RFI WORK PLAN

for

INDUSTRIAL SERVICE CORPORATION

1633 Marsh Avenue

Blue Summit, Missouri

Docket Number VII-94-H-0024

Prepared By:

Deffenbaugh Industries, Inc.
18181 West 53rd Street
Shawnee, Kansas 66217

JANUARY 23, 1995

RFI WORK PLAN

for

INDUSTRIAL SERVICE CORPORATION
1633 Marsh Avenue
Blue Summit, Missouri

Docket Number VII-94-H-0024

Prepared By:

Deffenbaugh Industries, Inc.
18181 West 53rd Street
Shawnee, Kansas 66217

JANUARY 23, 1995

TABLE OF CONTENTS

Introduction 1

1.0 Project Management Plan 4

1.1 Project Management Organization 4
1.2 Schedule and Budget 4

2.0 Data Collection Quality Assurance Plan 7

2.1 Data Quality Objective 7
2.1.1 Precision 7
2.1.2 Accuracy 8
2.1.3 Completeness 8
2.1.4 Representativeness 9
2.1.5 Comparability 10
2.1.6 Quality Assurance Reports 11
2.2 Sampling and Field Measurements 11
2.2.1 Methodology 11
2.2.2 Soil Sampling Procedure 12
2.2.3 Groundwater Sampling Procedure 13
2.2.4 Decontamination 15
2.3 Sample Analysis Quality Assurance Plan 16

3.0 Data Management Plan 18

3.1 Overview of Purpose 18
3.2 Data Documentation 18
3.3 Data Reduction and Presentation 19
3.4 Reporting 19

4.0 Health and Safety Plan 21

4.1 Facility Description 21
4.2 Chemical Hazards 25
4.3 Physical Hazards 28
4.3.1 Groundwater Monitoring Phases 28
4.3.2 Drilling Activities 29
4.4 Lines of Authority 29
4.4.1 Team Member Responsibilities 30
4.4.2 Public Health Protection 32
4.5 Work Area Delineation 32
4.5.1 Exclusion Zone 34
4.5.2 Contamination Reduction Zone 34
4.5.3 Support Zone 34

4.6 Protective Equipment 35
4.6.1 Respiratory Protection 35
4.6.2 Protective Clothing 37
4.6.3 Basic Safety Practice 38
4.7 Site Access 39
4.8 Decontamination 39
4.9 Site Emergency Procedures 40
4.10 Environmental Surveillance 42
4.11 Required Training 42
4.12 Weather Protection 43

5.0 Community Relations Plan 45

5.1 Objective 45
5.2 Procedure 45

FIGURES

Figure 1 General Site Location 3
Figure 1-1 Project Management Organization Chart 5
Figure 1-2 RFI Schedule 6
Figure 4-1 Emergency Facility Location Map 22
Figure 4-2 Facility Diagram 24
Figure 4-3 Diagram of Site Work Zones 33

TABLES

Table 2-1 Summary of Analytical Parameters, Containers and Hold Times 17
Table 4-1 Contaminants of Concern 25

ATTACHMENTS

Attachment A QAS Quality Assurance Plan
Attachment B Subsurface Exploration Specifications
Attachment C Material Safety Data Sheets

INTRODUCTION

Industrial Service Corporation (ISC) entered into an Administrative Order on Consent (Order) with the United States Environmental Protection Agency (EPA) effective October 4, 1994. In accordance with the terms and conditions of this order, ISC hereby submits to the EPA this RFI Work Plan (Work Plan) for its facility in Blue Summit, Missouri.

The Work Plan is developed to conform to the requirements specified in Task III of the Scope of Work (SOW) for a RCRA Facility Investigation ("RFI") which is included in the Order as attachment II. The Work Plan is comprised of the Project Management Plan, Data Collection Quality Assurance Plan, Data Management Plan, Health and Safety Plan, and Community Relations Plan. These plans are all designed with a common objective. The purpose is to provide a format for the planning and control of the RFI which assures it is complete and accurate, implemented with consideration of the safety of personnel and the surrounding community, and presents resulting conclusions and recommendations with candor.

The ISC facility is located at 1633 Marsh Avenue, Blue Summit, Missouri. Figure 1 is a USGS topographic map depicting the generalized location of the facility. The facility is in an area that is zoned for industrial use.

The facility is primarily used for the bulk storage and processing of used oil. This used oil recycling facility and subsequent marketing activities are operated within guidelines, as specified in 40 CFR Part 279 and applicable MDNR regulations. The US EPA Identification Number for the facility is MOD073027609.

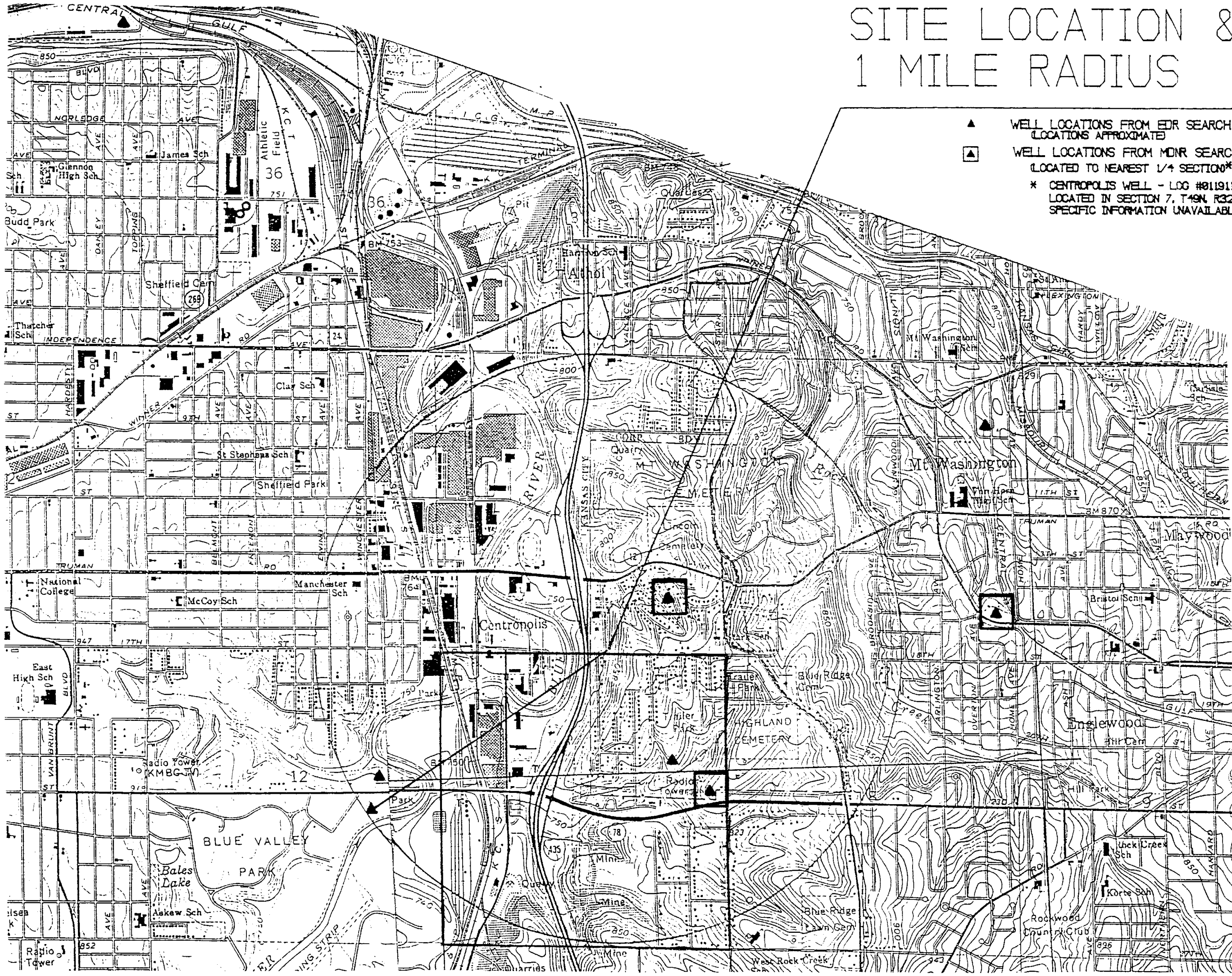
Reports for the Description of Current Conditions and Preliminary Corrective Measure Technologies for this facility have been previously submitted.

SITE LOCATION & 1 MILE RADIUS

▲ WELL LOCATIONS FROM EDR SEARCH (LOCATIONS APPROXIMATE)

[▲] WELL LOCATIONS FROM MDNR SEARCH (LOCATED TO NEAREST 1/4 SECTION)*

* CENTROPOLIS WELL - LOG #011911 LOCATED IN SECTION 7, T49N, R32W SPECIFIC INFORMATION UNAVAILABLE



SCALE 1 INCH = 2000 FEET

FIGURE 1

DATE	11-28-94
DESIGNED	JMC
DETAILED	JMC
CHECKED	BW

INDUSTRIAL SERVICE CORP
1633 MARSH AVE.
KANSAS CITY, MO 64126

GENERAL SITE LOCATION

COMPOSITE OF INDEPENDENCE & KANSAS CITY QUADRANGLE MAPS

1.0 PROJECT MANAGEMENT PLAN

1.1 PROJECT MANAGEMENT ORGANIZATION

Project management organization for the design and implementation of the RFI consists of management and technical guidance by Deffenbaugh Industries staff. Figure 1-1 is an organizational chart identifying persons responsible.

The designated project coordinator is Robert Lehr who will serve as the point of contact for all communications. Brent Nickel will serve as project manager and assume the primary responsibility for quality assurance. He will be assisted by Kevin J. Bailey in coordinating field activities. Personnel performing field activities will be provided by the T.E.S.T division under the direction of Clay Dyer. Brian Wilson, corporate Health and Safety Director, will retain responsibility for on-site safety. Laboratory analysis of samples collected will be provided by Quality Analytical Services, an affiliate of Deffenbaugh Industries, under the direction of Lou Cunningham.

1.2 SCHEDULE AND BUDGET

The schedule for major activities of the RFI begins with the effective date of the order and is graphically depicted by a bar chart in Figure 1-2. The time period required for agency review has not been defined. Sixty days was arbitrarily selected for this period of time for the purpose of schedule preparation. Therefore, actual calendar dates cannot be determined.

ISC has the necessary resources for the completion of this RFI. Financial assurance has previously been provided.

PROJECT MANAGEMENT ORGANIZATIONAL CHART

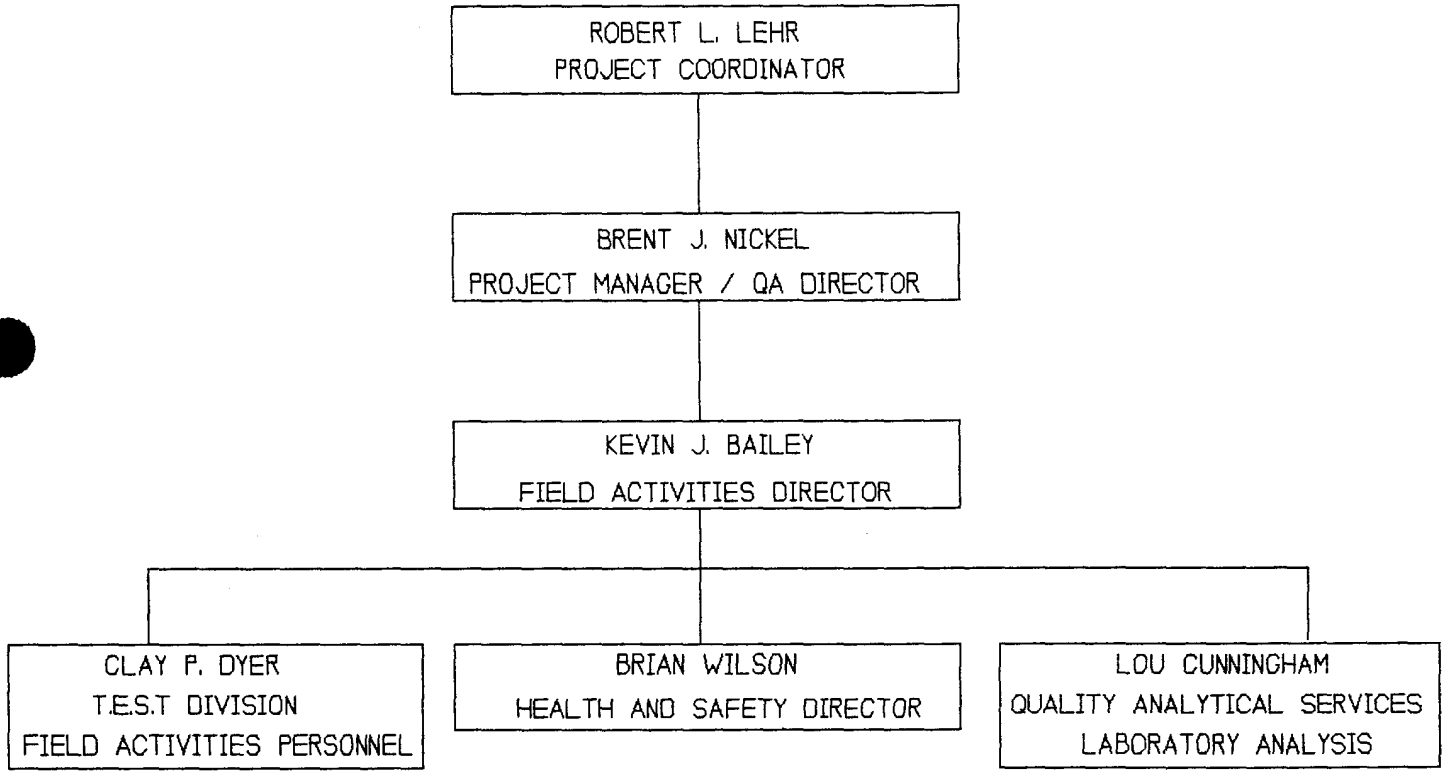
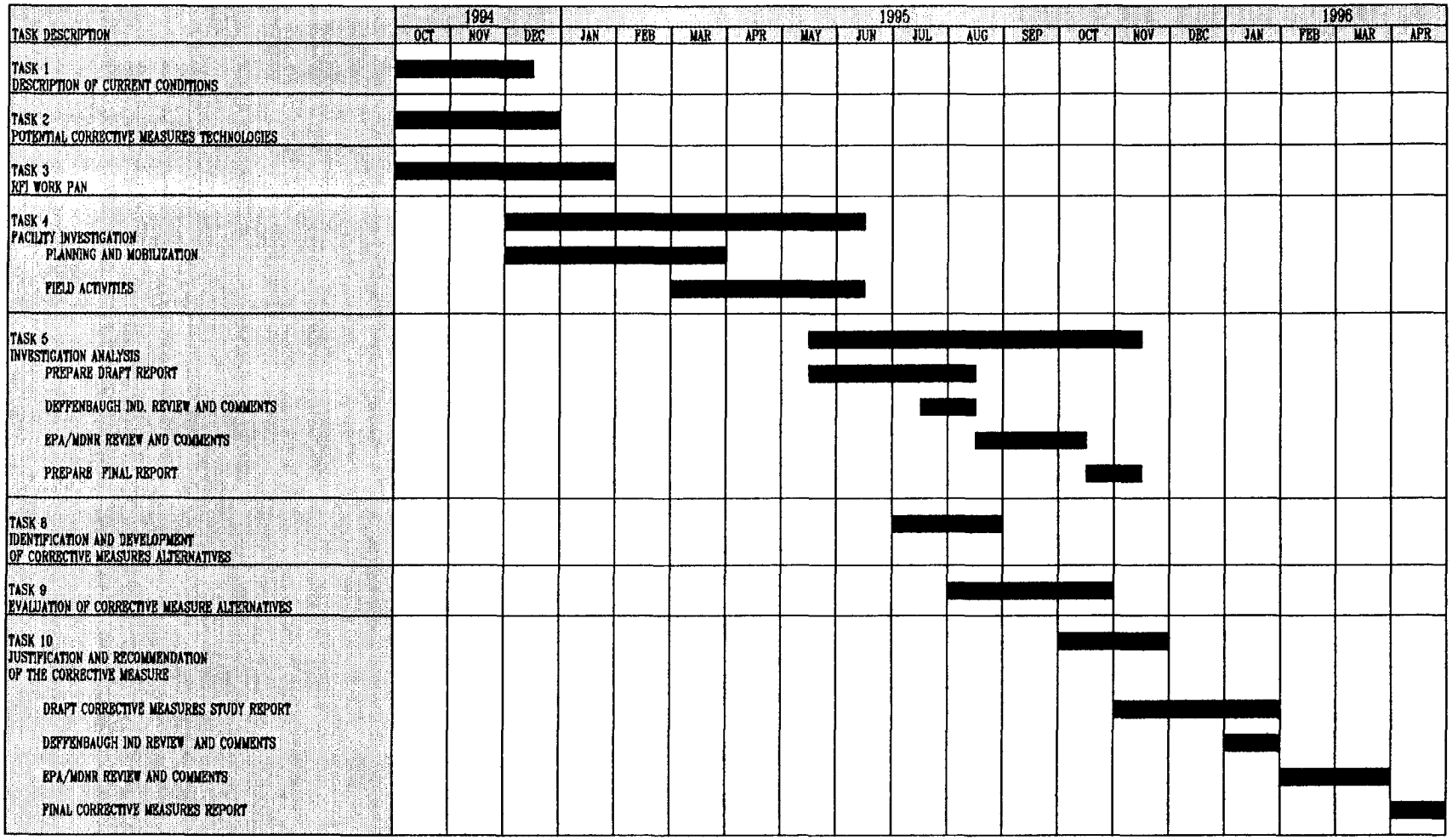


FIGURE 1-1

FIGURE 1-2

RFI SCHEDULE
FOR
INDUSTRIAL SERVICES CORPORATION

DOCKET # VII-94-H-0024



2.0 DATA COLLECTION QUALITY ASSURANCE PLAN

2.1 DATA QUALITY OBJECTIVES

The data collection quality assurance plan is designed to document that procedures used in the collection and analysis of samples and field measurements will yield valid data. The data generated from this investigation will be used to determine the nature and extent of contamination as well as provide information for the evaluation of corrective measures. Levels of precision and accuracy must be held to high standards in order that decisions based on the data generated are technically sound, statistically valid, and properly documented. Quality assurance objectives for measurement data are usually expressed in terms of precision, accuracy, completeness, representativeness, and comparability. Definitions and application of these characteristics are presented below.

2.1.1 PRECISION

The criteria of precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions". The specific criteria of precision for each major measurement parameter are detailed within their individual analytical test methodology. Blind duplicates will be collected and analyzed as a means to determine if analytical results are reproducible, and as a measure of precision of the data collection activity.

2.1.2 ACCURACY

The criterion of accuracy is the degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-Y)/T, and sometimes expressed as a ratio X/T. Accuracy is a measure of the bias in a system. The specific criteria of accuracy for each measurement parameter are detailed within their individual analytical methods.

Blank samples will be collected and analyzed to determine the accuracy of the field activities. This will provide a check for procedural contamination as well as the ambient conditions at the site which could cause sample contamination. Audit samples may be provided to QAS by the MDNR or USEPA, at their discretion. ISC may also submit blind audit samples to QAS, prepared by Pace Laboratories, Inc., Lenexa, Kansas. The audits will be prepared using certified environmental quality control standards. Audit samples will be used in assessing the bias of a measurement system and provide information on the accuracy of the analytical technique.

