higher concentrations, may cause palpitation, extreme weakness, and impaired reaction times. The PEL is 100 ppm.

1,1,1-Trichloroethane (Methyl Chloroform)—Exposure to the vapor or liquid phases may cause irritation to the eyes and respiratory system. Dizziness, lack of coordination, drowsiness, increased reaction time, unconsciousness, and death may be seen at high concentrations. Mild conjunctivitis may develop, and skin contact causes dry, scaly, and fissured dermatitis. The PEL is 350 ppm or 1900 mg/m³.

Trichloroethene—Trichloroethene, upon exposure, may produce visual disturbance, mental fatigue, nausea, vomiting, and flushing of the skin and face (if alcohol is consumed before or after exposure). The carcinogenesis is unclear at present. The PEL is 25 ppm.

Trichlorofluoromethane—Trichlorofluoromethane acts as a weak narcotic, with no noticeable effects until exposure levels many times higher than the ceiling limit are reached. The PEL is 1000 ppm.

Xylenes—Xylene may be narcotic in high concentrations. Chronic toxicity is not well defined, but the substance is less toxic than benzene. The PEL is 100 ppm.

4.1.2 Semivolatile Organic Compounds

Chrysene—This substance is classified as a

suspected human carcinogen by the ACGIH. No PEL or TLV-TWA values are available.

Bis(2-ethylhexyl)Phthalate (Di-sec-octyl-phthalate)—Bis-(2-ethylhexyl) phthalate is a poison by the intravenous route and a suspected carcinogen and experimental teratogen. It is a mild skin and eye irritant and affects the gastrointestinal tract. The PEL is 5 mg/m³.

Naphthalene—Poisoning may occur by ingestion of large doses, inhalation, or skin absorption. Symptoms can include nausea, vomiting, headache, diaphoresis, hematuria, hemolytic anemia, fever, hepatic necrosis, convulsions, and coma. The PEL 10 ppm.

Pentachlorophenol—Poisoning can occur through inhalation, absorption, ingestion, and contact. Target organs include the central nervous system, the cardiovascular system, respiratory system, eyes, liver, skins, and kidneys. Symptoms include eye, nose, and throat irritation; weakness, sweating, dizziness, nausea, vomiting, chest pain, and dermatitis. The PEL is 0.5 mg/m³.

4.1.3 Metals

Arsenic—The toxic effects of arsenic exposure are usually seen only in industrial workers who have inhalation exposure to arsenic trioxide (As₂O₃). Arsenic compounds are capable of producing severe gastrointestinal symptoms and acute dermatitis. The ACGIH classifies As₂O₃ a suspect human carcinogen (A₂). The PEL for inorganic arsenic compounds is 0.01 mg/m³.

Lead—Inhalation, ingestion, and dermal absorption of lead effects the central nervous system, blood, gastrointestinal, gums, and kidneys. The early effects are nonspecific and are difficult to distinguish from the symptoms of a cold or flu. The PEL for lead is 0.05 mg/m³.

4.1.4 Pesticides and PCBs

Arochlor 1260 is a member of the PCB family. Human experience data on PCB exposure are limited to a few poisoning incidents. Ingestion of

PCB-contaminated (1500–2000 ppm) rice bran oil has caused nausea, lethargy, chloracne, brown skin pigmentation, subcutaneous edema of the face, a cheese-like discharge from the eyes, and jaundice. Industrial skin exposures have caused dermatitis and chloracne. A slight increase in the incidence of cancer, particularly melanoma of the skin, has been reported in a small group of men exposed occupationally to Arochlor 1254. Animal studies have shown PCBs to be capable of increasing the incidence of several types of cancer. The PEL for exposure to PCBs (42% chlorine and 54% chlorine) is 1 mg/m³ and 0.5 mg/m³, respectively.

4.1.5 Miscellaneous

Thinners, Paint Removers, and Paints—

Various paints and paint removers have been stored or used on site. Some of the chemicals that may have been present in these substances include methyl alcohol, isopropanol, and methylethylketone. The PEL for these substances is 200 ppm, 400 ppm, and 200 ppm, respectively.

TPHs—The exact identity of the compounds on site is unknown. TPHs include gasoline, diesel, kerosene, and petroleum distillates. Inhalation of high concentrations of TPHs can cause dizziness, drowsiness, headache, nausea, and irritation of the eyes, nose, and throat. Dermal contact can cause dry, cracked skin.

Diesel Range Organics (DRO)—This group includes most diesel compounds. Inhalation of high concentrations of DROs can cause dizziness, drowsiness, headache, nausea, and irritation of the eyes, nose, and throat. Dermal contact can cause dry, cracked skin.

Gasoline Range Organics (GRO)—This group includes most gasoline type compounds: benzene, toluene, ethylbenzene, and xylenes (BTEX). Inhalation of high concentrations of BTEX can cause dizziness, drowsiness, headache, nausea, and irritation of the eyes, nose, and throat. Dermal contact can cause dry, cracked skin.

4.2 Physical Hazards

Field personnel may be exposed to a number of physical hazards during this project. Physical hazards that may be encountered are:

- Cold weather;
- Lifting;
- Slips, trips, and falls;
- Electrical equipment; and
- Fire.

4.2.1 Cold Stress

Fatal exposure to cold among workers has almost always resulted from accidental exposures involving failure to escape from low air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. Employees should be protected from exposure to cold so that the deep core temperature does not fall below 36°C; reduced body temperature will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness leading to death. See Standard Operating Procedure (SOP) A—Cold Stress in Appendix A for cold stress monitoring guidelines and control.

4.2.2 Lifting Hazards

Field team members may be exposed to injury caused by lifting heavy objects. All field team members are trained in the proper method used to lift heavy equipment and cautioned against lifting objects that are too heavy for one person. All drums will be staged using an approved drum dolly or other appropriate equipment. Proper care will be taken in the use of this equipment.

4.2.3 Slips, Trips, and Falls

The most common hazards that will be encountered will be slips, trips, and falls. Use common sense to avoid these hazards. When working on slippery surfaces, plan tasks to decrease the risk of slipping. Avoid slippery surfaces, do not hurry, and maintain good housekeeping.

4.2.4 ATV Hazards

An ATV will be operated during the field effort at Kalakaket RRS. In order to safely operate an ATV during the field sampling effort, ATV drivers will observe and follow the following safety rules concerning ATVs:

- No ATV may be operated without an approved motorcycle helmet, eye protection, long pants, and a long-sleeved shirt or jacket;
- No ATV may be operated at excessive speeds; the ATV will be driven with the proper speed for the terrain, visibility, and the driver's experience with ATVs;
- No stunts (i.e., wheelies, jumps, etc.) will be allowed; and
- Field team members will always be cautious when driving an ATV, especially when approaching hills, turns, and obstacles, and when in unfamiliar or rough terrain.

The preceding rules will be followed by all field team members who will be operating ATVs at the field site.

4.2.5 Electrical Hazards

A portable gas-powered generator may be required at this site. When using extension cords, ensure that they are in good condition. Never use extension cords in wet areas without plugging the extension cord into a ground fault interrupter (GFI). GFIs will sense a short to ground and cut power.

4.2.6 Fire Hazards

Fire hazards include ignited brush and grass, equipment, and flammable liquids (e.g., methanol). All field personnel should be instructed on how to prevent and extinguish fires. Field vehicles and laboratories should be equipped with fire extinguishers.

4.3 Biological Hazards

The field team should be aware that site activities, mainly in remote areas, may disturb the local wildlife population. Therefore, there is potential for field personnel to be bitten by animals and insects. Prompt first aid measures are extremely important. All field team members will be properly briefed regarding the potential for encountering wildlife as well as prompt first aid procedures in the event of insect or animal bites.

Both brown and black bears are common at Kalakaket Creek and pose a potential threat to employees working at the site. The following information provides guidelines for working in bear habitat:

- ▶ Make plenty of noise to avoid surprising bears at close distance and look for signs of a bear's presence.
- ▶ Avoid attracting bears through improper handling of food and garbage.
- ▶ Avoid "crowding" bears; respect their personal space. If a bear is seen at a distance, do not attempt to take a closer look.