2.1.3 COMPLETENESS

The criteria of completeness is a measure of the amount of valid data obtained from the collection and measurement system compared with the amount of data expected under normal circumstances. Under each task for the RFI, a specific number of samples or

measurements will be required in order to meet project objectives. If not collected, there may be insufficient data to properly evaluate and assess the nature and extent of contamination at the site and could potentially result in the need for additional sampling and analysis. If samples cannot be collected, the reason will be noted in the field book and final report. A determination of the effect of this omission on completeness must be made and discussed in the final report.

2.1.4 REPRESENTATIVENESS

The criteria of representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, or an environmental condition. At a minimum, ten percent duplicate samples will be collected and will be used as a means to assess field representativeness. By definition, duplicate samples should be representative of a given point in space and time. Representativeness is also assured by the sampling technique used. The following methods will be used to collect samples that are representative of site conditions.

Groundwater

To ensure that the ground water samples are consistently obtained, a minimum of three well volumes of water will be purged from the monitoring wells prior to sampling. Conductivity, temperature, and pH measurements will be taken and recorded. The amount of water purged will be documented by the field team. Bailers will be decontaminated between wells or dedicated bailers used to ensure that samples collected at subsequent wells are representative of the aquifer, and are not subject to cross contamination.

Soil Borings

Samples will be obtained from active and past operations areas of the site. Samples are to be collected at depths which will give the information necessary to characterize soil contamination beneath the site.

2.1.5 COMPARABILITY

The criteria of comparability expresses the confidence with which one data set can be compared to another. Comparability of data sets may vary as a function of samples collected over some period of time, collection and analysis by outside agencies, or both. ISC, in the performance of this investigation, will rely on in-house personnel for the collection and an affiliated laboratory for the analysis of samples. If it is found necessary to employ the services of outside agencies at some later time, procedures and analytical methods will be specified in the performance of the work contracted to assure comparability of the data produced.

Ground water samples collected over a period of time will be considered comparable if the same aquifer of interest is sampled according to procedure, and if the units of measurement are the same. Surface water, sediment, or soil samples will be comparable if the procedures for collecting samples are followed and if the units of measurement are the same.

2.1.6 QUALITY ASSURANCE REPORTS

Monthly reports will be issued by the Project Manager in consultation with the Project Coordinator. The reports will include assessment of the status of the project in relation to the schedule. The reports will include, as appropriate, an assessment of the measurement objectives and the results of performance or systems audits. Significant quality assurance problems will be discussed as well as possible solutions to resolve them. Any corrective actions taken as a result of current or past problems will also be reported.

2.2 SAMPLING AND FIELD MEASUREMENTS

Sampling activities associated with this RFI will include collection of subsurface soil and ground water samples as well as field measurements of various related parameters.

2.2.1 METHODOLOGY

Due to the amount of existing information at this site the location, depth, quantity, frequency, and duration of sampling and measurements will be determined on a judgmental basis. The objective driving these decisions is the final characterization of the extent of contamination and identification of physical properties affecting possible remediation technologies.

Grab samples of soil and groundwater will be collected in both upgradient and downgradient directions. Observations of field conditions and measurements will be

recorded in field log books and sampling sheets. Samples will be analyzed for the constituents included in Table 2-1. Steps will be taken to prevent inadvertent contamination of equipment and decontamination procedures will be followed to prevent cross contamination between sampling points. Samples will be labeled and preserved in accordance with specifications, and transferred to the laboratory under chain of custody procedures. Specific sampling procedures follow for the collection of both soil and groundwater samples.

2.2.2 SOIL SAMPLING PROCEDURE

Soil borings will be advanced following procedures included as Attachment B. Samples will be collected using a split core barrel and field screened by heated head space analysis using an Environmental Instruments OVM Model 580B. This instrument will be calibrated per manufacturers instructions, at a minimum, on a daily basis prior to that day's first sampling event and recorded in the field log book. If any sample shows evidence of contamination as a result of this screening, no laboratory analytical sample will be obtained and the boring will be plugged and abandoned.

The location will be moved in a direction away from the suspected point source and the process repeated until a sample showing no detectable levels of contamination is found. Discrete samples will be taken to bedrock or groundwater, at a rate of 2 1/2 feet and prepared for laboratory analysis. Samples submitted for analysis of 2,3,7,8-TCDD and

associated dioxins and furans will be collected at 5 foot intervals with a minimum of one per borehole. Table 2-1 identifies the required size and type of container, preservation, hold time, and method for each analysis to be performed on the sample. Examples of label and chain of custody documents are included Appendix A.

Samples will be collected from various lithologic units in both the saturated and unsaturated zone for analysis of permeability and hydraulic conductivity. Samples will also be collected from the unsaturated zone for Proctor tests to determine compaction standards. Decontamination procedures, as outlined in section 2.2.4, will be followed between each sample collected as well as from borehole to borehole.

2.2.3 GROUNDWATER SAMPLING PROCEDURE

Groundwater samples will be collected only after all planned well locations have been installed and developed. Upgradient wells will be sampled first, followed by the most recent downgradient wells, and lastly, the existing wells in order of lowest concentration to highest concentration of contaminants found in previous sampling events. Wells found with free product will be measured to determine static water level and calculate product thickness but will not be sampled for laboratory analysis.

All equipment necessary (e.g. pH meter, electroconductivity meter, thermometer, etc.) will be calibrated on a daily basis prior to sampling. The well will be inspected for evidence

of tampering or deterioration of surface seal prior to opening. A drop cloth will be placed on the surface around the well to prevent contamination of sampling equipment due to inadvertent contact with the ground. Entries will be made in the log book and/or sampling sheet, as appropriate, to record well I.D., location, well construction materials, weather conditions, physical measurements, and all ancillary data. A copy of this field sheet is included in appendix A.

Water level and depth sounding measurements will be completed and the volume of static water computed. If free product is encountered, an oil/water interface probe will be utilized to measure the thickness. This will be noted in the log book and further activity at this well will be stopped. If no free product is encountered, a dedicated or disposable bailer will be used to purge three times the computed volume of static water. Both the calculated and actual volumes will be recorded on the field sampling sheet.

After purging the well, the first bailer will be used to collect samples for VOC's. The remainder of this bailer may be used to measure the temperature, pH, and electroconductivity. Subsequent bailers will be used to collect the balance of the required sample. Table 2-1 identifies the required size and type of container, preservation, hold time, and method for each analysis to be performed on the sample. These containers will be supplied by the laboratory complete with preservative as necessary. If the well is bailed dry prior to collection of all samples required, sufficient time will be allowed for the well

to recharge and sample collection will then be completed. Labels and chain of custody documents will be completed and samples preserved on ice. All sampling and field measurement equipment will be decontaminated according to procedures in the following section and the well will be secured.

2.2.4 DECONTAMINATION

All equipment used to advance borings, sample soils, and take field measurements will be thoroughly cleaned with potable water prior to arrival at the site. A high pressure wash will be utilized to remove any encrusted soil, mud, or organic matter on the drilling and sampling equipment. This equipment may include but not be limited to the drill rigs, pumps, drill rods, augers, drill bits, threads, casing, sampling equipment, and all other tools required to perform the work.

On arrival at the site a decontamination station will be constructed. The station will be designed to collect water runoff from decontamination operations. All equipment will be cleaned prior to initiating boring operations using the following procedure:

1. Wash equipment with laboratory detergent (e.g. Alconox) and potable water.
2. Rinse with potable water.
3. Rinse with reagent grade ethanol or isopropanol if grease or oil is observed or as directed.
4. Rinse with distilled water.
5. Allow equipment to air dry.

A high pressure steam cleaner will be used to apply the first two steps on drilling and sampling equipment. This procedure will be used on all equipment between each boring and following boring activities at this site. In addition, sampling equipment will be cleaned using this procedure between each sampling attempt. All fluids from decontamination will be stored in containers pending final disposition based on results of analysis. All field decontamination activities will be recorded in the log book.

2.3 SAMPLE ANALYSIS QUALITY ASSURANCE PLAN

Laboratory analysis of samples will be performed by Quality Analytical Services, 1633 South Marsh, Kansas City, Missouri 64146. A copy of their QA/QC manual is included as Attachment A. The protocol of QAS is based upon the quality assurance guidelines provided in the following references:

"Handbook for Analytical Quality Control in Water and Wastewater Laboratories", EPA-600/4-79-019, March, 1979

" The Recommended Guidelines for EPA Methods 624 and 625" (Federal Register, December 3, 1979)

"EPA Solid Waste Manual SW-846", Third Edition, April, 1987

NIOSH Manual "Analytical Methods", 3rd Edition, February, 1984

"Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples", EPA 600/8-80-038, June, 1980

TABLE 2-1
SUMMARY OF ANALYTICAL PARAMETERS, CONTAINERS, AND HOLD TIMES

SOIL MATRIX

PARAMETER	METHOD	CONTAINER **	PRESERVATION	HOLD TIME *
Volatile Organics	SW 8260	(1) 4 oz. Glass	4°C	14 Days
BNA	SW 8270	(1) 4 oz. Glass	4°C	14-40 Days
Metals	SW 3050/6000, 7000 Series	(1) 4 oz. Glass (or poly)	4°C	180 Days Hg 28 Days
Pesticides/PCB's	SW 8080	(1) 4 oz. Glass	4°C	14-40 Days
2,3,7,8-TCDD Dioxins & Furans	SW 8280 or 8290	(1) 4 oz. Glass	4°C	30-45 Days

WATER MATRIX
(40 CFR, Part 264, Appendix IX)

PARAMETER	METHOD	CONTAINER **	PRESERVATION	HOLD TIME *
Volatile Organics	SW 8260	(2) 40ml VOA	HCL, 4°C	14 Days
BNA	SW 8270	(1) 1L Amber Glass	4°C	7-40 Days
Metals	SW 3050/6000, 7000 Series	(1) 500ml Poly (or glass)	HNO_3	180 Days Hg 28 Days
Pesticides/PCB's	SW 8080	(1) 1L Amber Glass	4°C	7-40 Days
Herbicides	SW 8150	(1) 1L Amber Glass	4°C	7-40 Days
Cyanide	SW 9010	(1) 500ml Poly	Asorbic Acid, NaOH, 4°C	14 Days
Sulfide	SW 9030	(1) 500ml Poly	Zinc Acetate, NaOH, 4°C	7 Days
2,3,7,8-TCDD Dioxins & Furans	SW 8280 or 8290	(2) 1L Amber Glass	4°C	30-45 Days

* When hyphenated, the first number represents the number of days allowed for completing extractions. The second number represents the number of days allowed for completing analysis.

** All Containers Include Teflon Lined Lids

3.0 DATA MANAGEMENT PLAN

3.1 OVERVIEW OF PURPOSE

The Data Management Plan outlines procedures to document, track, store, and retrieve data collected from the RCRA Facility Investigation. The purpose of the plan is to effectively process the data so that it is accurate, accessible, and well maintained. The plan specifies data documentation materials and procedures, outlines data reduction and presentation, and describes reporting requirements.

3.2 DATA DOCUMENTATION

All data collected will be properly documented and filed in a single location at the offices of Industrial Service Corporation. Field activities will be recorded using log books, photographs, and field sheets. A unique identification number will be assigned to each sample or measurement. The date and exact location where the sample or measurement was obtained will be noted. Samples will be labeled and tracked utilizing chain of custody forms. Laboratory reports will include the field identification number as well as laboratory analysis number, property or component measured, analytical results, and detection limits.

The file containing these records will be clearly identified and organized in a manner to allow swift retrieval. Project plans, calculations, data review notes, and other pertinent information will be marked with the project number and included in these files.

3.3 DATA REDUCTION AND PRESENTATION

Data reduction will be conducted to condense the information into a presentable format. Raw analytical data will be reduced by the laboratory into an analytical data package. This information will be tabulated to aid in the review and evaluation of the data. The tabulated data will be used to further sort the information by medium, constituent monitored, and stratification factors.

Graphical means will be employed to further condense this information and present it for evaluation. Plan maps, cross-sectional diagrams, and various graphs will be utilized to present the geographical extent of contamination. Isoconcentration maps will aid in displaying contamination levels and changes in concentration based on various parameters. These methods will be used to depict factors affecting intramedia transport, show potential receptors, and identify areas where more data is required.

3.4 REPORTING

In addition to this Work Plan report, the order is specific on additional reporting requirements. The Description of Current Conditions Report and the Pre-Investigation have been prepared and previously submitted. Draft and final reports will be prepared and submitted for both the RCRA Facility Investigation and the Corrective Measures Study. A schedule of the projected completion dates for these reports is included in the Project Management Plan. If requested, reports will be prepared and submitted for a Treatability Studies Work Plan and a Laboratory and Bench Scale

Studies. These are required to be completed within 30 days of a written request. All reports are to be submitted to the designated project coordinators.

Additionally, progress reports are required on a monthly basis. The progress reports will provide an estimate of the percentage of the RFI completed. It will provide a summary of all findings, changes to the RFI, and contacts made during the reporting period. Any problems or potential problems will be identified and a description of the actions being taken to rectify them will be provided. Changes in personnel will be included as well copies of all sampling, tests, and other data obtained during the period. Progress reports are due on the tenth day of the month following the reporting period.

4.0 HEALTH AND SAFETY PLAN

This Health and Safety Plan (HSP) was developed to protect employees from the hazards encountered during field investigations. It is based upon the result of experience, as well as consideration of all applicable government regulations and guidelines, and consultation with health and safety experts.

This HSP is intended to comply with United States Environmental Protection Agency (EPA) orders 1440.1 and 1440.3, the EPA Standard Operating Safety Guide, the Occupational Health and Safety Act (OSHA) 29 CFR 1910 and 29 CFR 1926, and National Institute for Occupational Safety and Health (NIOSH) Guidance Manual for Hazardous Waste Site Activities. All State and local regulations have also been considered for the development of this plan. Additional consideration for the Industrial Service Corporation (ISC) facility Contingency plan was also included in the development of this HSP.

4.1 FACILITY DESCRIPTION

ISC is a Missouri Corporation with corporate headquarters based at 1633 South Marsh, Kansas City, Missouri. ISC operates a used oil recycling facility under Resource Recovery Certification RR-004. The USEPA ID Number for the facility is M0073027609.

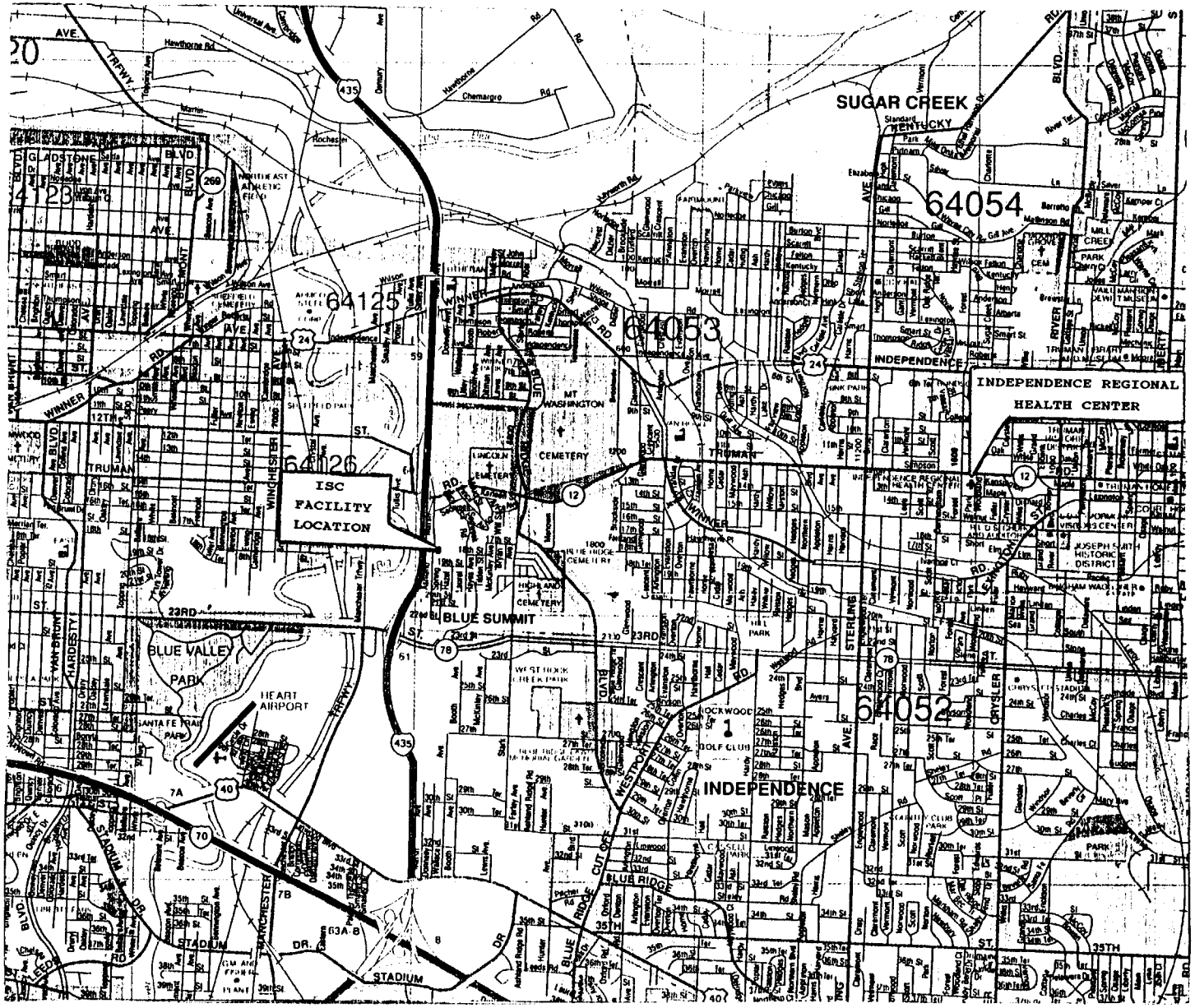


FIGURE 4-1	DATE 1-5-93
	DESIGNED JMC
	DETAILED JMC
	CHECKED BM

INDUSTRIAL SERVICE CORP.
1033 MARSH AVE.
KANSAS CITY, MO 64126

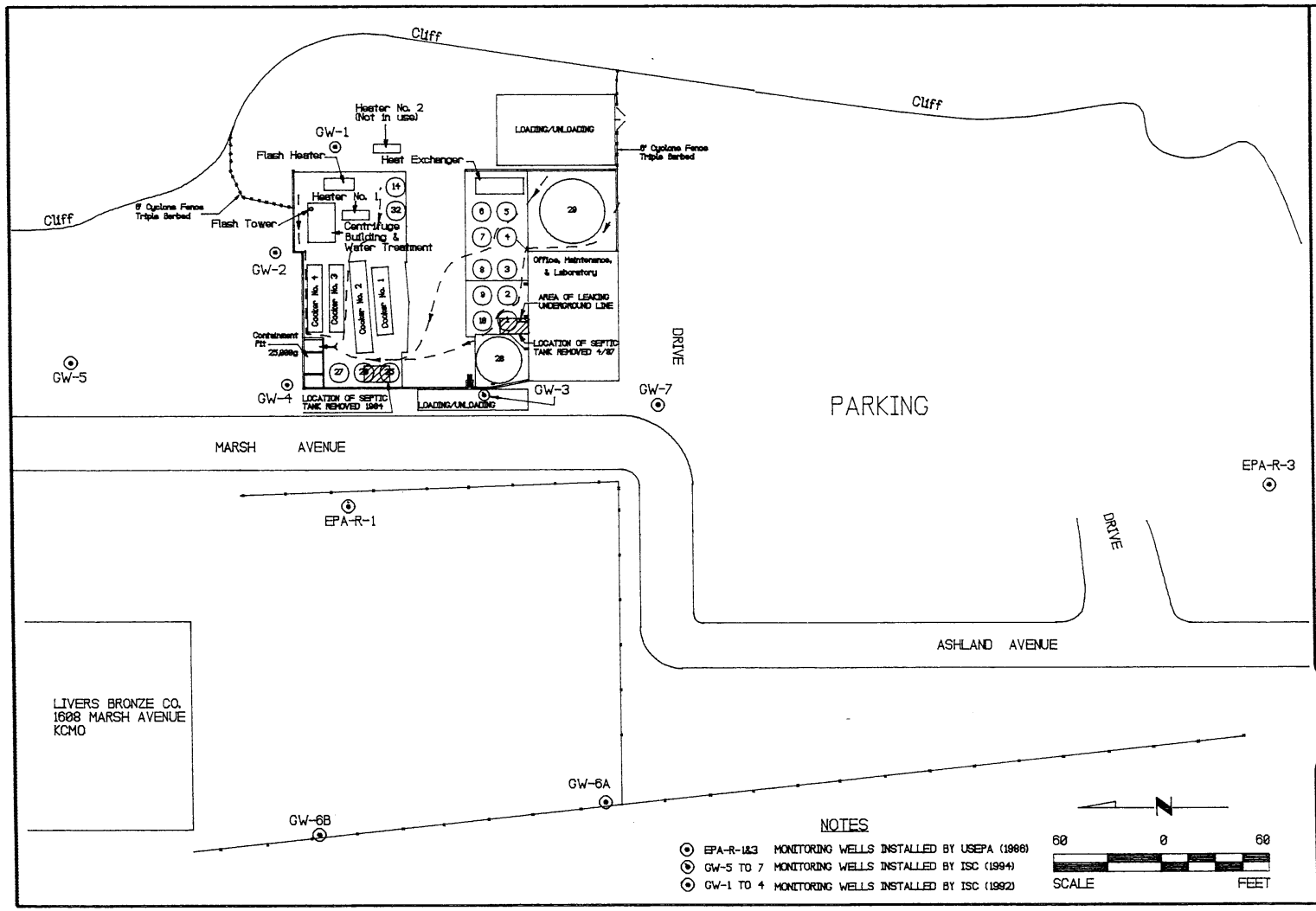
EMERGENCY FACILITY
LOCATION MAP

Figure 4-1 depicts the location of the facility and the location of the nearest and most easily accessed 24 hour emergency care response center. The Independence Regional Health Center is a Level II trauma center.

The ISC facility is primarily used for the bulk storage and processing of used oil and contains a number of above ground storage tanks in the tank farm. Figure 4-2 depicts a site plan of the facility. Used oil is the primary constituent stored on site.

Industrial Service Corporation is a multi-state transporter, collector, processor and distributor of used oil. Customers from whom ISC collects these products are service stations, railroads, retail auto dealers, car dealers, tune-up and auto repair shops, transmission shops, farm implement companies, truck and car leasing companies, and other business establishments. This petroleum product recycling facility and subsequent marketing activities are operated within guidelines as specified in 40 CFR Part 279 and applicable MDNR regulations.

Adequate roads, water supply, electricity and telephone service is available in case an emergency situation presents itself during the investigation of this facility. ISC has an operational facility contingency plan that will also be considered during all phases of the investigation.



LEGEND

TANK 1 - USED DIESEL
TANK 2 - USED OIL
TANK 3 - USED OIL
TANK 4 - USED OIL
TANK 5 - USED OIL
TANK 6 - TRUCK FUEL
TANK 7 - TREATED WATER
TANK 8 - ROAD OIL
TANK 9 - HYDRAULIC OIL
TANK 10 - USED DEISEL
TANK 14 - TRUCK FUEL
TANK 25 - USED OIL
TANK 26 - USED OIL
TANK 27 - UNTREATED WATER
TANK 28 - PROCESSED OIL
TANK 29 - USED OIL
TANK 32 - USED OIL
COOKER 1 - USED OIL
COOKER 2 - NEW #6 OIL
COOKER 3 - USED DEISEL
COOKER 4 - USED OIL
← — DRAINAGE LINE

FIGURE 4-2	DATE	1-10-94
	DESIGNED	JMC
	DETAILED	JMC
	CHECKED	BN

INDUSTRIAL SERVICE CORP.
1633 MARSH AVE.
KANSAS CITY, MO 64126

FACILITY DIAGRAM

4.2 Chemical Hazards

Previous investigations performed at the ISC Facility indicate the presence of the following compounds:

TABLE 4-1

CONTAMINANTS OF CONCERN

VOLATILE ORGANIC COMPOUNDS

Acetone	Benzene
2-Butanone	Carbon disulfide
cis-1,2-dichloroethane	1,2-dichloroethane
Chlorobenzene	Chloroethane
1,1-Dichloroethane	1,4-Dioxane
2-ethoxyethanol	Ethylbenzene
2-Hexanone	Isobutanol
Methylene chloride	Methyl chloride
4-Methyl-2-pentanone	O-xylene
1,1,1,2-Tetrachloroethane	Tetrachloroethene
1,1,2,2-Tetrachloroethane	Styrene
Toluene	Trans-1,2-dichloroethane
1,1,1-Trichloroethane	Trichloroethene
Vinyl chloride	Xylene (Total)

SEMI-VOLATILE ORGANIC COMPOUNDS

Acenaphthene	Anthracene
Benzoic acid	Benzo(a)anthragene
Bis(2-ethylhexyl)phthalate	Chrysene
2,4-Dimethylphenol	Dibenzofuran

TABLE 4-1

CONTAMINANTS OF CONCERN (Continued)

1,2-Dichlorobenzene	2,4-Dinitrotoluene
Hexachlorobenzene	Hexachloroethane
Hexachlorobutadiene	Fluoranthene
Fluorene	2-Methylnaphthalene
2-Methylphenol	Nitrobenzene
2-Nitropropane	Naphthalene
3-Methylphenol	Butyl benzyl phthalate
Pyradine	Di-N-butylphthalate
N-Nitrosodiphenylamine	Phenanthrene
Phenol	Pyrene

DIOXINS

2,3,7,8-TCDD	2,3,7,8-TCDF
1,2,3,7,8-PECDF	2,3,4,7,8-PECDF
1,2,3,7,8-PECDD	1,2,3,4,7,8-HXCDF
1,2,3,6,7,8-HXCDF	2,3,4,6,7,8-HXCDF
1,2,3,7,8,9-HXCDF	1,2,3,4,7,8-HXCDD
1,2,3,6,7,8-HXCDD	1,2,3,7,8,9-HXCDD
1,2,3,4,6,7,8-HPCDF	1,2,3,4,7,8,9-HPCDF
1,2,3,4,6,7,8-HPCDD	1,2,3,4,6,7,8,9-OCDF
1,2,3,4,6,7,8,9-OCDD	

HERBICIDES

2,4-d	2,4,5-TP (Silvex)

TABLE 4-1

CONTAMINANTS OF CONCERN (Continued)

PESTICIDES AND PCBS

betta-BHC	gamma-BHC
Heptachlor	PCB-1260
Heptachlor epoxide	

Total Metals

Aluminum	Antimony
Arsenic	Barium
Beryllium	Cadmium
Calcium	Chromium
Cobalt	Copper
Iron	Lead
Magnesium	Manganese
Mercury	Nickel
Potassium	Silver
Thallium	Tin
Vanadium	Zinc
Cyanide,Total	Sulfide,Total
Hexavalent chromium	

Due to the nature of the chemical compounds listed above, certain hazards are inherent. Because of this potential danger, Level D protection is required at all times. Employees should be prepared to upgrade to Level C protection if such a need should arise during intrusive activity when visible contamination is encountered and/or detection levels exceed established background levels. They will be HAZMAT certified in accordance with OSHA regulations 29CFR part 1910.120. They will be familiar with and conform to all the provisions of this plan, and any other safety directives that may be considered necessary by Project Managers, Safety Officers, and Supervisors.

Copies of applicable Material Safety Data Sheets (MSDS) can be found in Appendix C. Copies of all employee and subcontractor HAZMAT certificates will be maintained on file by Industrial Service Corporatiion. Certifications will be available for review.

4.3 PHYSICAL HAZARDS

Site personnel should be aware that protective equipment worn may limit manual dexterity, hearing, visibility, and may increase the difficulty of performing some tasks. Personal Protective Equipment (PPE) places an additional strain on the wearer when performing work that requires physical activity. Heat exhaustion or heat stroke is possible, especially during warm weather. Heat exhaustion may produce symptoms such as nausea, headache, weakness, dizziness, dry and pale skin, or extreme perspiration. This condition requires immediate attention. All personnel should be cognizant of their physical condition as well as the condition of co-workers.

4.3.1 GROUNDWATER MONITORING PHASES

All groundwater monitoring activities, measurement procedures, samples collection, and field test procedures, shall be completed with at least 2 people per team. The necessary protective clothing, hard hat, boots, etc. (see Section 4.6.2), shall be worn. All well heads, when opened, shall be checked at the Breathing Zone with an Organic Vapor Meter (OVM), or PhotoIonization Detector (PID), and/or equivalent for potential hazards. If the meter reading is below 5 ppm in excess of background levels, work may continue. If this level is exceeded, all personnel shall move upwind of the area and upgrade to level C protection. After a period of 5 minutes the breathing zone of the well head may be rechecked. If subsequent monitoring reveal levels have fallen below the 5ppm criteria, all personnel may downgrade to Level D protection.

4.3.2 DRILLING ACTIVITIES

All drilling activities shall be completed only by authorized personnel. Restrictive access precautions shall be implemented to assure this. These precautions include, but are not limited to, the use of barricades, barricade tape, and employee identification. Protective clothing, hard hats, gloves, steel toe boots, etc. (see Section 4.6.2) shall be worn by all drilling personnel. Physical hazards typically encountered by drilling personnel (e.g. overhead hazards, lifting of heavy material, trips and falls, drill rig protocol and safety, etc.), will be minimized through our drilling safety employee education and training.

4.4 LINES OF AUTHORITY

Lines of authority include, but are not limited to, the Project Manager, the Site Health and Safety Officer, and the Field Team Leader. Each field team on the site will have a Safety Supervisor. The number of teams will vary depending on the task assignments at the site each day.

A field team will be organized to efficiently and safely carry out the objectives of the investigation. The activities include sampling of soil, monitoring well installation, site mapping, metal detection or performing geophysical surveys. The team will typically include individuals with many different technical skills, such as chemists, geologists, and engineers. In addition to performing task objectives, the team must provide for its own safety to prevent injury. This can be accomplished by assignment of specific roles and responsibilities to members of the field team and by assuring that the proper team size is used to effectively accomplish specific objectives.

4.4.1 TEAM MEMBER RESPONSIBILITIES

There are a number of roles which are required for the safe and competent operation of a field investigation team. The roles which are necessary at every site where a field team will be working are Project Manager, Site Health and Safety Officer, Field team leader and Work Party. Guidelines are presented here for assignment of responsibilities to team members to ensure safety and for establishing the team size.

Project Manager

The Project Manger is responsible for the overall effectiveness of the field investigation. The specific responsibilities of the project manager include preparing and organizing all project work assignments, briefing team personnel on specific duties, obtaining site access permission from the owner or responsible party, ensuring that the health and safety requirements of the field team are complete and approved by the Health and Safety Officer, maintaining files, complying with chain-of-custody procedures, and coordinating with government representatives and subcontractors.

Field Team Leader

The Field Team Leader is accountable for the organization, operation, and safety of the field team. The Field Team Leader is responsible for proper field operations, maintaining a field notebook which records all site activities, completion of the objectives of the site Work Plan, compliance with document control procedures and proper field documentation of operating procedures, and

determining the level of personal protection necessary to ensure the health and safety of the field team. If subcontractors or outside observers are present, the Field Team Leader must enforce health and safety procedures.

Site Health and Safety Officer

The Site Health and Safety Officer has primary responsibility for all safety procedures and operations on-site. The Site Health and Safety Officer is responsible for determining the necessary level of personal protection based upon observations and changing circumstances during the field investigation. He/She must prepare an approved safety plan which outlines locations, routes, and emergency telephone numbers. Members of the field team will be briefed on its content and a copy will be posted on-site. He/She must verify that team members have met the health and safety requirements for field assignment, as well as monitor field activities for conformance to procedure. The Site Health and Safety Officer has the authority to halt any operation that threatens the health or safety of the team.

Work Party

The Work Party is ultimately responsible for the safe and successful completion of the work assignment. The members of the Work Party share many active and important functions which are necessary to fulfill the objectives of the investigation. These include setting up the personnel decontamination station, performing site characterization, taking photographs, collecting samples of various media, decontaminating sample containers, packaging and shipping of the samples in

accordance with Chain-of-Custody procedures, and decontaminating the entire Work Party prior to leaving the site. In the event of an accident, the first person to recognize the problem will immediately take the appropriate action. These actions will be detailed in the Site Emergency Procedures section 4.9.

4.4.2 PUBLIC HEALTH PROTECTION

Protection of public health will be provided by limiting access to contaminated work areas. Barricades and barricade tape will be utilized to delineate and prevent access to various work areas. Any visitor to the site must present proper identification and be authorized for site access. Visitors must comply with all aspects of the health and safety plan.

4.5 WORK AREA DELINEATION

Work areas will be delineated to assure the safety of all on-site employees, the surrounding public, and to prevent or reduce the transfer of hazardous materials between work areas and off-site locations by workers and equipment involved in on-site activities. The Project Manager and Health and Safety Officer shall be responsible for establishing the site and distance between zones at the site. The three work areas to be established on the site are:

1. Exclusion Zone (Contamination Zone)
2. Contamination Reduction Zone (Decontamination Zone)
3. Support Zone

These zones are graphically depicted in Figure 4-3.

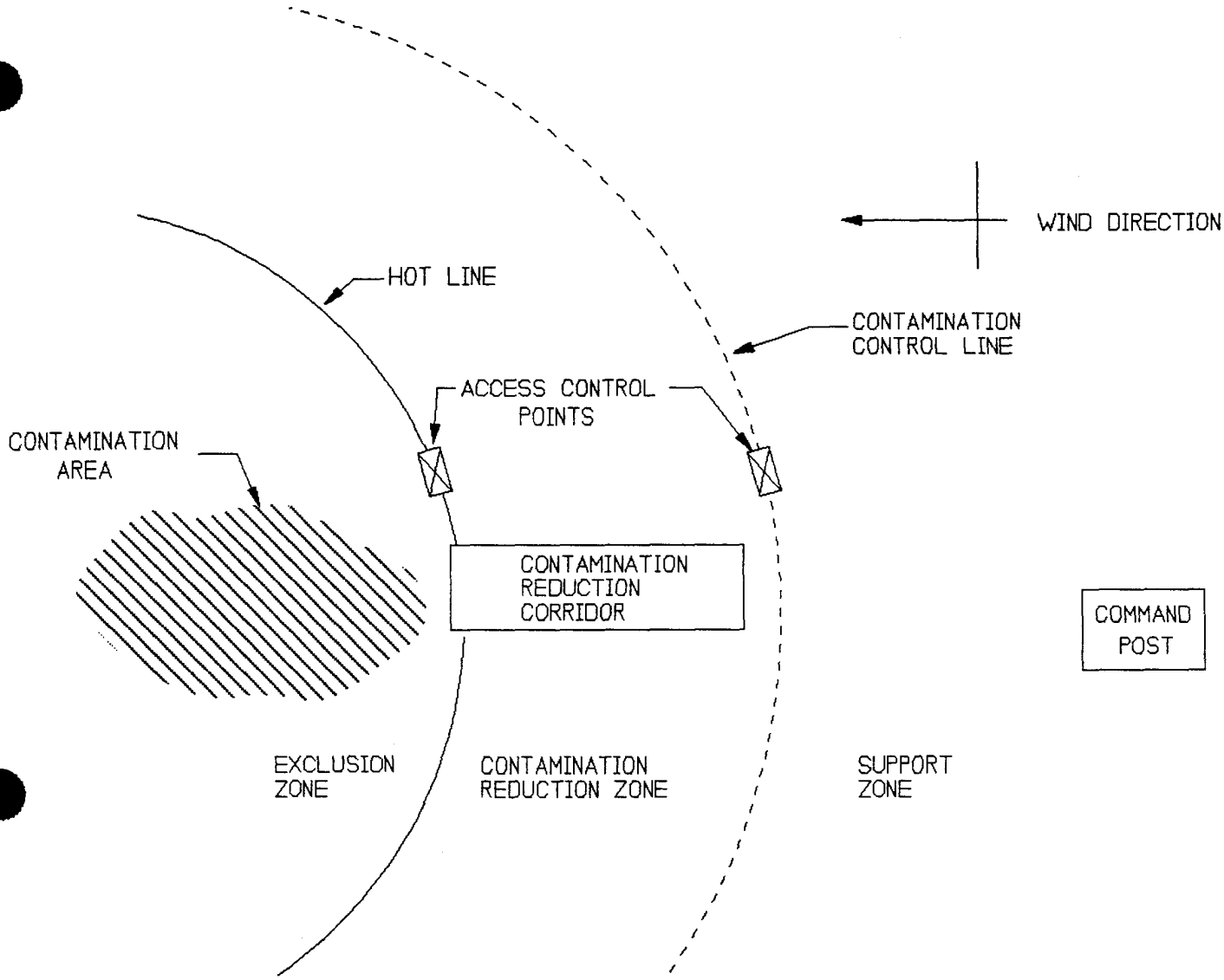


FIGURE 4-3

DIAGRAM OF SITE WORK ZONES

4.5.1 EXCLUSION ZONE

An exclusion zone will be constructed in areas where active drilling investigations or cleanup operations are taking place. In addition, an exclusion zone shall be constructed around all physical indicators of hazardous substances (e.g. drums, tanks, portable pits, etc..). Prescribed levels of protection must be worn by all personnel within these zones. The boundary used to contain these areas will be physically well-defined and easily visible.

4.5.2 CONTAMINATION REDUCTION ZONE

The contamination reduction zone shall lie between the exclusion zone and the support zone. Within this zone, decontamination of all personnel and equipment shall take place. Only upon successful completion of the decontamination process will personnel or equipment be allowed to leave this zone. The full decontamination process shall be described in Section 4.8 of this document.

4.5.3 SUPPORT ZONE

The support zone is the outermost zone of the work area. This zone contains the field headquarters, first aid station, and all other work and cleanup support areas necessary for the completion of the work site. This zone is considered a non-contaminated or clean area. Therefore, normal work clothes are appropriate within this zone. Ambient air will be monitored periodically within this zone. A reading of 5 ppm above background levels or greater will be used

to determine the safety of the surrounding region. If this level is exceeded, the zone will be evacuated. Employees will not be allowed to return until the ambient conditions return to acceptable levels.