The following information is taken from *The Bear Facts; The Essentials for Traveling in Bear Country*, a brochure published by several state and federal agencies, including Alaska Department of Fish and Game, Alaska Department of Public Safety, Division of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

Close Encounters: What to do

If you see a bear, avoid it if you can.

Give the bear every opportunity to avoid you. If you do encounter a bear at close distance, remain calm. Attacks are rare. Chances are, you are not in danger. Most bears are interested only in protecting food, cubs, or their "personal space." Once the threat is removed, they will move on. Remember the following:

- ▶ **Identify Yourself.** Let the bear know you are *human*. Talk to the bear in a normal voice. Wave your arms. Help the bear recognize you. If a bear cannot tell what you are, it may come closer or stand on its hind legs to get a better look or smell. A standing bear is usually curious, not threatening. You may try to back away slowly diagonally, but if the bear follows, *stop* and hold your ground.
- ▶ **Don't Run.** You can't outrun a bear. They have been clocked at speeds up to 35 mph, and like dogs, they will chase fleeing animals. Bears often make bluff charges, sometimes to within 10 feet of their adversary, without making contact. Continue waving your arms and talking to the bear. If the bear gets too close, raise your voice and be more aggressive. Bang pots and pans. Use noisemakers. Never imitate bear sounds or make a high-pitched squeal.
- ▶ **Surrender.** If a brown bear actually touches you, fall to the ground and play dead. Lie flat on your stomach, or curl up in a ball with your hands behind your neck. Typically a brown bear will break off its attack once it feels the threat has been eliminated. Remain motionless for as long as possible. If you move, a brown bear may return and renew its attack and you must again play dead. If you are attacked by a black bear, fight back vigorously.

Protection

Firearms should *never* be used as an alternative to common-sense approaches to bear encounters. If you are inexperienced with a firearm in emergency situations, you are more likely to be injured by a gun than a bear.

A .300-Magnum rifle or a 12-gauge shotgun with rifled slugs are appropriate weapons if you have to shoot a bear. Heavy handguns such as a .44-Magnum may be inadequate in emergency situations, especially in untrained hands.

State law allows a bear to be shot in self defense if you did not provoke the attack and

if there is no alternative, but the hide and skull must be salvaged and turned over to the authorities.

Defense aerosol sprays which contain capsicum (red pepper extract) have been used with some success for protection against bears. These sprays may be effective at a range of 6-8 yards. If discharged upwind or in a vehicle, they can disable the user. Take appropriate precautions. If you carry a spray can, keep it handy and know how to use it.

4.4 Confined Space Entry Hazards

Site activities will not include confined space entry.

Section 5

PERSONAL PROTECTIVE EQUIPMENT

PPE ensembles are specified to protect employees from potential contamination hazards while conducting on-site field activities. Only modified Level D is expected to be used at the Kalakaket Creek RRS work sites. The following subsections describe the PPE requirements for this investigation. See Table 5-1 for a summary of PPE requirements for this SI.

Table 5-1
Equipment Requirements for the PPE Program
Levels of Protection

	Level	
	Level D	Level C
Hard hat	X	X
Safety glass/splash shield	X/O	X/O
Work clothes	X	O
Boots, safety with steel toe and shank	X	NR
Boots, chemical resistant with steel toe and shank, or boot covers to go over safety boots	NR	X
Gloves, inner and outer, chemical resistant (nitrile)	O	X
Air purifying full-face or half-face respirator	NR	X
Chemical-resistant clothing	NR	X
Disposable boot protectors	NR	O
Hearing protection	O	O

X = Required.
O = Optional
NR = Not required.

5.1 Level D Protection

When the atmosphere contains no known hazard and work functions preclude splashes, immersions, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals,

Level D Protection may be used. Level D does not provide respiratory protection and provides minimal dermal protection. Level D ensemble consists of:

- Work clothes that may consist of a long-sleeved cotton shirt and cotton pants, or cotton overalls, or disposable overalls, such as Tyvek™;
- Safety boots/shoes;
- Safety glasses or chemical splash goggles;
- A Class A hard hat that is nonmetallic and impact-resistant worn for head protection in the presence of overhead hazards;
- Inner and outer nitrile gloves (only required for handling potentially contaminated items—e.g., during soil sampling); and
- Hearing protection (optional).

The level of protection required for specific field activities will be upgraded or downgraded by the supervising geologist. Modifications or upgrades in the level of protection may be initiated on the basis of results of air monitoring, as described in section 7.0, the presence of toxic metal-laden dust, the presence or absence of overhead hazards, or the presence or absence of loud equipment. Hard hats may not be required when the field crew is working in open fields. However, head protection must be worn in the presence of overhead hazards. Since no drilling rigs or other loud equipment will be used during this investigation, hearing protection will not be required but should be available.

5.2 Level C Protection

Level C protection may be used during the following conditions: when the atmospheric contaminants, liquid splashes, or other direct contact may adversely affect any exposed skin; if the types of

air contaminants have been identified and concentrations measured; if a cartridge is available that can remove the contaminant; and if all criteria for the use of air-purifying respirators are met. Level C provides the same level of skin protection as Level B, but a lower level of respiratory protection. The Level C ensemble consists of the following:

- Full-face or half-face (modified Level C) air purifying respirator equipped with organic vapor/HEPA filter cartridges;
- Chemical-resistant clothing such as Saranex®-coated Tyvek;
- Inner and outer nitrile gloves;
- Chemical-resistant safety boots/shoes or boot covers to go over safety boots;
- Hard hat (Class A); and
- Hearing protection (optional).

The above Level C ensemble may be modified under the following circumstances:

- 1) Downgrade to a half-face air purifying respirator when, based on chemical exposure monitoring results, personnel only require a respiratory protection factor equal to 10 times the PEL for inhalation of potential chemical contaminants (see section 7.0, Exposure Monitoring). However, when a potential for exposure to airborne dust contaminated with toxic metals exists, a full-face air purifying respirator that affords a greater protection factor (50 times the PEL) must be worn.
- 2) Downgrade to non-chemical-resistant coveralls when no potential for dermal contact with splashes or immersions exists.

The modified Level C ensemble consists of the following:

- Half-face air purifying respirator equipped with organic vapor/HEPA filter cartridges;
- Disposable coverall;
- Inner and outer nitrile gloves;
- Chemical-resistant safety boots/shoes or boot covers to go over safety boots;
- Hard hat; and
- Hearing protection (optional).

The supervising geologist may upgrade or downgrade the level of protection used by field team members on the basis of the following: 1) the air monitoring protocols in section 7.0 for respiratory protection, 2) the potential for inhalation exposure to toxic metals and the need for dermal protection during the activity, 3) the presence or absence of overhead hazards, and 4) the presence or absence of excess noise levels.

5.3 First Aid, Emergency, and Safety Equipment

The following first aid, emergency, and safety equipment will be maintained on site:

- A first aid kit;
- A 15-min portable eye wash that meets the American National Standards Institute (ANSI) Z-358.1 requirements. The eyewash equipment must be capable of delivering to the eye not less than 1.5 l per min (0.4 gal. per min) for 15 min.
- Appropriate A, B, or C type extinguisher not less than 2 lb carried in every vehicle used during field operations.
- Food, water, and supplies for overnight camping in the event that sudden changes in weather prevent the landing of the support plane at the end of the day.

Section 6

PERSONNEL TRAINING AND STANDARD SAFETY PROCEDURES

All authorized on-site personnel must have satisfactorily completed the required OSHA 40-hour Hazardous Waste Training Course and the 8-hour annual refresher training (when necessary). The supervisory geologist will conduct a site-specific safety orientation for all field team members engaged in field work. Section 6.1 describes the contents of the site-specific safety orientation.