4.6 PROTECTIVE EQUIPMENT

4.6.1 RESPIRATORY PROTECTION

The selection of adequate respiratory protection depends primarily on the type of hazardous substances to be encountered. Proper respirator use requires formal training and continued maintenance of the equipment, in accordance with 30 CFR Part II and provisions of the National Institute for Occupational Safety and Health. OSHA regulations pertaining to respiratory protection require a training program that encompasses user responsibilities, training for proper use, and respirator maintenance. OSHA also requires qualitative fit testing of face-pieces. Facial hair (beards) and wearing contact lens is prohibited.

Air-Purifying Respirator (APR)

The APR removes contaminants from the atmosphere, to a degree, and is used only in atmospheres containing sufficient oxygen to sustain life. APR equipment will be provided on-site and utilized when necessary. The criteria for use of APRs are listed below.

Specific concentration limitations exist for specific devices. The chemical-cartridge respirator provides respiratory protection against certain gases and vapors in concentrations not to exceed those labeled on the cartridge. An APR can only be used in an area where minimal concentrations might occur and where SCBA has been determined unnecessary. Many types of cartridges are available and field personnel should select the appropriate one for the contaminants expected.

Air purifying respirators or cartridge respirators are worn when:

* Any unidentified odor is detected.

* Substances in the air are not greater than 10 times the permissible exposure limit (PEL), and have good warning properties.

* The Project Manager judges that respirators are needed as a precaution against generation of low levels of contaminated substances in air due to sampling, handling, decontaminating or other operations.

* The capacity of the cartridge will not be exceeded by extended periods of use on-site. (If used for extended periods, cartridges must be changed).

Users of air purifying respirators must comply with the following:

* At least 19.5 percent oxygen must be present for respirator use, or unprotected breathing.

* Cartridge respirators do not supply oxygen. They are of no use in oxygen-deficient atmospheres.

* Air purifying respirators provide less protection than SCBAs and supplied air devices.

* Air purifying respirators must be NIOSH-approved.

* Cartridges must also be NIOSH-approved and should be matched to the respirator by the manufacturer.

* Cartridges must not be used past the expiration date.

* Air purifying respirators will provide adequate protection only if they have good face seals. A qualitative fit test is required for each employee using these respirators.

* Upon experiencing any warning signal (e.g. difficulty breathing, strong taste or smell, dizziness, or other distress), the user must immediately leave the site. The Field Team Leader or Site Health and Safety Officer may require that a user of an air purifying respirator carry an emergency escape air mask.

* Users of air purifying respirators must follow the manufacturer's instruction on the donning and use of the equipment.

* Cartridges must sometimes be replaced as often as each hour of use, or when the user senses or smells the vapor. If the contaminant of interest does not have warning properties, the APR cartridge must not be used.

4.6.2 PROTECTIVE CLOTHING

Protective clothing must be worn by all personnel to prevent skin exposure and to minimize spread of contamination. All on-site operations require protective clothing. Protective clothing may include, but is not limited to chemical-resistant pants and jackets or coveralls, disposable coveralls, steel toe boots, protective gloves, hard hats, face shields or chemical safety glasses. In addition to proper choice of protective clothing, employees must also be reminded to stay alert. Protective clothing is cumbersome and hastens the on-set of fatigue and heat exhaustion. It can also decrease alertness and limit stay-time.

The following section describes modified Level D protective equipment which is appropriate for the site.

> Modified Level D - Level D is the basic work uniform and is used when significant exposure is unlikely.
>
> Level D protection consists of:
> * Coveralls, cotton
> * Boots/shoes, safety, with steel toe
> * Safety glasses
> * Hard hat with optional face shield
> * Gloves

The following modifications to Level D protection will be made at the Site. Tyvek will be worn during on-site boring and sampling activities. If necessary, soils will be wetted down during on-site activities to minimize dust. Air purifying respirators with HEPA/organic vapor cartridges will be readily available at the site and will be used when upgrade to Level C protection is necessary.

4.6.3 BASIC SAFETY PRACTICE

Field personnel will observe basic safety practices. The Health and Safety Director will be responsible for informing all field personnel of these practices. They will include, but not be limited to the following:

* Observe the buddy system (work in pairs).
* Eating, drinking, and smoking are prohibited on-site.
* Contact lenses cannot be worn with any respirators.

* Practice contamination avoidance by avoiding obviously contaminated objects/areas and by not sitting or kneeling on the ground.

* Maintain contact with the Site Safety Officer.

4.7 SITE ACCESS

Access to contaminated work areas shall be regulated and limited to authorized persons. Barricades and barricade tape will be utilized to delineate work areas and limit access. Any visitors to the site must present proper identification and be authorized for site access. Visitors must comply with all aspects of the health and safety plan.

4.8 DECONTAMINATION PROCEDURES

All personnel and equipment involved with the exclusion zone shall be decontaminated using the following procedures:

Equipment Decontamination

1.) Scrub the equipment with a stiff bristled brush using Alconox soap (or equivalent) and potable water solution.
2.) Rinse the equipment with potable water.
3.) Wipe and rinse equipment with distilled/deionized water.
4.) Final rinse with distilled/deionized water.

Personnel Decontamination

1.) Wash work gloves, boots, and outer protective coverall (if water resistant) with Alconox Soap and potable water solution.
2.) Rinse work gloves, boots, and coverall (if water resistant) with portable water.
3.) Remove duct tape at wrists, ankles.
4.) Remove outer gloves.
5.) Remove safety glasses.
    a.) Level C-Remove MSA Full Face Respirator (FFR)

6.) Wash and rinse safety glasses.
   a.) Level C-Wash and rinse MSA-FFR.
7.) Remove outer coverall by turning inside out.
8.) Remove outer boots.
9.) Remove surgical gloves.

Final decontamination procedures will be completed in the Contamination Reduction zone. All non-reusable equipment (eg: coveralls, surgical gloves, outer gloves, and duct tape) will be placed in disposable bags and placed in a dumpster when located at the work site for proper disposal. When respirators are used they will be cleaned after every use within the Contamination Reduction Zone. The respirators will be cleaned and inspected according to the respirator manufacturer's instructions. Quality control and quality assurance wipe samples will be used when required to detect possible contamination levels in the Support Zone and/or Contamination Reduction Zones to demonstrate proper decontamination compliance.

4.9 SITE EMERGENCY PROCEDURES

If an emergency situation arises (eg: injury, illness, violent weather, or fire) the first person to recognize the problem will take the immediate appropriate action. If the situation is an injury or illness due to chemical and/or hazardous substance, immediate identification of the substance must be made. This information will be provided to both work and medical personnel in the form of MSDS sheets. Copies of these sheets are included in Attachment C.

If the situation is a physical injury, medical personnel will apply the appropriate stabilizing field injury application. First-aid equipment, emergency eyewash, and fire extinguisher will be available in all work areas.

If an injury requires hospitalization, the necessary calls will be placed immediately and a clear evacuation will take place. To assure the expedience of such an occurrence, all employees will be clearly briefed on the location of available phones, the location of emergency phone numbers, and the location and understanding of all available emergency evacuation routes to the nearest medical centers. A list of emergency phone numbers and a map to the nearest hospital (Figure 4-1) will be posted in all work areas, in all work vehicles, and beside all emergency phones. Two phones will be designated as emergency phones. One phone will be located in the ground level parking garage, the other shall be located in ISC's Main Office.

<u>Phone Numbers to use in Case of Emergency</u>

ISC Site Superintendent (Don Cozad)	-	833-1919
Fire Department	-	911
Police	-	911
M.A.S.T Ambulance	-	474-1111
Poison Control Center	-	234-3000
Independence Regional Health Center 1509 W. Truman Road Independence, Missouri	-	(816) 836-8100

4.10 ENVIRONMENTAL SURVEILLANCE

All Deffenbaugh personnel and/or major subcontractors on site shall have successfully completed an examination by an occupational physician in accordance with the Deffenbaugh Medical Surveillance Program. This program meets or exceeds the requirements as specified in 29 CFR 1910.120. This surveillance program includes tests taken on a pre-employment and periodic/update basis. These tests include:

* Complete physical exam.
* Chest x-rays (P/A and lateral).
* Electrocardiogram
* Pulmonary function (FEV1, FVC).
* Audiometry (500 to 8,000 Hz).
* Visual
* Urinalysis
* SMAC-21 or equivalent
* Drug and alcohol screening
* PCB screening
* Heavy metal screen (24-hr. urine).
* Pesticides/Herbicides (RBC Acetylcholinesterase).

4.11 REQUIRED TRAINING

All personnel involved in the investigation, shall be required to have successfully completed the OSHA 29 CFR 1910.120 40 hr. training course. An 8 hr. refresher course shall be mandatory for all employees who have retained their 40 hr. training for one year or more. All drillers shall have their Missouri drilling certification completed and up to date.

4.12 WEATHER PROTECTION

Heat Stress

To reduce heat stress the following items shall be provided and recommended for all personnel:

* adequate drinking water
* adequate shade
* (recommended)-cotton undergarments

Heat Exhaustion

To prevent possible heat exhaustion during extremely warm weather, the following methods shall be available for use:

* cooling devices to aid in ventilation.
* work only during the early morning and evening.
* Rotate crews wearing protective clothing.

Cold Exposure

Systemic hypothermia or frostbite can occur in freezing or rapidly dropping temperatures.

To avoid such occurrences, the following methods shall be recommended and implemented:

* cotton undergarments to adsorb perspiration.
* Layer clothing
* Wind break installation.
* Maintain good eating and drinking habits.
* Provide a sheltered rest break area for resting and warming up.
* Listen and act appropriately to body warning signals -
    - Apathy, listlessness and sleepiness.
    - Glassy stare, slow pulse, etc.
    - Watch extremities for signs of Frost Bite (whiting of skin, numbness, lack of feeling)

Wet/Slippery Conditions

All drilling activities shall cease when electrical activity is identified in an approaching storm. Drilling personnel shall be instructed to avoid contact with exposed flesh and metal parts of the drill rig during freezing weather. All personnel shall be instructed to move slowly and carefully during wet and slippery conditions.

5.0 COMMUNITY RELATIONS PLAN

5.1 OBJECTIVE

The objective of the community relations plan is to provide a means for the dissemination of information to the public regarding on-going investigation activities and results.

5.2 PROCEDURE

Industrial Service Corporation maintains a public relations department at the Shawnee, Kansas headquarters. Responses to public inquiries are provided by Mr. Tom Coffman. Requests for information should be directed to:

Industrial Service Corporation
Public Relations
PO Box 3220
Shawnee, Kansas 66203

Mr. Coffman will respond to inquiries promptly based on the most accurate information available at the time. He will work toward maintaining a good relationship with the public and the media.

Industrial Service Corporation is committed to the maintenance of an environmentally satisfactory condition at this site. To this end, the company will encourage open communication with the public regarding studies conducted as part of the RFI.

ATTACHMENT A

QAS Quality Assurance Plan

Quality Assurance Plan

Quality Analytical Services, Inc.

Table of Contents

1.0 Introduction 1-1

1.1 Purpose 1-1
1.2 Scope 1-1
1.3 Application 1-2

2.0 Project Description 2-1

2.1 General 2-1

3.0 Project Organization 3-1

3.1 Personnel 3-1
3.2 Key Personnel 3-1
3.3 Organization 3-3

4.0 Quality Objectives 4-1

4.1 Accuracy and Precision 4-1
4.2 Data Quality Objectives 4-3
4.3 Turn Around Time 4-4

5.0 Sampling Procedures 5-1

5.1 Techniques for Selecting Sites 5-1
5.2 Specific Sampling Procedures 5-1
5.3 Sampling Operations 5-1
5.4 Sampling Containers 5-1
5.5 Sampling Equipment and Container Preparation 5-2
5.6 Sampling Preservation 5-2
5.7 Chain of Custody Procedures 5-2
5.8 Record Keeping 5-2

6.0 Sample Custody 6-1

6.1 Field Sampling Documentation 6-1
6.2 Laboratory Operations 6-1

Table of Contents

7.0 Calibration Procedures and Frequency 7-1

7.1 Wet Lab Calibrations 7-1
7.2 Metal Calibrations 7-1
7.3 Organic Calibrations 7-2

8.0 Analytical Procedures 8-1

9.0 Data Reduction, Validation, and Reporting 9-1

9.1 Data Reduction Scheme 9-1
9.2 Equations for Concentration Calculations 9-2
9.3 Data Validation Criteria 9-5
9.4 Identification and Treatment of Outliers 9-6
9.5 Reporting Scheme 9-6

10.0 Internal Laboratory 10-1

10.1 Duplicates 10-1
10.2 Spikes 10-1
10.3 Control Charts 10-1
10.4 Blanks 10-1
10.5 Internal Standards 10-2
10.6 Quality Control Samples 10-2
10.7 Calibration Standards 10-2
10.8 Reagent Checks 10-2
10.9 Blind Field Spikes and Duplicates 10-3

11.0 Performance and System Audits 11-1

11.1 Performance and System Audits 11-1
11.2 Schedule 11-7

12.0 Preventative Maintenance 12-1

12.1 Schedule 12-1
12.2 Procedures 12-1

13.0 Assessment Procedures for Data Acceptability 13-1

Table of Contents

14.0 Corrective Action 14-1

14.1 Limits 14-1
14.2 Procedures 14-1
14.3 Identification of Responsible Personnel 14-1

15.0 Quality Assurance Reports to Management 15-1

15.1 Schedule 15-1

Appendices

A Sample Forms
B Key Personnel Resumes
C Equipment List

List of Tables

Table 4.A Laboratory Control Samples 4-2
Table 5.A Sample Preservation 5-3
Table 7.A Flow Chart "A" 7-3
Table 8.A Inorganic - Wet Lab Procedures 8-1
Table 8.B ICP 8-2
Table 8.B GFAA 8-3
Table 8.C Organic Lab Procedures 8-4
Table 11.A Wet Lab Method Detection Limits 11-1
Table 11.B Metals Method Detection Limits 11-2
Table 11.C Organics Method Detection Limits 11-3
Table 12.A Preventative Maintenance Checklist 12-2

List of Figures

Figure 1 Organizational Chart 3-3

1.0 INTRODUCTION

1.1 PURPOSE

This Quality Assurance Plan (QAP) is for the formal documentation of sampling and laboratory analysis, and its goals are to:

- Document the sampling process for the collection of representative and verifiable samples for analyses.
- Provide a framework for the generation of consistent analytical data.
- Establish standard practices for the documentation of sampling, analysis, and data review.
- Estimate the quality of each analytical procedure.
- Detect deficiencies before they affect the quality of the data.
- Insure the validity of the data.

1.2 SCOPE

This manual will outline the policies and procedures of our quality assurance program to insure the validity of the chemical analyses conducted for our clients, whether they be industry or government. Implementation of this quality assurance plan will insure the validity of the analytical data and will provide the client with a reliable and legally defensible foundation on which decisions can be made.

In studying the manual, one should understand the differences in quality assurance (QA) and quality control (QC).

Quality assurance will be used to describe the system used for monitoring the quality control data. It is the administrative section which allows traceability, completeness, and security of all documents concerned with a sample.

Quality control will refer to the specific actions taken to insure the analytical sequence is within laboratory controls and established limits. Quality control is the section which assures the client that the analysis is performed properly and accurately.

Quality assurance and quality control must be used together in order to have a successful program which insures the analysis and documentation will be there when they are needed.

1.3 APPLICATION

The emphasis of this quality assurance plan is on all activities which are used to generate analytical data, and it will include field sampling. Field sampling has a very important place in the validity of the analytical data. Even the best data on a sample which has been poorly sampled is of little use.

Specific requirements and procedures are given for the sampling and analysis of groundwater, surface water, soils, and sediments. Air sampling is not discussed in this manual, but will be handled on an individual basis due to numerous factors generally encountered.

2.0 PROJECT DESCRIPTION

2.1 GENERAL

In lieu of a specific project, a general overall description is given.

Quality Analytical Services' (QAS) primary goal or project is to provide verifiable and reliable sampling and analyses of environmental samples to the clients to enable them to make decisions regarding their site or processes. As a group of professional chemists and environmentalists, it is the laboratory's responsibility to conduct these analyses in accordance with EPA approved methods, to honor established holding times, and to provide the clients with detection limits which will meet their requirements. Quality Analytical strives to provide the client with a reliable and complete analytical report in the shortest turn around time possible.

To meet these general goals, each sample will receive a unique sample number which will be used for tracking the sample through the analytical process. Each analyst will be briefed on what analyses are requested so that analyses can be planned and started within the established holding times. All raw data for that sample will be placed in a common file for easy retrieval at a later date. Samples can be batched together for the purpose of grouping quality control samples with the actual analyses. The quality control officer will receive and review all data before releasing it. The lab director will approve the final report by his signature on the original.

3.0 PROJECT ORGANIZATION

3.1 PERSONNEL

The personnel at Quality Analytical Services are carefully selected based upon their education and experience. We strive to maintain our professionalism and dedication to quality assurance at very high levels and this is obtained by staffing our laboratory with conscientious people. The staff of QAS are encouraged and supported to continue their training by attending additional college courses, participating in seminars, joining professional societies, etc.

The staff at present includes the following positions:

- Laboratory Consultant
- Laboratory Manager/Organic Specialist
- QA/QC Officer/Sample Custodian
- Organic Chemist
- Inorganic Chemist
- Laboratory Technician (2)

Resumes are presented in Appendix B.

3.2 KEY PERSONNEL

Lab Director

The lab director is responsible for all of the technical and managerial efforts of the laboratory to insure all contractual requirements are met. He/she will prepare the analytical bids/quotes and direct the day-to-day operations of the inorganic, organic, and sample handling sections until such time that the sample load warrants otherwise. He/she will provide analytical backup and support to the various sections.

The lab director will give the final approval of the lab data before they are released to the client, and will be responsible for insuring the data packages are complete and intact.

Organic Specialist

The organic specialist will be responsible for all organic analysis and aiding the lab director in compiling and reviewing the organic lab data before reporting. He/she will be proficient in the use and maintenance of both GC/MS and GC for the analysis of environmental parameters. The Organic Specialist will understand and offer guidance in the interpretation of GC/MS and GC data.

Organic Chemist

The organic chemist positions will be filled by individuals with a minimum of 1 year of experience in performing organic analysis and interpreting data. They will be proficient in the analysis of trace level contaminants in various matrices. They will have a thorough understanding of organic and separation principles and techniques.

Inorganic Specialist

The inorganic specialist is presently being filled by the lab director who offers the inorganic chemist training and supervision in all aspects of inorganic analysis. This position will be filled in the near future by an individual who is experienced in the environmental analysis using AAS, Furnace, Cold Vapor, ICP, ion chromatography, ISE, as well as classical wet lab procedures.

Inorganic Chemist

The inorganic chemist presently is an individual who has demonstrated a great deal of knowledge in chemistry and laboratory practices. The individual is proficient in the equipment and techniques but has less than 2 years experience in the environmental matrices.

Lab Tech I

The lab tech will be responsible for keeping the glassware clean and available. He/she will be responsible for routine analytical determinations (i.e. pH, titrations, % moisture, etc.). The Lab Tech will have as a minimum, a high school diploma and 10 hours of college science or equivalent experience.

Sample Custodian

The sample custodian will be responsible for sample receipt and log-in. He/she will check all paperwork against the samples for any deficiencies. He/she will properly store the samples and ensure that the data files are prepared and will notify the corresponding labs that the samples have arrived and for what analysis. The individual will have a high school diploma as a minimum and a science background.

Quality Control Officer

The QC officer continually checks the QC of the lab data.

3.3 ORGANIZATION

Laboratory management communicates directly with the president, environmental engineers, and general counsel for Deffenbaugh Industries, Inc. This routine communication allows the lab to be continually aware of the current environmental regs or other information necessary to successfully operate the laboratory in an efficient manner.

The lab has a number of positions divided into three sections: sample handling, inorganic, organic. At the present time each individual is wearing the hat of more than one position; this will change as the sample volume dictates. An organizational chart is provided below.

ORGANIZATIONAL CHART

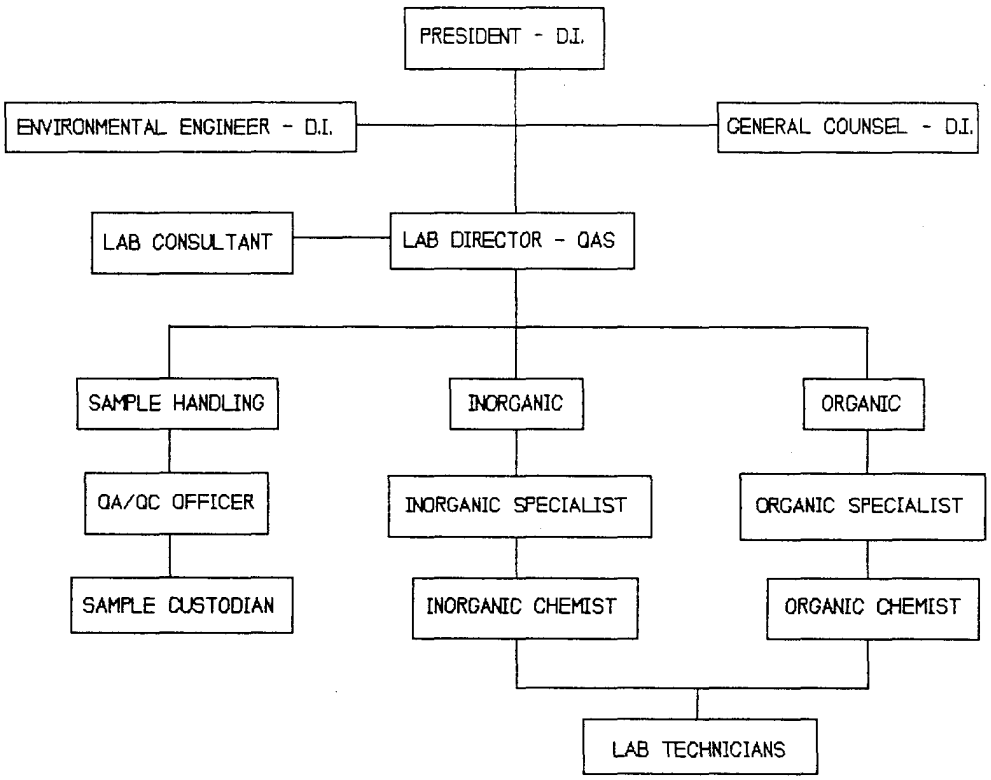


Figure 1

4.0 QUALITY OBJECTIVES

The objectives of this quality assurance plan are to provide the analyst with guidelines for the acceptance of data and to define the quality of the data.

4.1 ACCURACY AND PRECISION

The two primary parameters for the measurement of quality are accuracy and precision.

Accuracy is the difference between the experimental value and the true value. Accuracy is measured in the laboratory by the spiking of an unknown sample or reagent H_2O with a known concentration of the parameter of interest. When an actual sample is spiked, the analyst obtains a clearer understanding of matrix effects or interferences: the spiking of reagent H_2O allows a truer picture of the accuracy of the method.

Precision is the degree of mutual agreement among individual measurements made under analytical conditions with a single procedure. Precision is measured in the laboratory by analyzing a sample in duplicate and comparing the two values for a single sample.

Quality Analytical Services utilizes laboratory control samples for the purpose of generating its accuracy and precision data. A laboratory control sample (LCS) is a clean sample matrix with two or more analytes of interest spiked into it. A list of laboratory control samples is given in Table 4.A. A laboratory control sample is analyzed at a frequency of two for every 15 samples to provide data to calculate precision as well as accuracy.

In addition, organic samples are spiked with a suitable surrogate standard (when one is available) to determine whether or not acceptable recovery can be achieved. All GC/MS analyses are performed with internal standards as well.

TABLE 4.A - LABORATORY CONTROL SAMPLES

PARAMETER (GC)	LCS	CONCENTRATION (ug/L)
OCP	Lindane	0.2
	Heptachlor	0.2
	Aldrin	0.2
	Dieldrin	0.2
	Endrin	0.2
	p,p'-DDT	0.2
PCB's	Aroclor 1260	5
PNA's	Napthalene	3000
	Phenanthrene	100
	Pyrene	500
OPP	Diazinon	10
	Malathion	10
	Parathion	10
HERBICIDES	2,4-D	0.5
	Silvex	0.5
PHENOLS (GC)	Phenol	1000
	2,4 Dimethyl Phenol	500
	PCP	1000

PARAMETER (GC/MS)	LCS	CONCENTRATION (ug/L)
VOLATILES	1,1 Dichloroethene	50
	TCA	50
	Chlorobenzene	50
	Toluene	50
	Benzene	50
SEMIVOLATILES	PCP	200
	Phenol	200
	2 Chlorophenol	200
	4 Nitrophenol	200
	1,2,4 Trichlorobenzene	100
	Acenaphthene	100
	Pyrene	100
	1,4 Dichlorobenzene	100

4.2 DATA QUALITY OBJECTIVES

A. Accuracy Data: (Percent Recovery)

Control charts will be maintained for routine analyses based upon the results from the laboratory control samples. This data will allow the laboratory to determine the accuracy of the method itself aside from interferences and give a value which can be compared over a period of time. Percent recovery is calculated using:

% Recovery = (measured value / actual value) x 100

The control charts will be constructed quarterly with warning and control limits placed at two and three standard deviations of the mean, respectively.

For laboratory control samples with multiple components, 85 percent must fall within the limits of zero to three standard deviations. The specific warning limits are:

0 - 2 S.D.	Analysis is in control.
2 - 3 S.D.	Analysis is in control but look for problems developing.
3 & higher	Out of control, look for and correct problems and notify management before proceeding.

B. Precision Data: (Relative Percent Difference)

Precision will be calculated using the following equation for relative percent difference (RPD):

$$\text{RPD} = \frac{\text{\% recovery LCS - \% recovery LCS duplicate}}{\text{[(\% recovery LCS + \% recovery LCS duplicate) / 2]}}$$

These data will be used for the construction of control charts. Any data above three standard deviations will be considered out of control.

C. Surrogate Recovery:

Surrogate recovery will be monitored and compared to CLP surrogate values to determine if the sample and standards are in control. Surrogate percent recovery will be calculated using the same equation as accuracy given in Section 4.2A.

4.3 TURN AROUND TIME

The standard turn around time for most projects at Quality Analytical Services is 5 to 10 working days. The turn around time for any specific project is dependent on the current sample load in the laboratory at the time the sample(s) is (are) received, the scope and site of the project, and any special or additional requirements involved with the project. It must be realized that the following receipt, log-in, and analysis of a project, prior to the report being typed, that the data must go through a quality control review.

QAS always strives to meet the holding times for all parameters. Sometimes, samples are received on a day other than the day the sample was taken, may have a short holding time, or a machine is down, which would not allow us to meet the holding time. In these cases, QAS would contact the client to obtain replacement samples received on a more timely basis, have personnel work overtime, or subcontract the work to an approved laboratory.

5.0 SAMPLING PROCEDURES

5.1 TECHNIQUES FOR SELECTING SITES

Quality Analytical Services is not involved in the selection of the sampling sites. The sites to be sampled are chosen by the client to meet state and/or EPA requirements. Quality Analytical is then informed of the sampling locations and sampling commences.

5.2 SPECIFIC SAMPLING PROCEDURES

There are two site sampling categories. One is for the sampling of water from wells and the other for the sampling of soils.

When collecting a water sample, the sampler bails out three times the volume of the well or bails the well dry before sampling. A sample volume is then bailed from the well and placed in the proper sample container. After collecting the water sample, the well is resealed.

For soil samples, several collections are made from the contaminated area. At least one background sample is taken. This sample is used as a field blank, and the results are used for comparison with the sample results.

After a sample is collected, the container is labeled accordingly. Each container is labeled with the sample location, sampler's initials, date and time, any preservative added, analyses requested, and any additional comments. An example of Quality Analytical's sample label is presented in Appendix A.

5.3 SAMPLING OPERATIONS

Prior to field sampling, a written plan is prepared which outlines the goals and purpose of the sampling task. Consideration is given to the equipment needed, safety precautions, analyses needed, physical constraints, etc. Each of these areas is documented in the pre-sampling plan so that all information and samples will be collected in a manner which insures their reliability.

Occasionally, the pre-sampling plan will not encompass all that needs to be done and small changes may need to be made. These changes will be noted in a bound field sampling notebook described in further detail in Section 5.8. It is usually helpful to sketch a diagram of the sampling site for future reference.

5.4 SAMPLING CONTAINERS

There are two basic types of containers used for sample collection: polyethylene and glass containers. For samples requiring metal analysis only, a polypropylene container may be used in

place of a polyethylene one. The various parameters and their required sample containers are listed in Table 5.A.

5.5 SAMPLING EQUIPMENT AND CONTAINER PREPARATION

The equipment, as described in the pre-sampling plan, is decontaminated before each sample is collected. Equipment decontamination depends on each situation but generally consists of an Alconox soap wash, a tap water rinse, and a deionized water rinse. This step is essential for the prevention of cross contamination of the samples. The containers are prepared for sampling by rinsing with 1 percent HNO_3, acetone, or ASTM Type II water depending on the analysis to be performed on that sample. If it is believed that a site is contaminated, the equipment is cleaned after use before returning to the lab.

5.6 SAMPLING PRESERVATION

Upon collection of the sample, any necessary preservatives are added. Samples are preserved in accordance with current EPA guidelines. A listing of preservatives and maximum holding times is presented in Table 5.A.

5.7 CHAIN OF CUSTODY PROCEDURES

Chains of custody are used for the purpose of tracking samples from the time of sampling until the time of disposal. The external chain of custody tracks the sample from the time of collection until delivery to the lab. This form contains information such as the sampling site, sampler, date and time of sampling, field sample number, number of containers per sample, and a sample description. The chain of custody also provides space for the sampler's signature, and the date and time when a sample is relinquished as well as space for the receiving party to sign, date, and time the document. This chain of custody should be prepared at the time of sampling, and the original should remain with the sample at all times. A copy of the external chain of custody is presented in Appendix A.

5.8 RECORD KEEPING

All observations and measurements taken during the sample acquisition are recorded in a bound notebook with a complete description of the site, sampling protocol, physical observations of the sample, preservation techniques, etc. This bound notebook keeps the sampling information in one central place.

TABLE 5.A - SAMPLE PRESERVATION

PARAMETER	CONTAINER[1]	PRESERVATION	MAXIMUM HOLDING TIME
INORGANICS:			
Acidity	P,G	Cool, 4 C	14 days
Alkalinity	P,G	Cool, 4 C	14 days
Ammonia	P,G	Cool, 4 C H_2SO_4 to pH<2	28 days
Biochemical Oxygen Demand	P,G	Cool, 4 C	48 hours
Bromide	P,G	None required	28 days
Biochemical Oxygen Demand, carbonaceous	P,G	Cool, 4 C	48 hours
Chemical Oxygen Demand	P,G	Cool, 4 C H_2SO_4 to pH<2	28 days
Chloride	P,G	None required	28 days
Chlorine, total residual	P,G	None required	immediately
Color	P,G	Cool, 4 C	48 hours
Conductivity	P,G	Cool, 4 C	28 days
Cyanide, total and amenable to chlorination	P,G	Cool, 4 C NaOH to pH>12 0.6g ascorbic acid	14 days
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 TO pH<2, or H_2SO_4 to pH<2	6 months
pH (hydrogen ion)	P,G	None required	immediately
Kjeldahl and organic nitrogen	P,G	Cool, 4 C H_2SO_4 to pH<2	28 days
Nitrate	P,G	Cool, 4 C	48 hours
Nitrate - nitrite	P,G	Cool, 4 C	28 days
Nitrite	P,G	Cool, 4 C	48 hours
Oil and Grease	G	Cool, 4 C H_2SO_4 to pH<2	28 days
Oxygen, Dissolved probe	G bottle and top	None required	immediately
Phenols	G only	Cool, 4 C H_2SO_4 to pH<2	28 days
Phosphorus - ortho	P,G	Filter immediately Cool, 4 C	48 hours
Residue - settleable	P,G	Cool, 4 C	48 hours
Residue - total	P,G	Cool, 4 C	7 days
Residue - volatile	P,G	Cool, 4 C	7 days
Silica	P	Cool, 4 C	28 days
Sulfate	P,G	Cool, 4 C	28 days
Sulfide	P,G	Cool, 4 C, add zinc acetate plus sodium hydroxide to pH>9	7 days

TABLE 5.A - SAMPLE PRESERVATION - cont.

PARAMETER	CONTAINER[1]	PRESERVATION	MAXIMUM HOLDING TIME
Sulfite	P,G	None required	immediately
Surfactants	P,G	Cool, 4 C	48 hours
Temperature	P,G	None required	Analyze
Total Dissolved Solids	P,G	Cool, 4 C	7 days
Total Organic Carbon	P,G	Cool, 4 C, HCl or H_2SO_4 to pH<2	28 days
Total Organic Halogens	G, Teflon-lined cap	Cool, 4 C H_2SO_4 to pH<2	7 days
Total Suspended Solids	P,G	Cool, 4 C	7 days
Turbidity	P,G	Cool, 4 C	48 hours
METALS:			
Chromium	P,G	Cool, 4 C	24 hours
Mercury	P,G	HNO_3 to pH<2	28 days
Metals, except chromium IV and mercury	P,G	HNO_3 to pH<2	6 months
Phosphorus - elemental	G	Cool, 4 C	48 hours
Phosphorus - total	P,G	Cool, 4 C H_2SO_4 to pH<2	28 days
ORGANICS:			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4 C 0.008% $Na_2S_2O_3$	14 days
Purgeable aromatic hydrocarbons	G, Teflon-lined septum	Cool, 4 C 0.008% $Na_2S_2O_3$ HCl to pH 2	14 days
Acrolein and acrylonitrile	G, Teflon-lined septum	Cool, 4 C 0.008% $Na_2S_2O_3$ adjust pH to 4-5	14 days
Phenols	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$	
Benzidines	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$	7 days until extraction
Phthalate esters	G, Teflon-lined cap	Cool, 4 C	40 days after extraction
Nitrosamines	G, Teflon-lined cap	Cool, 4 C store in dark 0.008% $Na_2S_2O_3$	
PCB's, acrylonitrile	G, Teflon-lined cap	Cool, 4 C	

TABLE 5.A - SAMPLE PRESERVATION - cont.

PARAMETER	CONTAINER[1]	PRESERVATION	MAXIMUM HOLDING TIME
Nitroaromatics and isophorone	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$ store in dark	
Polynuclear aromatic hydrocarbons	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$ store in dark	7 days until extraction
Haloethers	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$	40 days after extraction
Chlorinated hydrocarbons	G, Teflon-lined cap	Cool, 4 C	
TCDD	G, Teflon-lined cap	Cool, 4 C 0.008% $Na_2S_2O_3$	
Pesticides	G, Teflon-lined cap	Cool, 4 C pH 5-9	
Radiological tests, Alpha, Beta, and radium	P,G	HNO_3 to pH<2	6 months

[1] P = Polyethylene
G = Glass

6.0 SAMPLE CUSTODY

6.1 FIELD SAMPLING DOCUMENTATION

A copy of the on-site notebook entry for each sample should be placed in the sample data file for easy future reference. If a sampling area sketch was made, this also should be placed in the sample data file.

When a sample is brought to the laboratory, the chain of custody is checked against the labels on the samples corresponding to that particular chain of custody. Any discrepancies are noted, and once they have been resolved, the chain of custody is signed by both the sampler and the sample custodian. Upon signing, the sampler has relinquished the samples and the sample custodian is solely responsible for them until their log-in.

6.2 LABORATORY OPERATIONS

Upon receipt, any outside samples are given a sample number. This number consists of the format ymmddxxx, where:

y = last digit of the year
mm = two digit number for the month
dd = two digit number for the day
xxx = three digit number for the order in which the sample was received on that day

After the sample has been given a number, a sample log-in sheet is filled out for that sample. This log-in sheet contains information about the sample such as: date of sample receipt, client, presence of a chain of custody, sample condition, sample identification, and analysis requested. An example of this sheet is presented in Appendix A.

The log-in of each sample is recorded in the sample log-in records book by the sample custodian. This book contains information about the date, company, or client, parameters or analyses requested, and the entrant's initials for each sample. This book of records is maintained to provide quick and easy information regarding a sample. A sample page from the log-in records book is presented in Appendix A.

An information sheet is filled out and distributed to each section of the laboratory for each outside sample. The sections are: inorganics, metals, and organics. Each sheet contains the sample number, matrix, storage, date due, date out, and space to indicate whether the sample is needed by another lab section. Each sheet also contains a listing of the various parameters for that section, and the parameters to be analyzed are checked.

Each lab section has its own 3-ring binder where the information sheets are stored. The analyses results are written on the respective data sheets. The data sheets, with the information sheets, are returned to the quality control officer upon completion of that section's analyses.

The information sheet and data sheets are a permanent part of the sample data file. An example of each section's information sheet is presented in Appendix A.

All in-house samples are logged-in and given a number before they reach the sample custodian. The sample custodian fills out an information sheet for each in-house sample. These sheets are kept in on 3-ring binder which is easily accessible to all lab sections. The completed in-house sample sheets are removed from the in-house sample book by the quality control officer. An example of the in-house information sheet is also given in Appendix A.

Once the sample has been logged-in, the sample custodian places it in the proper storage area. The laboratory maintains sample storage areas for 4^0C and room temperature. The 4^0C storage is for water soil, sediment, an other samples requiring refrigeration. Petroleum samples are stored at ambient temperatures. All samples are stored behind locked doors during non-business hours.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

The laboratory equipment is calibrated according to the specific requirements for each instrument. A current listing of laboratory equipment is presented in Appendix C.

7.1 WET LAB CALIBRATIONS

The equipment used for wet lab analysis is calibrated using standards of known concentration. For total organic halogens and total organic carbon, the standards are used to determine a recovery factor. This recovery factor is then used in the calculation of the final concentration of the samples. A calibration curve is determined from the standards used in Spec 20 analysis. Known standards are also used with the ion analyzer for the determination of an internal calibration.

All wet lab equipment which is calibrated is done so at the beginning of each day or every 12 hours, whichever is more frequent.

7.2 METAL CALIBRATIONS

There are two calibrations for the instruments used in metals analysis. These are for the Inductively Coupled Plasma Spectrometer (ICP) and the Graphite Furnace Atomic Absorption Spectrometer (GFAA).