6.1 On-Site Safety, Health, and Emergency Response Training

The OSHA 1910.120 standard requires that site training be provided by a trained, experienced supervisor. Trained is defined to mean an individual that has satisfactorily completed OSHA-HAZWOPER 40 hour and Supervisor Training. The supervising geologist will have received this training and will provide the on-site safety orientation. An on-site orientation session will be required for all on-site personnel and will include the following:

- ▶ Review of the employees rights and responsibilities under OSHA;
- ▶ Health effects and hazards of the chemicals identified or suspected to be on site;
- ▶ Protection against chemical and physical hazards, snakes, insects, animals, and human pathogens;
- ▶ Implementation of the "buddy system";
- ▶ Personal hygiene;
- ▶ Decontamination procedures;
- ▶ Standard safety procedures;
- ▶ PPE;
- ▶ Work area and zone health and safety information, including:

- Site layout,
- Procedures for entry and exit of areas and zones, and
- Standard safe work practices;

- ▶ Medical Surveillance Program;
- ▶ Emergency procedures, including:
 - Emergency contacts,
 - Instructions for implementing the emergency response and contingency plan, and
 - Location of emergency equipment; and
- ▶ Review of information contained in this SSHP, including the MSDSs in Appendix B.

The supervising geologist must maintain a record of the on-site training participants.

6.2 Standard Safety Procedures

This section describes the standard safety procedures that the contractor requires all on-site personnel to follow.

6.2.1 General Safety Work Practices

All on-site personnel will observe the following general safe work practices:

- ▶ No food, drink, or tobacco products will be allowed in the exclusion and contamination reduction zones;
- ▶ Loose clothing, hair, and jewelry will not be permitted around moving equipment;
- ▶ The "buddy system" will be implemented, whereby a pair of co-workers "watch out" for each other while in proximity of potential physical work hazards; and

- ▶ Aerosolization of contaminated soil, sediment, and water will be prevented where possible.

6.2.2 Respiratory Protection

Respiratory protection will be available for field personnel to use as required. The proper use and maintenance of the respirators are the responsibility of the field personnel. The air purifying respirator equipped with organic vapor cartridges and HEPA filters is capable of filtering airborne organic vapors, mists, and fumes out of inhaled air. This mask does not provide oxygen and should not be used in oxygen-deficient atmospheres. The mask will not provide adequate protection if the face seal is not tight. All members of the field team will be required to be clean shaven before wearing this mask. It is a violation of OSHA regulations to wear this mask with any facial hair that interferes with the face seal.

6.2.3 Personal Hygiene Practices

The field team must pay strict attention to sanitation and washing requirements to avoid personal contamination. The following instructions will be discussed and must be followed:

- ▶ Never put anything in the mouth, including fingers;
- ▶ All employees must wash their hands, forearms, face, and neck before eating, drinking, smoking, or using the restroom;
- ▶ Smoking and open flames are prohibited on site; and
- ▶ At the end of the day, all employees will shower thoroughly.

Section 7

EXPOSURE MONITORING PLAN

This exposure monitoring plan describes the air monitoring, personnel monitoring, the sampling methods and instrumentation to be used, the methods and frequency of calibration, and the action levels of the potential work-site hazards. When engaged in air monitoring, field personnel must use appropriate forms to record air monitoring data and air monitoring instrument calibration (see Figures 7-1 and 7-2, respectively). All monitoring records/forms will be maintained in the project file.

7.1 Air Monitoring

The following program is established for ongoing surveillance to detect changes in the ambient air to ensure the continuing accuracy of the work zones and the adequacy of the level of worker protection. During field activities, a designated field team member will monitor the work site for organic vapors. Calibration of all monitoring equipment will be performed in accordance with the manufacturers' procedures by trained instrument technicians or authorized representatives. The project manager or representative will be notified of any levels of contaminants that cause a suspension of site activities.

7.1.1 Organic Vapor Concentrations

Real time monitoring for organic vapor concentrations in the breathing zone will be conducted during field operations with an HNu® photoionization detector (PID) or equivalent organic vapor monitor (OVM) equipped with a 10.2- or 11.7-eV probe. The OVM will respond to gases and vapors that have an ionization potential less than the electron voltage of the lamp, including benzene (9.25 eV) and toluene (8.82 eV). A OVM will be taken into the field and operated during soil-disturbing activities where contaminated soil may be encountered. Air monitoring will be conducted whenever new soil is broken and at least every 30 min after that. Measurements will be made in the personnel breathing zones where activities are being performed. The instrument will be calibrated using isobutylene vapor of known concentration before

and after use each day. Air calibration measurements will be documented in writing and kept in the project file.

A working limit of 5 ppm (as registered on the OVM) above background is proposed as the maximum acceptable organic vapor level of exposure without respiratory protection. Only measurements made with the OVM in the breathing zone for a minimum of 3 min will be used as PPE selection criteria. The selection criteria for respiratory component of PPE are as follows:

- ▶ If air concentrations are 0-5 ppm (as detected by the OVM) above background, then modified Level D PPE will be worn.
- ▶ If air concentrations are 5-10 ppm (as detected by the OVM) above background, then Level C PPE will be worn.
- ▶ If air concentrations are greater than 10 ppm (as measured by the OVM) above background, then evacuate work site and notify the site safety and health officer, and the project manager. The project requirements in the field sampling plan will be reevaluated.

7.1.2 Airborne Particulate Concentrations

Field personnel are not required to monitor for airborne particulate or aerosols when working in areas where there is a potential for exposure to airborne toxic metal compounds. However, personnel will be required to don a full-face or half-face air purifying respirator if visible airborne dust is generated by work activities.

7.2 Physical Conditions Monitoring

Cold stress monitoring must comply with the Cold Stress SOP in Appendix A of this SSHP.

Date: ___/___/___

AIR MONITORING DATA

Page ___/___

Time	%LEL	%H ₂ S	%O ₂	PID	DETECTOR TUBE	CODES		REMARKS Weather Conditions
						Type	Reading	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	
						BZ HS SL OT	BH SS SB TP WO OT	

TYPE CODES

[BZ] - Breathing Zone [HS] - Headspace [SL] - Surface Location

[OT] - Other: _____

READING CODES

[BH] - Borehole [SS] - Soil Sample [SB] - Sample Bottle [TP] - Test Pit [WL] - Well

Figure 7-1. Air Monitoring Data Form

AIR MONITORING INSTRUMENTS

Page /

SITE:	ACTIVITY:		DATE:
Drilling:	Soil Gas Survey:		Water Sampling:
OTHER:	WEATHER:		
AMBIENT TEMPERATURE, °F	ATM. PRESSURE, in Hg	% HUMIDITY	TIME:

INSTRUMENTATION

☐ **Combustible Gas Indicator (CGI)**

CGI Model:	CGI Number:	
Calibration Gas Type:	Concentration, %LEL:	Cylinder Number:
CALIBRATOR NAME	PRINTED	Signature

☐ **Photoionization Detector (PID)**

Model	Serial number	Probe Number [] 10.2 ev [] 11.7 ev
Calibration Gas Type:	Concentration: at _____ ppm span _____	Cylinder Number:
CALIBRATOR NAME	PRINTED	Signature
Time:	Calibrated Span/Remarks:	

☐ **Detector Tube System**

System Model:	Bellows Pump Number:	
Tube Type	Batch Serial Number	Expiration Date
1.	_____	
2.	_____	
3.	_____	
4.	_____	
5.	_____	

Figure 7-2. Air Monitoring Instrument Calibration Form

Section 8

MEDICAL SURVEILLANCE

This section discusses what the medical surveillance program entails, how the results are reviewed by a physician, and how participation is certified.

8.1 Medical Surveillance Program

Contractors and subcontractors provide their employees with an annual in-depth medical examination, including a comprehensive health history, blood chemistry with complete blood count and differential, urinalysis, medical history, required chest x-rays, audiogram, pulmonary function testing, testing for heavy metals, as needed, and a physician's interpretation of each employee's medical surveillance examination, including the ability of the employee to wear a respirator.

A comprehensive medical examination will be performed if an employee develops signs or symptoms indicating possible overexposure to hazardous substances and/or heat or cold stress.

8.2 Physician Reviewal

All medical surveillance and examination results are reviewed by a licensed physician who is certified in occupational medicine by the American Board of Preventative Medicine.

8.3 Participation Certification

The results of employee participation in the medical surveillance program becomes part of their permanent medical record maintained in the employee's home office. A list of the names of all site employees participating in medical surveillance is certified by the corporate health and safety director and must be maintained on site. The list must include the date of each employee's most recent examination and name of the examining physician. Subcontractors must submit to the project manager documentation of all their site employees' participation in their medical surveillance program before starting operations at the site.

Section 9

SITE CONTROL MEASURES AND DECONTAMINATION PROCEDURES

To minimize the possibility of transferring hazardous substances from the site, contamination control procedures are needed. These procedures consist of site control measures (which entails the delineation of work zones, communications, and site security), and decontamination procedures (which are necessary for both personnel and equipment). This section discusses site control measures and decontamination procedures to be used during the SI at Kalakaket Creek RRS.

9.1 Site Control Measures

Site control can be achieved through effective delineation of the work zone, by providing a means to communicate, and by establishing site security.

9.1.1 Work Zone Delineation

To minimize the transfer of hazardous substances from the site and to ensure proper protection of personnel, informal work zones will be established during sampling operations by the SSHO (supervising geologist). An exclusion zone (EZ) and contaminant reduction zone (CRI) will be established for each sampling site; however, no formal work zones will be physically delineated.

Exclusion Zone (EZ)

Contamination does or could exist in this zone. Only properly authorized and trained individuals (refer to section 6.0), wearing appropriate PPE will be allowed to enter and work in this zone. All people entering the EZ must wear at least modified Level D protection.

Contamination Reduction Zone (CRZ)

Between the EZ and the support zone (SZ) will be the CRZ, which will provide a transition between the potentially contaminated EZ and the clean SZ. The CRZ (located upwind of the EZ if possible) will be a corridor leading from the EZ and will serve as a buffer to further reduce the probability of the SZ becoming contaminated. Exit from the EZ will be through this CRZ.

The CRZ will further ensure that the physical transfer of contaminating substances on people, equipment, or in the air will be limited through a combination of decontamination and zone restrictions. Within this zone, personnel may perform limited personal decontamination (e.g., face and hand washing) and certain PPE and small equipment decontamination. Buckets or wash basins for boot washing and equipment decontamination will be stationed on a sheet of plastic (a minimum of 8 x 8 ft), the boundaries of which will constitute the CRZ.

Support Zone (SZ)

The SZ will be considered a noncontaminated area. The location of support facilities in the SZ will be upwind of the EZ (where possible) and readily accessible to the nearest road. Support facilities, equipment vehicles, and first aid station will be located in this zone. Within this zone, potentially contaminated personal clothing, equipment, and samples are not permitted unless properly containerized.

9.1.2 Communications

Because of the remote nature of this site, off-site communications is restricted to the use of VHF radios. Base stations radios that will be capable of transmitting and receiving signals for a distance of 25 miles will be set-up at the Galena Airport Fire Station and at the Kalakaket Creek RRS site. This communication equipment will be installed prior to the start of sampling activities and will be tested daily to ensure that it is functional. The Galena Airport Fire Station will monitor the established emergency frequency continuously while field personnel are at Kalakaket Creek. Field personnel will inform the Galena Airport Fire Station of their arrival at Kalakaket Creek every morning and will check out, in person, upon their arrival in Galena in the evening. All other radio communication between Kalakaket Creek and the Galena Fire Station will be on an emergency basis only.

9.1.3 Site Security

No special site security measures will be required during this investigation. The facility is abandoned and therefore no one is expected to be on site other than contractor and Air Force oversight personnel. When the field crew leaves the site for the day, some supplies and the field radio may be placed in one of the abandoned structures and locked for overnight storage.

9.2 Decontamination Procedures

Decontamination of personnel and equipment leaving the EZ will be performed to minimize human exposure to hazardous substances and to minimize the spread of contamination to surrounding areas. The purpose of the CRZ is to provide a location to perform limited personnel decontamination and certain PPE and small equipment decontamination. If the decision is made not to establish an EZ or CRZ, decontamination will be performed on site in a manner deemed appropriate by the supervising geologist. More extensive personnel decontamination may be performed after returning to Galena at the end of the day.

9.2.1 Personnel Decontamination

Persons leaving the EZ must pass through the CRZ and follow decontamination procedures before entering the SZ. Hand tools and other sampling equipment used in the EZ and reusable PPE (boots, safety glasses, etc.) will be appropriately cleaned prior to removal from the site each day. The step-by-step sequence for personnel decontamination is as follows:

- Wash outer gloves and chemical-resistant boots (if used) at the boot washing station;
- Remove wrist tape (if used) and outer gloves, and place them in the disposal container provided;
- Remove ankle tape (if used) and disposable coveralls (if used), and place them in the disposal container provided;
- Remove respirators (if used) and place each in designated locations in the CRZ;
- Remove inner gloves and discard in the disposal container provided; and
- Wash hands and face, and proceed to the SZ.

Respirators must be fully decontaminated after each use. All project personnel are required to take a thorough soap and water shower at the end of each work day. If monitoring or a general exposure assessment indicates that an employee has become contaminated, notify the SSHO.

9.2.2 Equipment Decontamination

All equipment leaving the EZ must be decontaminated either within the CRZ or at the central decontamination area. Small equipment, such as hand tools, will be thoroughly decontaminated within the CRZ before being placed in the SZ. Personnel performing decontamination shall wear the appropriate level of PPE (refer to section 5.0) and must follow approved protocol outlined in the field sampling plan.

Section 10

EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

The objective of emergency response and contingency procedures is to ensure that effective actions are implemented in a timely manner to minimize or control the effects of adverse events (potential chemical exposures, personal injuries, fires/explosions, spills/releases). The following subsections describe the basic emergency responses required for the field investigation.

10.1 Emergency Phone Numbers

Table 10-1 is the listing of emergency telephone numbers and agencies. Radio contact will be maintained with the Galena Airport Fire Station.

10.2 Clinic Information

The Galena Medical Clinic is prepared to treat minor injuries. The phone number for the health clinic is 656-1266. In the event of trauma or serious injury, emergency aircraft support to airlift patients to the nearest medical facility can be arranged through the clinic. These services can also be called directly. Air ambulance service to Humana Hospital, Anchorage, AK, can be arranged by calling 1-258-3822.

10.3 Accident and Emergency Medical Response

Accident and emergency medical response planning for potential chemical exposures and personal injuries is included in this SSHP. Before beginning site activities, the supervising geologist will ensure that each field team member knows where the nearest emergency medical facilities are and how to get there. The closest medical aid facility is the Galena Medical Clinic, which is to be used in all cases of serious emergencies at the direction of the supervising geologist. The telephone numbers of the local emergency services will be available in the SZ, and the supervising geologist will brief the field team on the procedures for calling/radioing for help in an emergency.

The field team will be aware of the location of a first aid kit kept on site. The supervising

geologist should be prepared to handle minor injuries and perform cardiopulmonary resuscitation (CPR).

Depending on the severity of an accident or medical emergency, the supervising geologist will be responsible for:

- ▶ Removing the injured or ill person from the hazardous area;
- ▶ Helping a person splashed with potentially hazardous chemicals to 1) use the emergency eyewash a minimum of 15 min or while being transported to an emergency facility; 2) decontaminate and remove PPE, and 3) remove contaminated clothing and wash the skin a minimum of 15 min or while being transported to an emergency facility;
- ▶ Arranging transportation of the injured worker from the site and to an emergency medical facility;
- ▶ Requesting emergency medical assistance via the on-site radios; and/or
- ▶ Treatment of minor injuries.

Accidents or medical emergencies that require support will be brought to the attention of the Kalakaket Creek RPM as soon as possible. The supervising geologist will cooperate with the RPM in accomplishing all required administrative functions. In addition, the supervising geologist will notify the EAC and project manager.

Immediate reporting required by OSHA (29 CFR 1904) will be done for accidents involving fatalities or catastrophes (five or more people sent to hospital). All other personal injuries requiring first aid or resulting in lost time must be recorded on OSHA form 200.