The ICP Spectrometer is calibrated once for each run on a high standard, a mid-range standard, and a blank. The spectrometer may also be calibrated using only a high standard and a blank. The calibration is then verified by an independent standard from EPA, NBS, or another non-calibration source. This initial calibration verification (ICV) standard must be within plus or minus 10 percent of the true value or within plus or minus the detection limit. If it is not, then calibration must be terminated, the problem corrected, and the instrument zero is verified immediately after the ICV by running a blank. This blank must be within plus or minus the detection limit. If it is not, then calibration must be terminated, the problem corrected, and the instrument restandardized. The instrument zero is verified immediately after the ICV by running a blank; this blank must be within plus or minus the detection limit and is called the initial calibration blank (ICB).

An ICP interference check sample (ICS) is ran at the beginning and end of each group of standards analyzed. It consists of two solutions; one with the analytes and interferents (ICSAB) and one with the interferents only (ICSA). For every ten analytical samples, a mid-range standard continuing calibration verification (CCV) is used to verify the curve; it must be plus or minus 10 percent. Immediately after the CCV, the instrument zero is reverified with a blank, the continuing calibration blank (CCB) must be plus or minus the detection limit. If the acceptability criteria for these are not met, the analysis must be terminated and the previously analyzed samples must be reanalyzed back to the last acceptable CCV and CCB.

The detection limit is determined quarterly by running seven consecutive standards at a level three to five (3 - 5) times the estimated instrument detection limit (IDL) on 3 non-consecutive days. These results are statistically analyzed, and three times the standard deviation of each is the IDL.

Inter-element correction standards are used as deemed necessary. They are always applied for Aluminum, Calcium, Magnesium, and Iron. Others may be added depending on the sample matrix.

The GFAA Spectrometer is calibrated using a blank, a low standard near the detection limit, a medium standard, and a high standard. The calibration is checked with an independent standard. A mid-range calibration standard is read, along with a standard at two times the EPA contract required detection limit (2 times CRDL) and a blank. The standards should read plus or minus 10 percent of the true value. The standards should read plus or minus the detection limit. Every sample is spiked and the Flow Chart "A" is followed based on the spike result. The flow chart is taken from the EPA CLP Statement of Work 787 and is presented in Table 7.A. The calibration is reverified with a mid-range standard every ten analytical samples, including spikes.

7.3 ORGANIC CALIBRATIONS

For calibration of the GC, three concentrations of a mixed standard are injected at the beginning of each 72 hour run to establish linearity. The ratio of the total area to the mass injected (calibration factor) for each compound is calculated, and the percent relative deviation of the calibration factors for Aldrin, Endrin, and DBC must be greater than or equal to 10 percent to continue with the analysis of the samples.

Before initial calibration for the GC/MS can be performed, the auto-tune specifications must be met with BFB or DFTPP, depending on the analysis to be performed. The check for the auto-tune must be done every day. There are two basic types of calibrations for the GC/MS, the initial calibration and the continuing calibration.

Initial calibration for the GC/MS involves a five point calibration for both volatile organics and semi-volatile organics. This five point calibration is used to establish linearity, column performance, and ionization performance. If even one of these criteria does not fall within acceptable EPA guidelines, then the initial calibration needs to be redone. The initial calibration is performed once every 2 weeks or every 20 samples, whichever is more frequent.

The continuing calibration is done by returning and running one of the five point standards to verify that nothing has changed since the initial calibration, then the initial calibration should be redone. Continuing calibrations are performed once for every 12 hour interval of continuous GC/MS usage or a minimum of one per day depending on the work load. Reagent blanks, surrogate recoveries, and internal standards may also serve as indicators that there has been an altercation since the initial calibration. If any of these warning flags does not fall within the accepted EPA guidelines, then the initial calibration will need to be reperformed.

TABLE 7.A - FLOW CHART "A"

PREPARE AND ANALYZE SAMPLE
AND ONE SPIKE (2 X CRDL)
(double injections required)

ANALYSES WITHIN CALIBRATION RANGE — no → DILUTE SAMPLE AND SPIKE

yes

RECOVERY OF SPIKE GREATER THAN 40% — if no, repeat only once

if still no → FLAG DATA WITH AN "E"

yes

REPORT RESULTS TO IDL

yes

SAMPLE ABSORBANCE GREATER THAN 50% OF SPIKE ABSORBANCE* — no → SPIKE RECOVERY GREATER THAN 85% AND LESS THAN 115%

no → REPORT RESULTS TO IDL, FLAG WITH A "W"

yes

SPIKE RECOVERY GREATER THAN 85% AND LESS THAN 115% — yes → QUANTITATE FROM CALIBRATION CURVE AND REPORT TO IDL

no

QUANTITATE BY MSA WITH 3 SPIKES AT 50, 100, & 150% OF SAMPLE ABSORBANCE
(only single injections required)

CORRELATION COEFFICIENT GREATER THAN 0.995 — if no, repeat only once

if still no → FLAG DATA WITH "s+"

yes

FLAG DATA WITH "s"

*Spike abs. = (abs. of spike sample) - (abs. of the sample)

8.0 ANALYTICAL PROCEDURES

The analytical procedures are divided into three lists. The first is a list of all inorganic or wet lab procedures excluding metals (Table 8.A). The second list is that of metals procedures. This list includes the digestion preparation of total, dissolved, or EP tox metals, as well as the method for each metal analyzed (Table 8.B). The final procedure list encompasses all of the organic procedures from volatiles to herbicides and pesticides (Table 8.C).

TABLE 8.A

REFERENCES:
A = Solid Waste Manual, SW - 846 3rd Ed., 1986.
B = Standard Methods for the Examination of Water and Wastewater, 16th Ed., 1985.
C = Methods for Chemical Analysis of Water and Wastes, EPA - 600 4-79-020, 1978.

PROCEDURE	METHOD NO.	REFERENCE
Acidity	402	B
Alkalinity	403	B
Ammonia	417.C	B
Ammonia - electrode	417.E	B
Chemical Oxygen Demand (COD)	508.C	B
Chlorides - Mercuric Nitrate	407.B	B
Conductivity	205	B
Cyanide - total	412.D	B
Fluorides - electrode	413.B	B
Fluorides - SPANDS	413.C	B
Hardness - total	314.A & B	B
Hexavalent Chromium	312.B	B
Nitrates - Brucine	352.1	C
Nitrates and Nitrites	418.C	B
Oil and Grease - water	503.A	B
pH	423,9040	B,A
Phenols	510.B	B
Phosphorus - total & ortho	424.C-3,F	B
Sulfates	426.C	B
Sulfides	427.D	B
Total Dissolved Solids @ 180 C	209.B	B
Total Organic Carbon (TOC)	505.B	B
Total Suspended Solids @ 103 C	209.C	B
Turbidity	214.A	B

TABLE 8.B - ICP

REFERENCES:
A = EPA Federal Register,
B = Solid Waste Manual, SW - 846 3rd Ed., 1986.

PARAMETER	METHOD NO.	REFERENCE
Aluminum	200.7/6010	A/B
Antimony	200.7/6010	A/B
Arsenic	200.7/6010	A/B
Barium	200.7/6010	A/B
Beryllium	200.7/6010	A/B
Boron	200.7/6010	A/B
Cadmium	200.7/6010	A/B
Calcium	200.7/6010	A/B
Chromium	200.7/6010	A/B
Cobalt	200.7/6010	A/B
Copper	200.7/6010	A/B
Germanium	200.7/6010	A/B
Iron	200.7/6010	A/B
Lead	200.7/6010	A/B
Lithium	200.7/6010	A/B
Magnesium	200.7/6010	A/B
Manganese	200.7/6010	A/B
Mercury	200.7/6010	A/B
Molybdenum	200.7/6010	A/B
Nickel	200.7/6010	A/B
Palladium	200.7/6010	A/B
Phosphorus	200.7/6010	A/B
Potassium	200.7/6010	A/B
Scandium	200.7/6010	A/B
Selenium	200.7/6010	A/B
Silicon	200.7/6010	A/B
Silver	200.7/6010	A/B
Sodium	200.7/6010	A/B
Strontium	200.7/6010	A/B
Thallium	200.7/6010	A/B
Titanium	200.7/6010	A/B
Tungsten	200.7/6010	A/B
Vanadium	200.7/6010	A/B
Zinc	200.7/6010	A/B

TABLE 8.B - GFAA

REFERENCES:
A = Methods for Chemical Analysis of Water and Wastes, EPA - 600 4-79-020, 1978.
B = Solid Waste Manual, SW - 846 3rd Ed., 1986.

PARAMETER	METHOD NO.	REFERENCE
Aluminum	202.2	A
Antimony	204.2/7041	A/B
Arsenic	206.2/7060	A/B
Barium	208.2	A
Beryllium	210.2/7091	A/B
Cadmium	213.2/7131	A/B
Chromium	218.2/7191	A/B
Cobalt	219.2/7201	A/B
Copper	220.2	A
Iron	236.2	A
Lead	239.2/7421	A/B
Manganese	243.2	A
Mercury	245.1/7470	A/B
Molybdenum	246.2/7481	A/B
Nickel	249.2	A
Palladium	253.2	A
Selenium	270.2/7740	A/B
Silver	272.2	A
Thallium	279.2/7841	A/B
Vanadium	286.2/7911[1]	A/B
Zinc	289.2	A

1 = Not recommended

TABLE 8.B - DIGESTION METHODS

REFERENCES:
A = Solid Waste Manual, SW - 846, 3rd Ed., 1986.

PROCEDURE	METHOD NO.
EP Toxicity Extraction	1310
Total Metals	3050
Dissolved Metals	3005

TABLE 8.C

REFERENCES:
A = USEPACLP Statement of Work for Organic Analysis, October 1986.
B = Solid Waste Manual, SW - 846, 3rd Ed., 1986.
C = Standard Methods for the Examination of Water and Wastewater, 16th Ed., 1985.

PROCEDURE	METHOD NO.	REFERENCE
Pesticides	Exhibit D, Sect II	A
PCB's H_2O/Soil	Exhibit D, Sect II	A
Herbicides	8150	B
PCB's Oil	8080	B
Volatiles	624	C
Semi-volatiles	625	C

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA REDUCTION SCHEME

The method used to prepare the raw data for interpretation and acceptance depends on the analysis to which it applies.

The analyses performed in the wet lab section of the laboratory require little data reduction. This is because the result is either a direct readout or a concentration which is calculated from a direct read-out.

Metals analyses also require little data reduction. If the quality control samples, the continuing calibration blanks, and the continuing calibration verification standards all meet the calibration criteria, the numbers that are read directly off of the spectrometer and considered valid. Dilution factors are calculated by the computer, and a report of the final number is generated by the ICP/GFAA data station.

The raw data from the GC requires more data reduction than wet lab and metals analyses. When quality control requirements for linearity and degradation have been met and samples have been analyzed, the chromatograms are evaluated. The sample is identified when the sample's retention time matches the retention time of a corresponding standard that was chromatographed on the same GC within the same 72 hour sequence. Pattern recognition techniques are required for identification of PCBs. The sample is considered negative when its peak concentration is less than the required quantitation level. The sample is complete at this point.

If the response for any compound is full scale or less, the sample is ready to be confirmed and quantitated; if the response is greater than full scale, the sample needs to be diluted and reanalyzed.

Any sample which is identified in the primary analysis must be confirmed on a second GC column with a different stationary phase. A compound identified in the primary analysis is confirmed and quantitated; if the response is greater than full scale, the sample should be diluted and reanalyzed.

Any sample identified in the primary analysis must be confirmed on a second GC column with a different stationary phase. A compound identified in the primary analysis is confirmed on the confirmation column when the retention time falls within the retention time window of a corresponding standard in the sample. The concentration is then calculated.

The GC/MS accomplishes data reduction through the use of an automated library. This library searches through all its information to find the compounds which best fits the sample data. A copy of the sample data and the compounds they fit is printed out by the instrument.

9.2 EQUATIONS FOR CONCENTRATION CALCULATIONS

The equations used to calculate concentrations are not listed in one specific area in the laboratory. Each analyst has his necessary equations programmed into his calculator. Most of the equations for the wet lab and inorganic analyses, with the exception of metals, are included on the analysis data sheet for each parameter. The remaining equations for concentration calculation, primarily organics , are taken directly from the method used in analysis. A list of these equations has been compiled for the quality assurance plan and is presented on the following pages.

EQUATIONS FOR WET LAB OR INORGANIC CONCENTRATIONS:

Alkalinity:

$$\text{AKL mg } CaCO_3/L = \frac{A \times N \times 50{,}000}{\text{ml sample}}$$

where A = ml standard acid used
N = normality of the standard acid

Percent Ash:

$$\% \text{ Ash} = \frac{\text{ash weight}}{\text{sample weight}} \times 100$$

BTU:

$$\text{BTU} = \frac{2400.6 \times 1.8 \times T\,©}{\text{sample weight}}$$

Chloride:

$$\text{mg Cl - /L} = \frac{(A - B) \times N \times 35450}{\text{ml sample}}$$

where A = ml titrant for sample
B = ml titrant for blank

Hardness:

$$\text{mg } CaCo_3/L = \frac{A \times B \times 1000}{\text{ml sample}}$$

where A = ml titrant added for sample
B = mg $CaCO_3$ equivalent to 1.00 ml EDTA solution. For a 0.0100 N EDTA B = 1.
If the normality of EDTA solution is not 0.01 then B = N / 0.01.
N = normality of EDTA solution.

Percent of Moisture:

$$\% \text{ moisture} = \frac{(\text{Initial weight} - \text{tare weight}) - (\text{final weight} - \text{tare weight})}{(\text{Initial weight} - \text{tare weight})} \times 100$$

Oil & Grease and Total Petroleum Hydrocarbon:

$$\text{oil \& grease} = \frac{\text{Final O \& G weight} - \text{tare weight}}{\text{Sample weight}} \times 1000 \text{ mg/g} \times 1000 \text{ g/Kg}$$

$$\text{TPH} = \frac{\text{Final TPH weight} - \text{tare weight}}{\text{Sample weight}} \times 1000 \text{ mg/g} \times 1000 \text{ g/Kg}$$

Sulfides:

$$\text{mg } S_2\text{-}/L = \frac{[(A \times B) - (C \times D)] \times 16{,}000}{\text{ml sample}}$$

where A = ml iodine
B = normality iodine
C = ml sodium thiosulfate
D = normality sodium thiosulfate

Total Dissolved Solids:

$$\text{TDS} = \frac{\text{Final weight} - \text{tare weight}}{\text{ml sample}} \times 1000 \text{ mg/g} \times 1000 \text{ ml/L}$$

Total Suspended Solids:

$$TSS = \frac{\text{Final weight - tare weight}}{\text{ml sample}} \times 1000\ mg/g \times 1000\ ml/L$$

TOX Adjusted Reading:

$$ADJ = \frac{\text{top (ug)}}{100\ ml} \times \frac{1}{\%\ rec} \times \frac{1\ mg}{1000\ ug} \times 1000\ ml/L$$

TOX (Volatile):

$$TOX\ ppm = \frac{\text{ng x final weight}}{\text{RF x ul injected x initial weight}}$$

where RF = recovery factor

EQUATIONS FOR PESTICIDE, HERBICIDE, AND PCB CONCENTRATIONS

For Water Samples:

$$TOX\ ppm = \frac{\text{pk ht sample x amt std inj(ng) x vol total extract (ul)}}{\text{pk ht std x vol extract inj(ul) x vol } H_2O \text{ extracted (ml)}}$$

For Sediment/Soil Samples:

$$ug/Kg = \frac{\text{pk ht sample x amt std inj(ng) x vol total extract (ul)}}{\text{pk ht std x wt sample extracted (g) x vol extract inj (ul)}}$$

then

$$\frac{ug/Kg}{(100 - \%\ moisture) / 100}$$

9.3 DATA VALIDATION CRITERIA

Each laboratory section has its own criteria for the validity of sample data.

For inorganic wet lab analysis, the data is considered acceptable if the analytical equipment has been properly calibrated with known standards and blanks. Any time the data is questionable, the sample is reanalyzed. For example, if a duplicate is ran and the relative percent difference is greater than 50 percent, then the sample is reanalyzed.

For all metals analyses, except that of mercury by cold vapor, the following criteria must be met in order to consider the data acceptable.

	ICP	GFAA	MERCURY HYDRIDE
Duplicate	<20%	<20%	<20%
Spike (% recovery)	80% -120%	85% -115%	75% - 125%
LCS	+/- 10% of the true value	+/- 10% of the true value	+/- 20% of the true value

Linear regression is applied to mercury by cold vapor analysis. A correlation coefficient of greater than 0.995 must be achieved to consider the curve valid. All quality control checks are then validated. The numbers are recorded from the curve onto the mercury data sheet which is given to the sample custodian to be reported when the sample is complete.

Sample data from GC analysis is considered valid if the method blank results, duplicate relative percent differences, spike percent recoveries, calibration standards, and all standards ran with the samples fall within the quality control requirements set up by the laboratory and USEPA. The laboratory does not set its own values for acceptance of organics data, but it encourages the use of EPA advisory limits. One example is the surrogate percent recovery for pesticides and PCBs of 24 to 154 percent.

For each Individual Standard Mix A and B, the differences in the calibration factors (pk ht / ng inj) must not exceed 20 percent (15 percent for any standard used for quantitation) during the 72 hour sequence.

All standards must fall within the established 72 hour retention time windows.

For data validation, the GC/MS operator rechecks the printed copy of the fitting compounds to insure that all compounds were matched correctly. For the quantitation of samples, the major peaks must have 10 percent abundance of the analyte in question.

As a precautionary measure for all laboratory analyses, a sample is reanalyzed when the original sample data is within plus or minus 20 percent of the allowable limits for that particular method.

9.4 IDENTIFICATION AND TREATMENT OF OUTLIERS

For all analyses, outliers may be identified by the use of duplicates for relative percent difference and spikes for percent recovery.

For wet lab analysis, anything outside the calibration curve is also considered to be an outlier. If any outliers are identified, the analysis of that particular sample is reanalyzed, along with a duplicate or spike to verify the validity of the newly obtained data.

A metals sample is classified as an outlier if it fails to meet the previously mentioned criteria for data acceptability. As a general rule, a sample can be identified as an outlier if its relative percent difference is greater than 20 percent and/or if its percent recovery is not within the limits of 80 to 120 percent.

When a sample is labeled as an outlier, the problem is identified and corrected, and the analysis is reran. If the repeated analysis' results indicate again that the sample is an outlier, then the sample is diluted and the analysis redone. If deemed necessary, the Method of Standard Additions (MSA) is applied to determine the concentration results. On graphite furnace analyses that are determined to have high background absorbance, the sample is diluted. If the dilution is too high to meet the CRDL, the use of a suitable alternate wavelength is investigated.

Any sample which violates the GC performance criteria is reanalyzed. The sequence with the standard that would have followed that sample is restarted, and the sample is then reanalyzed. If for some reason the sample, after reanalysis, still violates the GC performance criteria, it is then determined whether the sample should be re-extracted.

Outliers for GC/MS analysis are identified by the use of a surrogate. If the surrogate does not show up in the final results, the sample is considered an outlier. The sample is then reinjected. If the surrogate appears on this second run, the first run is discarded. However, if the surrogate does not appear on the second run either, it is concluded that there is sample matrix interference. If this happens, calculations for this sample are made without the use of the surrogate, and the results are flagged.