Table 10-1
Emergency and Information Numbers, Galena

Organization	Number
Fire Department for Emergency Only	911
Police Department	656-1303
Galena City Health Clinic	656-1266
Galena Public Utilities	656-1444
State Troopers	656-1233
BLM—To Report Forest Fires	656-1222
Air Ambulance, Humana Hospital, Alaska	1 + 258-3822
Poison Control Center, Providence Hospital	1 + 800-478-3193
Providence Hospital Emergency Department	1 + 261-3111
Search and Rescue Air Force Rescue Coordination Center, Elmendorf AFB	Call Collect 552-5375

10.4 Fire Emergency Procedures

The threat of fire on this particular project is considered slight. Fire hazards can, however, exist during equipment refueling. The supervising geologist will check to see that each vehicle fire extinguisher is appropriate for the fire hazard presented by this project. Generally, a Type A, B, or C extinguisher will be appropriate and must have been certified within the past year.

Immediately upon discovery of any fire, the field team will notify the supervising geologist. All large fires that require additional assistance for containment will be reported via radio to the Galena Airport Fire Station as soon as possible.

In event of a fire, the supervising geologist will direct precautionary actions on site after notifying the fire department. These precautionary actions include:

- ▶ Notification of all site personnel that a fire exists and to return to the support area;
- ▶ Shutting down site activities immediately;

- ▶ Accounting for all site workers; and
- ▶ Evacuating the site if necessary.

10.5 Chemical Spills and Releases

The SI activities pose only a small risk of a chemical spill or release into the environment because of the contractor's spill prevention plan and spill response preparation. The spill prevention plan discusses such issues as 1) storing a sufficient amount of spill containment equipment (i.e., adsorbents, scoops, and disposal containers) in proximity to the bulk chemicals; and 2) limiting the amount of chemicals transported, handled, and stored to the smallest amount needed to complete the field activities. The bulk chemicals necessary for the field activities are centrally stored in a secured storage area. All chemicals brought to the site will be appropriately contained before, during, and after use. All field employees are trained to watch for equipment leaks and to prevent spills while handling chemicals.

In the event of a chemical spill, all field employees are trained to respond in the following manner:

- ▶ Alert all employees in the area;
- ▶ Notify the supervising geologist and the RPM;
- ▶ Identify the material;
- ▶ Contain the spill by immediately stopping further spillage and by using the containment equipment, without risking personal injury;
- ▶ Prohibit access to spill area except for properly protected personnel involved in cleanup and disposal;
- ▶ Clean up the spill if there is not a hazardous chemical and there is no risk of injury; and

- ▶ Dispose of waste material correctly.

10.6 Accident Prevention

Potential physical, chemical, biological, and safety hazards have been previously discussed in this SSHP. Field personnel are required to be aware of potential hazards and to use appropriate protective gear to prevent accidents. If an accident, injury, or near miss does occur, the project manager/supervising geologist will complete 1) a "First Report of Injury" and submit it to the contractor's Human Resources Department; and 2) an "Incident Report" to be submitted to the EAC. This reporting and corrective action information is used to prevent a more serious occurrence.

Section 11

LOGS, REPORTS, AND RECORD KEEPING

This section outlines the health and safety logs, reports, and record keeping that must be maintained by the supervising geologist.

11.1 Logs

The following logs and records must be completed, retained, and submitted to the supervising geologist:

- Site Specific Training Record Form or logbook; and
- Environmental monitoring and sampling results.

11.2 Reports

The following reports and records will be submitted as required by OSHA or Air Force regulations, whichever are more stringent:

- First Report of Injury Form;
- Accident/Injury Report Form; and
- Medical monitoring records of field team members.

11.3 Record Keeping

All record keeping will be in accordance with applicable OSHA or Air Force regulations, whichever are more stringent.

Section 12

REFERENCES

CH2M Hill, *Preliminary Assessment, Kalakaket Creek*, January 1994.

Code of Federal Regulations (CFR). 29 CFR Part 1910 and Part 1926.

United States Air Force (Air Force Center for Environmental Excellence). *Handbook to Support the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Studies (RI/FS)*. 1993.

APPENDIX A
COLD STRESS SOP

SOP A:

Cold Stress

1.0 COLD STRESS

Fatal exposure to cold among workers has almost always resulted from accidental exposures involving failure to escape from low air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in deep core temperature of the body. Employees should be protected from exposure to cold so that the deep core temperature does not fall below 36°C. Reduced body temperature will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

1.1 Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C. At temperatures of 2°C or less, it is imperative that employees who become immersed in water or whose clothing becomes wet be immediately provided with a change of clothing and be treated for hypothermia. Special protection of the hands is required to maintain manual dexterity for the prevention of accidents.

1.1.1 Work Below 4°C

Provisions for additional total body protection is required if work is performed at or below 4°C as follows:

- The employees shall wear cold protective clothing appropriate for the level of cold and physical activity.

- If the air velocity at the site is increased by wind or artificial ventilation, the cooling effect of the wind shall be reduced by shielding the work area or by wearing a removable outer windbreak garment.
- If the clothing on the employee might become wet on the job site, the outer layer of the clothing in use should be water repellent.
- If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.
- Employees handling evaporative liquids at temperatures below 4°C shall take special precautions to avoid soaking of clothing or gloves because of the added danger of cold injury due to the evaporative cooling.

1.1.2 Work below -12°C

For work practices at or below -12°C, the following shall apply:

- The worker shall be under constant protective observation (buddy system).
- If work must be done, rest periods must be taken in heated shelters and opportunity for changing into dry clothing shall be provided.
- New employees shall not be required to work full-time in cold in the first few days until they become accustomed to the working conditions and required protective clothing.
- The work shall be arranged in such a way to minimize sitting still or standing still for longer periods.
- The workers shall be instructed in safety and health procedures. The training program shall include, as a minimum, instruction in:
 - Proper rewarming procedures and appropriate first aid treatment.
 - Proper clothing practices.
 - Proper eating and drinking habits.

- Recognition of impending frostbite.
- Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
- Safe work practices.

1.2 Special Workplace Recommendations

Special caution shall be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits. Eye protection shall be provided to workers employed outdoors in a snow and/or ice terrain. Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues in addition to providing for first aid treatment.

APPENDIX B

MATERIAL SAFETY DATA SHEETS

MATERIAL SAFETY DATA SHEET

PG 1

FREON

REVISION OF: 11/20/85

RADIAN CORPORATION

ORDER NO: 584W05991

3501 MOPAC BLVD

AUSTIN

TX 78758

MCKESSON CHEMICAL COMPANY ONE POST STREET SAN FRANCISCO, CA 94104

-----EMERGENCY ASSISTANCE-----

FOR EMERGENCY ASSISTANCE INVOLVING CHEMICALS CALL CHEMTREC
(800) 424-9300.

-----FOR PRODUCT AND SALES INFORMATION-----

CONTACT YOUR LOCAL MCKESSON CHEMICAL COMPANY SERVICE CENTER

-----PRODUCT IDENTIFICATION-----

PRODUCT NAME: FREON (R) TF
COMMON NAMES/SYNONYMS: FREON (R) TF;
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE

CAS NO.: 76-13-1
MCKESSON CODE: T1110002

FORMULA: C2 CL3 F3
HAZARD RATING (NFPA 704)
HEALTH: 1
FIRE: 1
REACTIVITY: 0
SPECIAL: NONE

DATE ISSUED: 10/85
SUPERCEDES: NONE
HAZARD RATING SCALE:
0=MINIMAL 3=SERIOUS
1=SLIGHT 4=SEVERE
2=MODERATE

-----HAZARDOUS INGREDIENTS-----

COMPONENT	%	EXPOSURE LIMITS, PPM			HAZARD
		OSHA PEL	ACGIH TLV	OTHER LIMIT	
FREON (R) TF	>99	1000	1000	NONE	OSHA / ACGIH LIST

(R) TRADEMARK OF DUPONT FOR ITS FLUOROCARBON COMPOUNDS

MATERIAL SAFETY DATA SHEET

PG 2

FREON

REVISION OF: 11/20/85

-----PHYSICAL PROPERTIES-----

BOILING POINT, DEG F: 117.6 VAPOR PRESSURE, MM HG/20 DEG C: 334
MELTING POINT, DEG F: -31 VAPOR DENSITY (AIR=1): 2.9
SPECIFIC GRAVITY (WATER=1): 1.57 WATER SOLUBILITY, %: NIL
APPEARANCE AND ODOR: CLEAR. EVAPORATION RATE (BUTYL ACETATE=1): <1
COLORLESS LIQUID; SLIGHT
ETHEREAL ODOR

-----FIRST AID MEASURES-----

IF INHALED: REMOVE TO FRESH AIR. GIVE ARTIFICIAL RESPIRATION IF NOT BREATHING BUT NEVER TO AN UNCONSCIOUS OR CONVULSING PERSON. GET IMMEDIATE MEDICAL ATTENTION.

IN CASE OF EYE CONTACT: IMMEDIATELY FLUSH EYES WITH LOTS OF RUNNING WATER FOR 15 MINUTES, LIFTING THE UPPER AND LOWER EYELIDS OCCASIONALLY. GET IMMEDIATE MEDICAL ATTENTION.

IN CASE OF SKIN CONTACT: IMMEDIATELY WASH SKIN WITH LOTS OF SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND SHOES; WASH BEFORE REUSE. GET MEDICAL ATTENTION IF IRRITATION PERSISTS AFTER WASHING.

IF SWALLOWED: DO NOT INDUCE VOMITING. IF CONSCIOUS, GIVE LOTS OF WATER OR MILK. GET IMMEDIATE MEDICAL ATTENTION. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON.

-----HEALTH HAZARD INFORMATION-----

PRIMARY ROUTES OF EXPOSURE: INHALATION, SKIN OR EYE CONTACT.

SIGNS AND SYMPTOMS OF EXPOSURE

INHALATION: PROLONGED OR REPEATED EXPOSURE MAY CAUSE LIGHT-HEADEDNESS, GIDDINESS, SHORTNESS OF BREATH AND POSSIBLE NARCOSIS. AT HIGH CONCENTRATIONS MAY CAUSE CARDIAC ARRHYTHMIAS.

EYE CONTACT: LIQUID AND MIST MAY IRRITATE THE EYES.

SKIN CONTACT: NO IRRITATION IS LIKELY AFTER BRIEF CONTACT BUT MAY BE IRRITATING AFTER PROLONGED CONTACT.

MATERIAL SAFETY DATA SHEET

PG 3

FREON

REVISION OF: 11/20/85

SWALLOWED: SWALLOWING LARGE QUANTITIES MAY CAUSE NAUSEA AND VOMITING.

CHRONIC EFFECTS OF EXPOSURE: NO SPECIFIC INFORMATION AVAILABLE.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: NONE KNOWN.

-----TOXICITY DATA-----

ORAL: RAT LD50 = 43 G/KG

DERMAL: RABBIT 500 MG ON OPEN SKIN PRODUCED MILD IRRITATION.

INHALATION: RAT LCLO = 87.000 PPM / 6H

CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY THE NATIONAL TOXICOLOGY PROGRAM, THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER, OR THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

OTHER DATA: NONE

-----PERSONAL PROTECTION-----

VENTILATION: LOCAL MECHANICAL EXHAUST VENTILATION CAPABLE OF MAINTAINING EMISSIONS AT THE POINT OF USE BELOW THE PEL.

RESPIRATORY PROTECTION: NIOSH-APPROVED CANNISTER RESPIRATOR IN THE ABSENCE OF ADEQUATE ENVIRONMENTAL CONTROLS AT THE POINT OF USE.

EYE PROTECTION: CHEMICAL GOGGLES.

PROTECTIVE CLOTHING: LONG-SLEEVED SHIRT, TROUSERS, SAFETY SHOES, RUBBER GLOVES, AND RUBBER APRON.

OTHER PROTECTIVE MEASURES: AN EYEWASH AND SAFETY SHOWER SHOULD BE NEARBY AND READY FOR USE.

-----FIRE AND EXPLOSION INFORMATION-----

FLASH POINT, DEG F: NONE

FLAMMABLE LIMITS IN AIR, %

METHOD USED: N/A

LOWER: N/A UPPER: N/A

EXTINGUISHING MEDIA: THIS MATERIAL IS NOT COMBUSTIBLE.

MATERIAL SAFETY DATA SHEET

PG 4

FREGON

REVISION OF: 11/20/85

SPECIAL FIRE FIGHTING PROCEDURES: FIRE FIGHTERS SHOULD WEAR SELF-CONTAINED BREATHING APPARATUS. USE WATER SPRAY TO COOL NEARBY CONTAINERS AND STRUCTURES EXPOSED TO FIRE.

UNUSUAL FIRE AND EXPLOSION HAZARDS: EXTINGUISH ALL NEARBY SOURCES OF IGNITION SINCE VAPORS DECOMPOSE TO HAZARDOUS PRODUCTS AT HIGH TEMPERATURES.

-----HAZARDOUS REACTIVITY-----

STABILITY: STABLE POLYMERIZATION: WILL NOT OCCUR
CONDITIONS TO AVOID: OPEN FLAMES, WELDING ARCS, OR OTHER HIGH TEMPERATURE SOURCES WHICH MAY INDUCE THERMAL DECOMPOSITION.

MATERIALS TO AVOID: ALKALIS, OXIDIZING MATERIALS, WATER, AND MOIST AIR. ALSO ALKALI OR ALKALINE EARTH METALS, SUCH AS POWDERED ALUMINUM OR ZINC.

HAZARDOUS DECOMPOSITION PRODUCTS: MAY LIBERATE CARBON MONOXIDE, CARBON DIOXIDE, HYDROGEN CHLORIDE, CHLORINE, PHOSGENE, OR HYDROGEN FLUORIDE.

-----SPILL, LEAK, AND DISPOSAL PROCEDURES-----

ACTION TO TAKE FOR SPILLS OR LEAKS: WEAR PROTECTIVE EQUIPMENT INCLUDING RUBBER BOOTS, RUBBER GLOVES, RUBBER APRON, CHEMICAL GOGGLES, AND RESPIRATORY PROTECTION. EXTINGUISH ALL IGNITION SOURCES. FOR SMALL SPILLS OR DRIPS, MOP OR WIPE UP AND DISPOSE OF IN DOT-APPROVED WASTE CONTAINERS. FOR LARGE SPILLS, CONTAIN BY DIKING WITH SOIL OR OTHER ABSORBENT MATERIAL AND THEN PUMP INTO DOT-APPROVED WASTE CONTAINERS OR ABSORB WITH SORBENT MATERIAL AND PLACE THE RESIDUE IN DOT-APPROVED WASTE CONTAINERS. KEEP OUT OF SEWERS, STORM DRAINS, SURFACE WATERS, AND SOIL. COMPLY WITH ALL APPLICABLE GOVERNMENTAL REGULATIONS ON SPILL REPORTING, AND HANDLING AND DISPOSAL OF WASTE.

DISPOSAL METHODS: DISPOSE OF CONTAMINATED PRODUCT AND MATERIALS USED IN CLEANING UP SPILLS OR LEAKS IN A MANNER APPROVED FOR THIS MATERIAL. CONSULT APPROPRIATE FEDERAL, STATE AND LOCAL REGULATORY AGENCIES TO ASCERTAIN PROPER DISPOSAL PROCEDURES.

NOTE: EMPTY CONTAINERS CAN HAVE RESIDUES, GASES AND MISTS AND ARE SUBJECT TO PROPER WASTE DISPOSAL, AS ABOVE.

MATERIAL SAFETY DATA SHEET

PG 5

FREON

REVISION OF: 11/20/85

-----SPECIAL PRECAUTIONS-----

STORAGE AND HANDLING PRECAUTIONS: STORE IN A COOL, DRY PLACE. STORE AWAY FROM ALL OTHER CHEMICALS AND POTENTIAL SOURCES OF CONTAMINATION. KEEP CONTAINER TIGHTLY CLOSED WHEN NOT IN USE. DO NOT USE PRESSURE TO EMPTY CONTAINER. WASH THOROUGHLY AFTER HANDLING. DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING. DO NOT HEAT ABOVE 125 DEG F.