9.5 REPORTING SCHEME

The quality control officer double checks all sample data before reporting. Final concentrations are recalculated to insure that they are correct. Relative percent differences and percent recoveries are also recalculated to insure their correctness and to verify that the data was justly accepted.

10.0 INTERNAL LABORATORY

The laboratory maintains an extensive quality control program which assures the accuracy and reliability of its analytical data. The laboratory routinely performs checks on the samples through the use of duplicates, spikes, and blind samples.

10.1 DUPLICATES

Duplicate samples are analyzed to determine the precision of the analysis. As a minimum, 10 percent of the samples are duplicated. The laboratory tries to choose a sample which is expected to contain the analyte in question for duplicating. A relative percent difference (RPD) is calculated from the duplicate data obtained; the relative percent difference should be within 20 percent for the data to be accepted. The relative percent difference will, however, increase as the detection limit is approached.

10.2 SPIKES

Spiked samples are used as a measure to assess the accuracy of the method. The lab uses spiked samples at a minimum frequency of 10 percent. The spiked sample data are used to calculate the percent recovery which will typically be within the range of 85 to 115 percent recovery for the data to be deemed acceptable.

10.3 CONTROL CHARTS

Quality control charts are maintained on the laboratory's IBM personal computer and hard copy for duplicates, spikes, and laboratory control samples. These control charts are taken from quality control data sheets. Each analyst maintains a quality control data sheet which he updates constantly for all duplicates, spikes, and laboratory control samples. The quality control officer collects the quality control sheets quarterly and enters the information into the computer. A copy of the control chart along with a new quality control sheet is given to each analyst. The control charts contain the criteria for the acceptance of duplicate and spike results. The present acceptability criteria are:

2 S.D. = warning limit, check for error

3 S.D. = control limit, recheck after attempting problem correction

10.4 BLANKS

Blanks are used for the purpose of checking for laboratory contamination. Blanks are analyzed before a each set of samples. The blank is believed to be contaminated if the analyte is detected at a concentration greater than the required detection limit. For common solvents used in a laboratory, the level will normally be at two times the detection limit. All results, unless otherwise

noted, will not be corrected for blanks, but it will be noted as suspect if a contaminant is found in the blanks.

10.5 INTERNAL STANDARDS

Surrogate and internal standards are used for analysis where the use of one is feasible. This will most likely occur with organic analysis. All samples analyzed by GC/MS will have both surrogates and internal standards added. Where an internal standard is added, the calculations will be determined from both the internal standard and known concentrations of the analyte in question.

10.6 QUALITY CONTROL SAMPLES

Quality control check samples, such as those provided by the EPA, are analyzed periodically to verify the reliability of the analyses. Blind quality control samples will also be used by the quality control officer as a means of testing the analysts' proficiency and accuracy.

10.7 CALIBRATION STANDARDS

Calibration standards are used at various times to contribute to the acquisition and validity of sample results.

For inorganics analyses, the calibration standards are done before the analysis to establish an internal correlation curve. This correlation curve is used in the calculation of final concentrations.

When performing organics analyses, three concentrations of a mixed standard are injected at the beginning of each run to establish linearity. The ratio of the total area to the mass injected (calibration factor) for each compound is calculated, and the percent relative standard deviation of a calibration factors for Aldrin, Endrin, and DBC must be less than or equal to 10 percent to continue with the analysis of the samples.

10.8 REAGENT CHECKS

Reagent checks are performed in the laboratory by the use of reagent blanks. Reagent water is monitored by conductivity. Reagent water, acids, and peroxides are monitored for impurities by ICP analysis. When working with the GC or the GC/MS, a method blank is ran with each set of samples. Because of this method blank analysis, any contamination due to reagents can be detected and corrected.

10.9 BLIND FIELD SPIKES AND DUPLICATES

Blind field spikes and duplicates are provided to the laboratory by the sampler and the sample custodian. The sampler collects a field spike or duplicate to be used as a blind sample. The sample is recorded on the chain-of-custody as a spike or duplicate, but when it is logged in by the sample custodian it is given its own sample number. Also, the sample custodian will prepare blind spikes and duplicates to be processed by the laboratory as ordinary samples.

The laboratory is unaware of the true identity of any blind samples. Therefore, the use of blind samples allows the quality control officer to evaluate the proficiency and accuracy of the analysts and their procedures.

All blind spikes and duplicates are processed by the sample custodian in the same manner as the other laboratory samples.

11.0 PERFORMANCE AND SYSTEM AUDITS

The laboratory actively participates in various external laboratory evaluations and certification programs.

11.1 PARAMETERS METHOD DETECTION LIMITS

The method detection limits are presented in three tables on the following pages. Table 11.A consists of the detection limits for inorganic wet lab parameters. Table 11.B is a listing of the metals parameters and their detection limits. The organics parameters are given in Table 11.C.

TABLE 11.A WET LAB METHOD DETECTION LIMITS

PARAMETER	DETECTION LIMIT
Acidity	0.05 pH units
Alkalinity	20 mg/L
Ammonia	0.1 mg/L
Ammonia - electrode	0.1 mg/L
Chemical Oxygen Demand (COD)	50 mg/L
Chloride	1 mg/L
Conductivity	10 ohms
Cyanide - total	0.2 mg/L
Fluorides - electrode	0.1 mg/L
Fluorides - SPANDS	0.05 mg/L
Hardness - total	4 mg/L
Hexavalent Chromium	0.1 mg/L
Nitrates - Brucine	0.1 mg/L
Nitrates and Nitrites	0.01 mg/L
Oil and Grease - water	10 mg/L
pH	0.01 pH.units
Phenols	1 ug/L
Phosphorus - total & ortho	10 ug/L
Sulfates	10 mg/L
Sulfides	1 mg/L
Total Dissolved Solids @ 180 C	2.5 mg/L
Total Organic Carbon (TOC)	0.05 mg/L
Total Suspended Solids @ 103 C	0.5 mg/L
Turbidity	0.02 NTU

11.B METALS METHOD DETECTION LIMITS

PARAMETER	DETECTION LIMIT ICP (mg/L)	DETECTION LIMIT GFAA (ug/L)
Aluminum	0.05	1.0
Antimony	0.06	4.0
Arsenic	0.05	5.0
Barium	0.05/0.002[1]	3.0
Beryllium	0.003	0.5
Boron	0.05/0.01[1]	---
Cadmium	0.005	0.1
Calcium	0.05/0.0003[1]	---
Chromium	0.010	0.3
Cobalt	0.02	0.5
Copper	0.025	0.3
Germanium	0.05	---
Iron	0.02	0.5
Lead	0.05	1.3
Lithium	0.005	---
Magnesium	0.05/0.0003[1]	0.3
Manganese	0.005	0.3
Mercury	0.05	0.2
Molybdenum	0.02	0.5
Nickel	0.05	2.5
Palladium	0.05	6.3
Phosphorus	0.05	---
Potassium	1.0/0.03[2]	---
Scandium	0.005	---
Selenium	0.08	5.0
Silicon	0.02	---
Silver	0.02	0.1
Sodium	0.2/0.005[2]	---
Strontium	0.001	---
Thallium	0.08	3.0
Titanium	0.01	---
Tungsten	0.05	---
Vanadium	0.02	5
Zinc	0.01	0.03

1 = Low level
2 = Flame AA, impact bead, low level

TABLE 11.C ORGANICS METHOD DETECTION LIMITS

PARAMETER PESTICIDES	DETECTION LIMIT WATER (ug/L)	DETECTION LIMIT LOW SOIL/SEDIMENT (ug/Kg)
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor Epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDE	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan Sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Endrin Ketone	0.10	16.0
Methoxychlor	0.5	80.0
alpha-chlordane	0.5	80.0
gamma-chlordane	0.5	80.0
Toxaphene	1.0	160.0

PCB's	DETECTION LIMIT (ug/L)
Aroclor-1016	0.05
Aroclor-1221	0.05
Aroclor-1232	0.05
Aroclor-1242	0.065
Aroclor-1248	0.05
Aroclor-1254	0.05
Aroclor-1260	0.05

HERBICIDES	DETECTION LIMIT (ug/L)
2,4-D	1.2
2,4-DB	0.91
2,4,5-T	0.20
2,4,5-TP (Silvex)	0.17
Dalapon	5.8
Dicamba	0.27
Dichloroprop	0.65
Dinoseb	0.07
MCPA	249
MCPP	192

TABLE 11.C - cont.

MATRIX	FACTOR[b]:
Ground water	10
Low-level soil by sonication with GPC cleanup	670
High-level soil and sludges by sonication	10,000
Non-water miscible waste	100,000

VOLATILES	QUANTITATION LIMITS**	
	Water ug/L	Low Soil/Sediment[a] ug/Kg
Chloromethane	10	10
Bromoethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (total)	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (Total)	5	5

TABLE 11.C - cont.

[a]Medium Soil/Sediment Contract Required Quantitation (CRQL) for Volatile TCL Compounds are 100 times the individual Low Soil/Sediment CRQL.

*Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

SEMI-VOLATILES	QUANTITATION LIMITS** Water ug/L	Low Soil/Sediment[b] ug/Kg
Phenol	10	330
bis(2-Chloroethyl) ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl) ether	10	330
4-Methylphenol	10	330
N-Nitroso-Dipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy) methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethyl Phthalate	10	330

TABLE 11.C - cont.

SEMI-VOLATILES	QUANTITATION LIMITS** Water ug/L	Low Soil/Sediment[b] ug/Kg
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ester	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenyl ether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butyl Benzyl Phthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-ethylhexyl)phthalate	10	330
Di-n-octyl Phthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

[b]Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Semi-Volatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.

*Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**Quantitation limits listed for soil/sediment are based on wet weight. The quantitation calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

11.2 SCHEDULE

A. Federal Audits: the laboratory participates on a routine basis in the water pollution and water supply studies conducted by EMSL-Cincinnati. These studies are generally on a quarterly basis but never fewer than every 6 months.

B. State Certifications: The laboratory is currently certified by Kansas, Oklahoma, and North Dakota for laboratory analysis of groundwater, drinking water, solids and hazardous wastes.

12.0 PREVENTATIVE MAINTENANCE

12.1 SCHEDULE

Preventative maintenance is practiced on a routine basis in the laboratory. The various instruments for analysis have their own specific schedules of maintenance.

The total organic carbon and total organic halogens instruments are serviced on a weekly and/or monthly basis. The remainder of the wet lab instrumentation is checked once a month.

The ICP, GFAA, and GC/MS are covered by a service contract under which they are checked every 6 months. Additional preventative maintenance for the ICP is performed on both a weekly and quarterly basis. The GFAA is performed at the beginning of each run. The mercury cold vapor system is cleaned quarterly.

Preventative maintenance on the GC is performed as needed.

12.2 PROCEDURES

The preventative maintenance for all wet lab instrumentation involves checking the parts for proper functioning and changing any necessary solutions.

Preventative maintenance for the ICP Spectrometer involves realignment, cleaning the torch and the alumina injector in aqua regia. The Spectrometer is then optimized by aspirating 10 ppm Manganese and monitoring the Manganese 257.610 nm line. The viewing height is then adjusted to Zn/Ca ratio, in the instruments diagnostics, of 2.0.

All accumulated data is backed-up weekly on a floppy disk. The entire wavelength range is verified quarterly by running the wavelength calibration program.

For the graphite furnace, the graphite tube and platform are checked for degradation, cracks, chips, etc. If any are found, the defective part is replaced. The graphite contact rings and the quartz windows are cleaned with methanol. The lamp energy is also checked to ensure that the lamp is operable.

The quartz for the mercury cold vapor system is cleaned with 40 percent Hydrofluoric acid for 2 hours.

For packed GC columns, the glasswool is replaced with fresh deactivated glasswool any time there is discoloration or change in the retention times of the standards injected in a 72 hour sequence. The injection end of the column is also swabbed out periodically, and any packing material which is showing signs of discoloration is removed.

Use of high grade solvents and a gas purifications system for all of the GCS also helps to eliminate contamination problems.

The GC/MS is monitored using a checklist. This list is followed by the service representative for the instrument. Some of the items covered on the checklist are presented in Table 12.A.

TABLE 12.A

REFERENCES:
1000 Series Preventive Maintainance Checklist

INITIAL

1. Line voltage = ____ + ____ V/24 hrs. System ground adequate: __yes __no Presence of noise spikes __yes __no If yes, describe:_____.

2. Recirculator fluid charge checked.__ Inline water filter cleaned. __

3. Room temperature = ___ C.

4. Mechanical pump oil changed. __yes __no (four times/year)

5. Analyzer cleaned. __ Not required. __

6. Ionizer cleaned. __ Not needed. __

7. Filament changed. __ Not needed. __

8. Turbo oil changed. __ Not needed. __ (two times/year)

9. All air filters cleaned or changed. __ All cooling fans checked. __

10. Separator cleaned. __ Not required. __

VACUUM SYSTEM

1. Vacuum system leak free. __yes __no

2. Forepressure alarm resets at ____Torr.

3. Turbo electronics turn on at ____Torr.

4. Ultimate forepressure = ____Torr.

Flow and temperature sensors operational. __

TABLE 12.A - cont.

ELECTRONICS CHECKLIST

1. Computer Assembly:
   C. All front panel lights working.

2. Disc Drive Module:
   B. PCB's dust free. __
   D. Heads cleaned. __yes __no
   E. Head alignment verified. __yes __no
   F. Index data verified. __yes __no
   G. All lights working. __yes __no

4. Mass Spec Electronics:
   A. Card cage power supplies +____V____ripple (+15V)
   -____V____ripple (-15V)
   +____V____ripple (+5V)
   -____V____ripple (-125V)

5. GC Functions:
   A. Flow verified. __
   B. Programming and cooling functions verified. __
   C. Oven protect circuit verified. __
   D. GC lights and LED's functional. __

6. Tekmar Sample Concentrator:
   A. Temperature functions verified (digital display). __
   B. Timing sequences verified. __

7. Emission =____V
   Electron energy = ____V
   Collector volts = ____V

13.0 ASSESSMENT PROCEDURES FOR DATA ACCEPTABILITY

The quality control officer checks all sample data before a final report is written and sent. He rechecks the calculations to insure that there are no mathematical errors. He also checks to be sure that all accepted data adhere to the criteria established by the laboratory and the EPA.

If any problems arise in calculations or acceptability, the quality control officer discusses them with the responsible analyst. The analyst explains his reasoning to the quality control officer, and any problems are corrected.

14.0 CORRECTIVE ACTION

14.1 LIMITS

The established limits for quality control data such as relative percent difference and percent recovery will not be altered if too many samples do not fit this range. Quality Analytical values its quality control and will not compromise its position on this data. Exceptions may be made after careful consideration, depending on the sample matrix.

14.2 PROCEDURES

If the quality control data indicate that there is a problem in the procedure, there are several steps which are taken. The first step is to make sure that the analyst is familiar with the method and is performing it correctly. If the problem does not appear to be caused by something in the analyst's performance method, the equipment used for the procedure is checked. The cleanliness of the glassware is double checked, as well as the purity of the reagents. If the source of the problem still has not been identified, any possible interference is accounted for, and the instrumentation is cleaned as much as possible. The majority of the discrepancies may be solved by the application of these corrective actions.

14.3 IDENTIFICATION OF RESPONSIBLE PERSONNEL

The responsibility of corrective action in the laboratory lies with the quality control officer and the laboratory director.

15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

15.1 SCHEDULE

The quality control officer puts together a report detailing the updated status of the quality control charts. This report is given to the lab director and is available for all interested analysts.

The quality control report includes such things as quality control charts, areas needing improvement, and a brief summary of the overall status of quality control. These reports are written on a quarterly basis.

Appendix A

Sample Forms

SAMPLE LABEL

Quality Analytical Services
1633 S. Marsh
Kansas City, Mo.
64126
(816) 254-5257
(800) 821-4302

Client: _____

Sample I.D.: _____

Date Collected: _____ Time: _____

Collected by: _____

Analysis: _____

Preservative: _____

☐ DO NOT RINSE OUT OR OVERFILL ☐ VOA - ZERO HEADSPACE

CHAIN OF CUSTODY FORM

Quality Analytical Services

1633 S. Marsh * Box 266426 * Kansas City, MO. 64126 * (816) 254-5257

002723

CHAIN-OF-CUSTODY RECORD and Analytical Requests

Client

Address

Phone ( ) Fax

Report To:

Bill To:

P.O. # / Billing Reference

Project Name / No.

QAS Client No.

QAS Project Manager

QAS Project No.

* Requested Due Date:

Sampled By (PRINT):

Sampler Signature Date

ITEM NO.	SAMPLE DESCRIPTION	DATE & TIME OF COLLECT.	MATRIX	QAS NO.	NO. OF CONTAINERS / CONTAINER TYPE: UNPRES.	H_2SO_4	HNO_3	VOA	NaOH	ANALYSES REQUESTED (BE SPECIFIC)	REMARKS
1											
2											
3											
4											
5											
6											

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	IN / DATE

COC NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME

Additional Comments:

PART 1- ORIGINAL
PART 2- TRANSFER
PART 3- CUSTOMER

SEE REVERSE SIDE FOR INSTRUCTIONS

FIELD SAMPLE SHEET

TEST
Total Environmental Services & Technologies
18181 West 53rd Street • Shawnee, Kansas 66217
(913) 631-3300

GROUND-WATER SAMPLING FORM

Job Name _____
Job Number _____
Recorded by _____ (Signature)

Well No. _____
Well Type: ☐ Monitor ☐ Extraction ☐ Other _____
Well Material: ☐ PVC ☐ St. Steel ☐ Other _____
Date _____ Time _____
Sampled by _____ (Initials)

WELL PURGING

PURGE VOLUME

Casing Diameter (D in inches):
☐ 2-inch ☐ 4-inch ☐ 6-inch ☐ Other _____
Total Depth of Casing (TD in feet BTOC): _____
Water Level Depth (WL in feet BTOC): _____
Number of Well Volumes to be purged (# Vols)
☐ 3 ☐ 4 ☐ 5 ☐ 10 ☐ Other _____

PURGE METHOD

☐ Bailer - Type: _____
☐ Submersible ☐ Centrifugal ☐ Bladder, Pump No.: _____
☐ Other - Type: _____

PUMP INTAKE SETTING

☐ Near Bottom ☐ Near Top ☐ Other _____
Depth in feet (BTOC): _____ Screen interval in feet (BTOC): from _____ to _____

PURGE VOLUME CALCULATION

(_____ – _____) X _____ X _____ X 0.0408 = _____ gallons
TD (feet) WL (feet) D (inches)^2 # Vols Calculated Purge Volume

PURGE TIME

_____ Start _____ Stop _____ Elapsed

PURGE RATE

Initial _____ gpm Final _____ gpm

ACTUAL PURGE VOLUME

_____ gallons

FIELD PARAMETER MEASUREMENT

Minutes Since Pumping Began	pH	Cond. (umhos/cm)	T ☐ °C ☐ °F	Other _____

Minutes Since Pumping Began	pH	Cond. (umhos/cm)	T ☐ °C ☐ °F	Other _____
Meter Nos.				