REPAIR AND MAINTENANCE PRECAUTIONS: DO NOT CUT, GRIND, WELD, OR DRILL ON OR NEAR THIS CONTAINER.

OTHER PRECAUTIONS: VAPORS OF THIS PRODUCT ARE HEAVIER THAN AIR AND WILL COLLECT IN LOW PLACES, SUCH AS PITS OR DEGREASERS, OR OTHER POORLY VENTILATED AREAS. DO NOT ENTER PLACES WHERE VAPORS ARE SUSPECTED UNLESS SPECIAL RESPIRATORY PROTECTION IS WORN AND AN OBSERVER IS PRESENT.

OTHER PRECAUTIONS: CONTAINERS, EVEN THOSE THAT HAVE BEEN EMPTIED, WILL RETAIN PRODUCT RESIDUE AND VAPORS. ALWAYS OBEY HAZARD WARNINGS AND HANDLE EMPTY CONTAINERS AS IF THEY WERE FULL.

-----FOR ADDITIONAL INFORMATION-----

CONTACT DOUGLAS EISNER, TECHNICAL DIRECTOR, MCKESSON CHEMICAL COMPANY
DURING BUSINESS HOURS, PACIFIC TIME (415)983-9214

-----NOTICE-----

ALL INFORMATION, RECOMMENDATIONS, AND SUGGESTIONS APPEARING HEREIN CONCERNING THIS PRODUCT ARE BASED UPON DATA OBTAINED FROM THE MANUFACTURER AND/OR RECOGNIZED TECHNICAL SOURCES; HOWEVER, MCKESSON CHEMICAL COMPANY ("MCC") MAKES NO WARRANTY, REPRESENTATION OR GUARANTY AS TO THE ACCURACY, SUFFICIENCY OR COMPLETENESS OF THE MATERIAL SET FORTH HEREIN. IT IS THE USER'S RESPONSIBILITY TO DETERMINE THE SAFETY, TOXICITY AND SUITABILITY OF HIS OWN USE, HANDLING AND DISPOSAL OF THE PRODUCT. ADDITIONAL PRODUCT LITERATURE MAY BE AVAILABLE UPON REQUEST. SINCE ACTUAL USE BY OTHERS IS BEYOND OUR CONTROL, NO WARRANTY, EXPRESS OR IMPLIED, IS MADE BY MCC AS TO THE EFFECTS OF SUCH USE, THE RESULTS TO BE OBTAINED OR THE SAFETY AND TOXICITY OF THE PRODUCT, NOR DOES MCC ASSUME ANY LIABILITY ARISING OUT OF USE BY OTHERS OF THE PRODUCT REFERRED TO HEREIN. THE DATA IN THIS MSDS RELATE ONLY TO THE SPECIFIC MATERIAL DESIGNATED HEREIN AND DO NOT RELATE TO USE IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY PROCESS.

SEP 04 1990

information/emergency telephone no. 616.726.3171
chemtrec telephone no. 800.424.9300
canadian emergency telephone no. 613.996.6666

**MATERIAL SAFETY
DATA SHEET**

HEXANE

I. Identification

chemical name Hexane molecular weight 86.18
chemical family Aliphatic Hydrocarbon formula C₆H₁₄
synonyms n-Hexane
DOT proper shipping name Hexane
DOT hazard class Flammable Liquid
DOT identification no. UN1208 CAS no. 110-54-3

II. Physical and Chemical Data

boiling point, 760mm Hg. 68.7°C freezing point -95.3°C evaporation rate (BuAc=1) ca 10
vapor pressure at 20°C 124 mm Hg vapor density (air=1) 3.0 solubility in water @ 20°C 0.014%
% volatiles by volume ca 100 specific gravity (H₂O=1) @ 20°C 0.659 stability Stable
hazardous polymerization Not expected to occur.
appearance and odor Clear, colorless liquid with a mild hydrocarbon odor.
conditions to avoid Heat, sparks, open flame, open containers, and poor ventilation.

materials to avoid Strong oxidizing agents.

hazardous decomposition products Incomplete combustion can generate carbon monoxide and other toxic vapors.

III. Fire and Explosion Hazard Data

flash point, (test method) -26°C (Tag closed cup) auto ignition temperature 225°C
flammable limits in air % by volume: lower limit 1.1 upper limit 7.5
unusual fire and explosion hazards Very volatile and extremely flammable.

extinguishing media Carbon dioxide, dry chemical or foam.

special fire fighting procedures Water will not be effective in extinguishing a fire and may spread it, but a water spray can be used to cool exposed containers. Wear full protective clothing and self-contained breathing apparatus. Heat will build pressure and may rupture closed storage containers.

IV. Hazardous Components

Hexane and isomers % ca 100 TLV 50 ppm CAS no. 110-54-3

Burdick & Jackson's Disclaimer: The information and recommendations presented in this Material Safety Data Sheet are based on sources believed to be reliable on the date hereof. Burdick & Jackson makes no representation on its completeness or accuracy. It is the user's responsibility to determine the product's suitability for its intended use, the product's safe use, and the product's proper disposal. No representations or warranties, either express or implied, merchantability or fitness for a particular purpose or of any other nature are made with respect to the information provided in this Material Safety Data Sheet or the product to which such information refers. Burdick & Jackson neither assumes nor authorizes any other person to assume for it, any other or additional liability or responsibility resulting from the use of, or reliance upon, this information.

V. Health Hazards

Occupational Exposure Limits

OSHA TWA - 50 ppm
 STEL - not listed
 Ceiling - not listed

ACGIH TLV-TWA - 50 ppm
 TLV-STEL - not listed
 (15-min)

OSHA 10 hour TWA - 100 ppm
 15 min Ceiling - 510 ppm

Concentration Immediately Dangerous to Health

OSHA/NIOSH 5,000 ppm

Odor Threshold

NSC not listed
NIOSH not listed

Carcinogenic Data

Hexane is not listed as a carcinogen by IARC, NTP, OSHA, or ACGIH.

Primary Routes of Entry

Hexane may exert its effects through inhalation, skin absorption, and ingestion.

Industrial Exposure: Route of Exposure/Signs and Symptoms

Inhalation: Exposure can cause dizziness, numbness of extremities, and intoxication.

Eye Contact: Liquid and high vapor concentration can be irritating.

Skin Contact: Prolonged or repeated skin contact can cause irritation and dermatitis through defatting of skin.

Ingestion: Can cause gastrointestinal tract discomfort.

Effects of Overexposure

Hexane is a mild eye and mucous membrane irritant, primary skin irritant, central nervous system depressant and neurotoxin. Acute exposure causes irritation, narcosis, and gastrointestinal tract irritation. Chronic inhalation causes peripheral neuropathy. No systemic toxicity has been reported.

Medical Condition Aggravated by Exposure

Preclude from exposure those individuals susceptible to dermatitis.

Emergency First Aid

- Inhalation:** Immediately remove to fresh air. If not breathing, administer mouth-to-mouth rescue breathing. If there is no pulse administer cardiopulmonary resuscitation (CPR). Contact physician immediately.
- Eye Contact:** Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.
- Skin Contact:** Flush thoroughly for at least 15 minutes. Wash affected skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before re-use, and discard contaminated shoes. Get emergency medical assistance.
- Ingestion:** Call local Poison Control Center for assistance. Contact physician immediately. Aspiration Hazard - Do not induce vomiting.

VI. Safety Measures and Equipment

- Ventilation:** Adequate ventilation is required to protect personnel from exposure to chemical vapors exceeding the PEL and to minimize fire hazards. The choice of ventilation equipment, either local or general, will depend on the conditions of use, quantity of material, and other operating parameters.
- Respiratory:** Use approved respirator equipment. Follow NIOSH and equipment manufacturer's recommendations to determine appropriate equipment (air-purifying, air-supplied, or self-contained breathing apparatus).
- Eyes:** Safety glasses are considered minimum protection. Goggles or face shield may be necessary depending on quantity of material and conditions of use.
- Skin:** Protective gloves and clothing are recommended. The choice of material must be based on chemical resistance and other user requirements. Generally, neoprene or nitrile rubber offer acceptable chemical resistance. Individuals who are acutely and specifically sensitive to hexane may require additional protective equipment.

Storage: Hexane should be protected from temperature extremes and direct sunlight. Proper storage of hexane must be determined based on other materials stored and their hazards and potential chemical incompatibility. In general, hexane should be stored in an acceptably protected and secure flammable liquid storage room.

Other: Emergency eye wash fountains and safety showers should be available in the vicinity of any potential exposure. Ground and bond metal containers to minimize static sparks.

VII. Spill and Disposal Data

Spill Control: Protect from ignition. Wear protective clothing and use approved respirator equipment. Absorb spilled material in an absorbent recommended for solvent spills and remove to a safe location for disposal by approved methods. If released to the environment, comply with all regulatory notification requirements.

Waste Disposal: Dispose of hexane as an EPA hazardous waste. Contact state environmental agency for listing of licensed hazardous waste disposal facilities and applicable regulations. Hazardous waste number: D001(Ignitable).

VIII. SARA/Title III Data

<u>Hazard Classification</u>		<u>Chemical Listings</u>	
Immediate Health	Yes (irritant)	Extremely Hazardous Substances	No
Delayed Health	Yes	CERCLA Hazardous Substances	No
Fire	Yes	Toxic Chemicals	No
Sudden Release	No		
Reactive	No		

Hexane is not subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40CFR Part 372. This product does not contain any other toxic chemical above 1% concentration or a carcinogen above 0.1% concentration.

Revision Date: July, 1989

KEY

ca Approximately
na Not applicable
C Ceiling

STEL Short Term Exposure Level (15 minutes)
TLV Threshold Limit Value
TWA Time Weighted Average (8 hours)
BuAc Butyl Acetate

CERCLA Comprehensive Environmental Response, Compensation and Liability Act
NSC National Safety Council, "Fundamentals of Industrial Hygiene," 3rd. Ed., 1988)

SEP 17 1990

information/emergency telephone no. 616.726.3171
chemtrec telephone no. 800.424.9300
canadian emergency telephone no. 613.996.6666

**MATERIAL SAFETY
DATA SHEET**

METHANOL

pure

I. Identification

chemical name Methanol molecular weight 32.04
chemical family Alcohol formula CH₄O
synonyms Carbinol, Methyl Alcohol, Wood Alcohol
DOT proper shipping name Methyl Alcohol or Methanol
DOT hazard class Flammable Liquid
DOT identification no. UN1230 CAS no. 67-56-1

II. Physical and Chemical Data

boiling point, 760mm Hg. 64.7°C freezing point -97.7°C evaporation rate (BuAc=1) ca 5
vapor pressure at 20°C 97 mm Hg vapor density (air = 1) 1.11 solubility in water @ 20°C complete
% volatiles by volume ca 100 specific gravity (H₂O=1) @ 20°C 0.792 stability Stable
hazardous polymerization Not expected to occur.
appearance and odor A clear, colorless liquid with a slight alcoholic odor.
conditions to avoid Heat, sparks, open flame, open containers, and poor ventilation.

materials to avoid Strong oxidizing agents and reactive metals which will displace hydrogen.

hazardous decomposition products Incomplete combustion can generate carbon monoxide and other toxic vapors such as formaldehyde.

III. Fire and Explosion Hazard Data

flash point, (test method) 12°C (Tag closed cup) auto ignition temperature 385°C
flammable limits in air % by volume: lower limit 6.7 upper limit 36.5
unusual fire and explosion hazards May burn with an invisible flame. Mixtures with water as low as 2 by volume are still flammable (flash point below 37.8°C). Under some circumstances can corrode certain metals, including aluminum and zinc, and generate hydrogen gas.
extinguishing media Carbon dioxide, dry chemical, alcohol foam, water mist or fog.
special fire fighting procedures Wear full protective clothing and self-contained breathing apparatus. Heat will build pressure and may rupture closed storage containers. Keep fire-exposed containers cool with water spray.

IV. Hazardous Components

Methanol % ca 100 TLV 200 ppm (skin) CAS no. 67-56-1

Burdick & Jackson's Disclaimer: The information and recommendations presented in this Material Safety Data Sheet are based on sources believed to be reliable on the date hereof. Burdick & Jackson makes no representation on its completeness or accuracy. It is the user's responsibility to determine the product's suitability for its intended use, the product's safe use, and the product's proper disposal. No representations or warranties, either express or implied, of merchantability or fitness for a particular purpose or of any other nature are made with respect to the information provided in this Material Safety Data Sheet. The product to which such information refers. Burdick & Jackson neither assumes nor authorizes any other person to assume for it, any other or additional liability or responsibility resulting from the use of, or reliance upon, this information.

CHW

Emergency First Aid

- Inhalation:** Immediately remove to fresh air. If not breathing, administer mouth-to-mouth rescue breathing. If there is no pulse administer cardiopulmonary resuscitation (CPR). Contact physician immediately.
- Eye Contact:** Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.
- Skin Contact:** Flush thoroughly for at least 15 minutes. Wash affected skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before re-use, and discard contaminated shoes. Get emergency medical assistance.
- Ingestion:** Call local Poison Control Center for assistance. Contact physician immediately. Never induce vomiting or give anything by mouth to a victim unconscious or having convulsions.

Note to Physician

In case of ingestion or massive inhalation, observe victim as an inpatient because slow metabolism causes a latent period of 24 hours between exposure and acidosis and blindness.

VI. Safety Measures and Equipment

- Ventilation:** Adequate ventilation is required to protect personnel from exposure to chemical vapors exceeding the PEL and to minimize fire hazards. The choice of ventilation equipment, either local or general, will depend on the conditions of use, quantity of material, and other operating parameters.
- Respiratory:** Use approved respirator equipment. Follow NIOSH and equipment manufacturer's recommendations to determine appropriate equipment (air-purifying, air-supplied, or self-contained breathing apparatus).
- Eyes:** Safety glasses are considered minimum protection. Goggles or face shield may be necessary depending on quantity of material and conditions of use.
- Skin:** Protective gloves and clothing are recommended. The choice of material must be based on chemical resistance and other user requirements. Generally, neoprene, nitrile rubber, or rubber offer acceptable chemical resistance. Individuals who are acutely and specifically sensitive to methanol may require additional protective equipment.

Storage: Methanol should be protected from temperature extremes and direct sunlight. Proper storage of methanol must be determined based on other materials stored and their hazards and potential chemical incompatibility. In general, methanol should be stored in an acceptably protected and secure flammable liquid storage room.

Other: Emergency eye wash fountains and safety showers should be available in the vicinity of any potential exposure. Ground and bond metal containers to minimize static sparks.

VII. Spill and Disposal Data

Spill Control: Protect from ignition. Wear protective clothing and use approved respirator equipment. Absorb spilled material in an absorbent recommended for solvent spills and remove to a safe location for disposal by approved methods. If released to the environment, comply with all regulatory notification requirements. CERCLA Reportable Quantity — 5,000 lbs.

Waste Disposal: Dispose of methanol as an EPA hazardous waste. Contact state environmental agency for listing of licensed hazardous waste disposal facilities and applicable regulations. Hazardous waste numbers: U154(Ignitable); D001(Ignitable).

VIII. SARA/Title III Data

Hazard Classification

Immediate Health	Yes
Delayed Health	Yes
Fire	Yes
Sudden Release	No
Reactive	No

Chemical Listings

Extremely Hazardous Substances	No
CERCLA Hazardous Substances	Yes
Toxic Chemicals	Yes

Methanol is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40CFR Part 372. This product does not contain any other toxic chemical above 1% concentration or a carcinogen above 0.1% concentration.

Revision Date: July, 1989

KEY

ca Approximately
na Not applicable
C Ceiling

STEL Short Term Exposure Level (15 minutes)
TLV Threshold Limit Value
TWA Time Weighted Average (8 hours)
BuAc Butyl Acetate

CERCLA Comprehensive Environmental Response, Compensation and Liability Act
NSC National Safety Council: "Fundamentals of Industrial Hygiene," 3rd Ed., 1988)