Observations During Purging (Well Condition, Turbidity, Color, Odor): _____
Discharge Water Disposal: ☐ Sanitary Sewer ☐ Storm Sewer ☐ Other _____

WELL SAMPLING

SAMPLING METHOD

☐ Same As Above
☐ Baller - Type: _____
☐ Grab - Type: _____
☐ Submersible ☐ Centrifugal ☐ Bladder, Pump No.: _____
☐ Other - Type: _____

SAMPLE DISTRIBUTION

Sample Series: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments

QUALITY CONTROL SAMPLE

Duplicate Samples

Original Sample No.	Duplicate Sample No.

Blank Samples

Type	Sample No.

Other Samples

Type	Sample No.

SAMPLE LOG-IN SHEET

QAS SAMPLE LOG-IN

QAS SAMPLE #: 50115001
DATE SAMPLED: 05/13/95/
DATE RECEIVED: 05/15/95

DATE DUE: 05/27/95
SAMPLED BY: JOE SMITH
RECEIVED BY: TDG

CLIENT: CLIENT
ADDRESS
CITY, STATE ZIP CODE

CONTACT: JOE SMITH

PHONE: 123-4567
FAX: 223-4567

==========

PROJECT NAME:
PROJECT #:

MATRIX: WATER

STORAGE: AMBIENT/4 C/VOA FRIG

SAMPLE CONDITION: 4-UNP/ 1-H2SO4/ 1-HNO3/ 1-NAOH/ 2-VOA (HCL)

CALL WITH RESULTS (Y/N): N

CHAIN OF CUSTODY (Y/N): Y

SPECIAL INSTRUCTIONS OR COMMENTS:

==========

REPORTED (Y/N):

DATE:

INVOICE (Y/N:

DATE:

REMITTANCE RECEIVED (Y/N):

DATE:

QAS SAMPLE LOG-IN

****

QAS SAMPLE #: 50115001 MATRIX: WATER
DATE SAMPLED: 05/13/95/ SAMPLED BY: JOE SMITH
SAMPLE IDENTIFICATION: MW-1

ANALYSES REQUESTED:

TOTAL METALS FURNACE

THALLIUM

TOTAL METALS ICP

ARSENIC, ANTIMONY, BORON, BARIUM, BERYLLIUM, CALCIUM, CADMIUM

COPPER, IRON, CHROMIUM, MAGNESIUM, MANGANESE, LEAD, NICKEL

PHOSPHOROUS, SELENIUM, POTASSIUM, SODIUM, SILVER, ZINC, MERCURY

WET LAB PARAMETERS

ALKALINITY_____ AMMONIA_____ BOD_____ COD_____

CONDUCTIVITY_____ TOTAL CYANIDE_____ FLUORIDE_____

HARDNESS_____ NITRATE_____ NITRITE_____

OIL AND GREASE_____ pH_____ PHENOLS_____

SETTLEABLE SOLIDS_____ SULFATE_____

TOTAL SULFIDE_____ TOC_____ TOX_____ TPH_____

TDS_____ TSS_____ TURBIDITY_____

GC/MS PARAMETERS

VOA'S_____ BNA'S_____ PESTICIDES_____ PCB'S_____

HERBICIDES_____

SAMPLE LOG-IN RECORD BOOK

EXAMPLE PAGE

Quality Analytical Record Log

Client/Sample #	Date Rcv'd	Date Due	Matrix	Analysis Requested

INFORMATION SHEETS

METAL ANALYSES

QAS SAMPLE # 50115001
DATE DUE: 05/27/95
MATRIX: WATER

STORAGE: AMBIENT/4 C/VOA FRIG

****

TOTAL METALS FURNACE

THALLIUM

TOTAL METALS ICP

ARSENIC	ANTIMONY	BORON
BARIUM	BERYLLIUM	CALCIUM
CADMIUM	COPPER	IRON
CHROMIUM	MAGNESIUM	MANGANESE
LEAD	NICKEL	PHOSPHOROUS
SELENIUM	POTASSIUM	SODIUM
SILVER	ZINC	MERCURY

WET LAB ANALYSES

QAS SAMPLE # 50115001
DATE DUE: 05/27/95
MATRIX: WATER

STORAGE: AMBIENT 4 C VOA FRIG

****

ALKALINITY	AMMONIA	BOD
COD	CONDUCTIVITY	TOTAL CYANIDE
FLUORIDE	HARDNESS	NITRATE
NITRITE	OIL AND GREASE	pH
PHENOLS	SETTLEABLE SOLIDS	SULFATE
TOTAL SULFIDE	TOC	TOX
TPH	TDS	TSS
TURBIDITY		

ORGANIC ANALYSES

QAS SAMPLE # 50115001
DATE DUE: 05/27/95
MATRIX: WATER STORAGE: AMBIENT/4 C/VOA FRIG

****

VOA'S	BNA'S	PESTICIDES
PCB'S	HERBICIDES	

DATA SHEET

AUTOANALYZER WORKSHEET

TEST: _____ GAIN: _____ FILTER: _____ DATE: _____ CURVE TYPE: _____ CORR. _____

ANALYST: _____ NOTES: _____

CUP #	SAMPLE I D	CHART UNITS	CORRECTED CHART UNITS	DILUTION FACTOR	CONC. (___/___)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					

CUP #	SAMPLE I D	CHART UNITS	CORRECTED CHART UNITS	DILUTION FACTOR	CONC. (___/___)
1-41					
2-42					
3-43					
4-44					
5-45					
6-46					
7-47					
8-48					
9-49					
10-50					
11-51					
12-52					
13-53					
14-54					
15-55					
16-56					
17-57					
18-58					
19-59					
20-60					
21-61					
22-62					
23-63					
24-64					
25-65					
26-66					
27-67					
28-68					
29-69					
30-70					
31-71					
32-72					
33-73					
34-74					
35-75					
36-76					
37-77					
38-78					
39-79					
40-80					

IN-HOUSE SAMPLE

INFORMATION SHEETS

METAL ANALYSES

QAS SAMPLE #: _____ MATRIX: _____

DATE DUE: _____ STORAGE: _____

****

___ EP TOX ___ Total ___ Dissolved

Digestion Method: ___ ICP ___ Furnace

___ Arsenic ___ Antimony ___ Boron

___ Barium ___ Beryllium ___ Calcium

___ Cadmium ___ Nickel ___ Copper

___ Chromium ___ Thallium ___ Iron

___ Lead ___ Zinc ___ Magnesium

___ Mercury ___ Manganese

___ Selenium ___ Phosphorus

___ Silver ___ Potassium

___ Sodium

___ Other (List)

Special Instructions:

INORGANIC ANALYSES

QAS SAMPLE #: _____ MATRIX: _____

DATE DUE: _____ STORAGE: _____

****

___ Alkalinity (as $CaCO_3$)

___ Ammonia (as NH_3-N)

___ Biochemical Oxygen Demand (BOD)

___ Chemical Oxygen Demand (COD)

___ Chloride

___ Conductivity

___ Cyanide - Reactive

___ Cyanide - Total

___ Flash Point

___ Fluoride

___ Hardness (as $CaCO_3$)

___ Moisture (%)

___ Nitrate (as NO_3-N)

___ Nitrite (as NO_2-N)

___ Oil and Grease

___ pH

___ Phenols

___ Settleable Solids

___ Sulfate

___ Sulfide - Reactive

___ Sulfide - Total

___ Total Organic Carbon (TOC)

___ Total Organic Halogen (TOX)

___ Total Petroleum Hydrocarbons (TPH)

___ Total Dissolved Solids (TDS)

___ Total Solids

___ Total Suspended Solids (TSS)

___ Turbidity

___ Microbiological (List)

___ Other (List)

Special Instructions:

ORGANIC ANALYSES

QAS SAMPLE #: _____ MATRIX: _____

DATE DUE: _____ STORAGE: _____

****

___ Volatile Organics (VOA)

___ Base Neutral/Acid (BNA)

___ Pesticides

___ PCBs

___ Herbicides

___ BTEX

___ Total Toxic Organics (Attach List)

___ Other (List)

Special Instructions:

OIL SAMPLE ANALYSIS

SAMPLE #: _____ DATE DUE: _____

DATE REC.: _____ CLIENT: _____

_____ ASH

_____ API GRAVITY

_____ BS&W

_____ FLASH POINT

_____ FILTERABILITY

_____ SULFUR

_____ HALOGENS

_____ POUR POINT

_____ CLOUD POINT

_____ NEUTRALIZATION # (ACID/BASE#)

_____ HEATING VALUE (BTU´s)

_____ VISCOSITY (TYPE _____:TEMP_____)

_____ DISTILLATION (TYPE_____)

_____ PCB´s

_____ TOTAL METALS (As , Cd, Cr, Pb)

_____ OTHER

(b) (6)

(b) (6)

(b) (6)

(b) (6)

(b) (6)

(b) (6)

(b) (6)

(b) (6)

Appendix C

Equipment List

EQUIPMENT LIST

MANUFACTURER	DESCRIPTION	MODEL	YEAR
Fisher	Sonic Dismembrator	300	85
Dohrmann	Filter Apparatus	82	86
Dohrmann	TOX Analyzer	DX 20	86
Dohrmann	Microcoulometer	C300	86
Dohrmann	Pyrolisis Furnace	5300	86
Dohrmann	TOC Reactor	DC 80	86
Dohrmann	TOC Electronics	DC 80	86
Hewlett Packard	GC	5890A	85
Tektronix	CRT	4006-1	84
Tektronix	Oscilloscope	604A	84
Tekmar	Purge Trap	LSC-2	84
Varian	Autosampler	8000	84
Alcatel	Vacuum Pump	2008A	84
Alcatel	Vacuum Pump	2004A	84
Hewlett Packard	GC	5890II	90
Hewlett Packard	Integrator	HP3394	91
Shimadzu	Integrator	C-R4A	86
Hewlett Packard	GCMS	5971A	93
Hewlett Packard	Printer	---	93
Tekmar	Purge Trap	LCS 2000	93
Tekmar	Autosampler	ALS 2016	93
Finnigan MAT	GCMS	4500	88
Printonix	Printer	---	88

EQUIPMENT LIST

MANUFACTURER	DESCRIPTION	MODEL	YEAR
Ohaus	Triple Beam Balance	800	84
Lindberg	Hot Plate	53015	84
Precision Sci.	Centrifuge	10-X-10	84
Mettler	Analytical Balance	AE100	85
Labconco	Fume Hood	---	84
Hemco	Fume Hood	11803	86
Precision Sci.	Saybolt Viscometer	---	84
Precision Sci.	Viscosity Bath	12-X-7	84
Montgomery Ward	Freezer	FFT851800F	86
Amer. Sci. Prod.	Refrigerator	LR504ANJ	86
Zeiss	Microscope	---	84
Precision Sci.	PMCC Flash Tester	---	84
Precision Sci.	Water Bath	8-Hole	86
Kruger	Vacuum Pump	K15	84
Brinkman	Water Circulator	1C2	86
Parr	Calorimeter	---	84
Amer. Sci. Prod.	Ultrasonic Cleaner	ME21	85
IBM	Monitor	---	85
IBM	Printer	---	85
IBM	Disc Drive	---	85
Precision Sci.	Drying Oven	---	87
Blue M	Drying Oven	RS-18A-2	87
Blue M	Water Bath	MW-1162SSA-1	87
Cannon	Viscometer	H1	87
Cannon	Vacuum Source	PR2	87
PGT	X-Ray Chem Anal	100	87
AT	Computer	486	91
Sunshine	Color Monitor	---	91
Epson	Printer	FX-86e	90
Kaypro	Computer	286	88
Kaypro	Monitor	---	88

EQUIPMENT LIST

MANUFACTURER	DESCRIPTION	MODEL	YEAR
Blue M	Muffle Furnace	M15A-1A	84
Thermolyne	Muffle Furnace	FA1635	86
Thermolyne	Furnace Controller	CP18215	86
Amer. Sci. Prod.	Drying Oven	DX 38	84
Lindberg	Tube Heater	55035	85
Lab Line Ind.	Block Heater	H2025-1	86
Hach	Ratio Turbidimeter	18900-60	86
Orion	ISE Meter	EA940	87
Orion	pH Meter	301	84
Orion	pH Meter	301	84
Orion	Portable pH Meter	SA230	86
YSI	Portable Cond. Meter	33	86
Technicon	AutoAnalyzer	AutoAnalyzer II	91
Labconco	Fume Hood	---	91
Precision	Soxhlet Extraction	---	
Milton Roy	Spectrophotometer	Spectronic 20	93
Perkin Elmer	Infrared Spectrophotometer	283	91
Mettler	Analytical Balance	AE100	87
Thermolyne	Hot Plate	2200	92
Perkin Elmer	AA	4100ZL	94
Perkin Elmer	FIAS	100	94
Okidate	Printer	Microline 320	94
Digital	Computer	433dxLP	94
Perkin Elmer	FIAS-200 Mount	200	94
Perkin Elmer	Cooling System	---	94
Digital	Monitor	---	94
Digital	Keyboard	---	94
Perkin Elmer	Autosampler	AS71	94
Thermo Jarrell Ash	ICP	Atomscan-16	94
Thermo Jarrell Ash	Samplechanger	TJA 96	94
Thermo Jarrell Ash	RF Generator	---	94
Caliber	Computer	---	94
KDS	Monitor	---	94
KDS	Keyboard	---	94

ATTACHMENT B

Subsurface Exploration Specification

SUBSURFACE EXPLORATION SPECIFICATION

GENERAL. This specification covers the detailed requirements for the Subsurface Exploration work which includes the completion of——borings and the installation of ——monitoring wells.

Throughout this specification, Deffenbaugh Industries. Engineering Dept. shall be referred to as the ENGINEER, and Total Environmental Services shall be referred to as the CONSULTANT.

The CONSULTANT shall locate all utilities at each boring, guard post, and well location prior to drilling. The CONSULTANT shall not begin drilling at any location until the location of utilities has been reviewed by the ENGINEER and the ENGINEER has issued authorization to proceed.

The hours worked each day shall be limited to 10 hours and shall be restricted to daylight hours only.

The CONSULTANT shall provide a fire extinguisher, and one first aid kit equipped with an eye wash bottle on the drilling rig.

The CONSULTANT shall be held responsible for any damage to existing structures or property because of his negligent operations, and shall repair or replace any such damaged structures or property to the satisfaction of the property owner, and at no additional cost to the ENGINEER.

The CONSULTANT shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property which may be caused by transporting equipment, materials, or men to or from the site. CONSULTANT shall make satisfactory and acceptable

arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

Power may not be available at the site for use by the CONSULTANT. The CONSULTANT shall be responsible for acquiring necessary power if required.

A2.2 REFERENCE STANDARDS. Wherever an ASTM designation is cited in this document, it shall mean the American Society for Testing and Materials Standard Specifications of that designation appearing in the most recent "Annual Book of ASTM Standards," published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania.

"EM 1110-2-1907" refers to the U.S. Department of the Army, "Soil Sampling", March 31, 1972.

A2.3 DRILLING METHODS. The Subsurface Exploration shall be performed using one or more of the following methods.

Hollow stem auger borings with a minimum inside diameter of 4-1/4 inches to accommodate a 3-inch outside diameter thin-walled tube sampler, continuous tube sampler, split barrel sampler, and/or monitoring well installation using the tremie method to place the grout.

Rock coring with a minimum inside core barrel diameter of two inches.

Air rotary drilling with a minimum 5-3/4-inch O.D. diameter bit to advance boring or ream out cored portion of a boring.

Air rotary drilling with a 10-inch O.D. bit for preparation of the corehole for installation of 6-inch I.D. PVC surface casing if required.

Before completing borings, and when a borehole is unattended, it shall be secured to prevent introduction of any foreign material into the borehole.

Cuttings generated during advancement of the boring shall be contained on 6-mil minimum clear plastic sheeting at each drilling location and disposed of in accordance with Article A2.15.

A2.4 AUGER BORINGS. Auger borings shall include earth drilling with or without soil sampling, as required hereafter. Auger borings shall be made using machine driven hollow stem flight augers with a minimum inner diameter of 4-1/4 inches, large enough to accommodate a 3-inch outside diameter continuous barrel sampler and monitoring well installation acceptable to the ENGINEER. Unless otherwise accepted by the ENGINEER, auger borings shall be performed in accordance with ASTM D 1452. Standard continuous barrel sampling in the auger borings shall be performed in accordance with the requirements of Articles A2.8.1, A2.8.2, and A2.8.3, respectively.

Auger borings shall be performed as required to satisfy the requirements for advancing and cleaning the boring for each sampling procedure. If soil material comes up into the interior of the hollow stem augers, the CONSULTANT shall use an air rotary drill or other techniques approved by the ENGINEER to clean the soil material out of the interior of augers prior to soil sampling. The interior of the hollow stem augers shall be cleaned out and prepared for sampling using a rotary bit equipped with baffles to deflect the air upward. Air used during drilling to remove the rock and soil cuttings shall be filtered to remove organic contaminants from the air prior to the air entering the boring. A minimum of two air filtering devices shall be provided in the air supply line. Certification of the absence of organics in the air shall be provided to the ENGINEER.

The drilling equipment and materials required to perform the auger borings shall be decontaminated in accordance with Article A2.14. Auger borings for wells and borings shall be vertical.

Grease and other lubricants shall not be used on the augers, drill rods, sampling equipment, or on tools required to perform the auger borings.

If a zone of contaminated soil of bedrock is encountered during drilling the above targeted interval of any boring, drilling may be stopped as specified by the

ENGINEER and a permanent PVC surface casing shall be installed to isolate the contamination. The PVC surface casing shall have a minimum 6-inch inside diameter, to allow drilling through the PVC surface casing with the air rotary drilling technique, if required by the ENGINEER. The surface casing shall be installed to a depth sufficient to isolate the contamination, as specified by the ENGINEER, and in a manner to prevent sloughing of surface soil into the borehole at the top of the casing. The annulus between the casing and the soil shall be a minimum of 2 inches and shall be backfilled with grout in accordance with Article A2.10. Drilling shall not continue until this casing has been placed and the grout has hardened for a minimum of 12 hours, and the ENGINEER has issued verbal authorization to proceed. Following installation of the surface casing, all loose soil and any water shall be removed from inside the casing and disposed of in accordance with the requirements of Article A2.15. Prior to drilling below the surface casing, all drilling equipment including but not limited to the drill bit, drill rods, and tools, shall be decontaminated in accordance with Article A2.14.

A2.5 ROTARY BORINGS. Air rotary borings shall include bedrock and earth drilling and sampling and reaming out of coreholes in borings. Unless otherwise permitted by the ENGINEER, air rotary borings shall be performed in accordance with EM 1110-2-1907, Chapter 4. All borings shall be drilled vertically.

Air used during drilling to remove the rock cuttings shall be filtered to remove organic contaminants from the air prior to the air entering the boring. A minimum of two air filtering devices shall be provided in the air supply line. Certification of the absence of organics in the air shall be provided to the ENGINEER.

The drilling equipment and materials required to perform the air rotary boring shall be decontaminated in accordance with Article A2.14.

Grease and other lubricants shall not be used on the drilling rods, sampling equipment, or on tools required to perform the air rotary borings.

In silty formations which might be disturbed by conventional side discharging chopping bits, the hole shall be prepared for split barrel sampling and thin-walled tube sampling with a bit equipped with baffles to deflect the air upward.

The ENGINEER will monitor soil and bedrock cuttings at the top of the borehole for possible contaminants as required in the Site Safety Plan, (Attachment 1).

A2.6 ROCK CORING.

Rock coring shall be performed in accordance with ASTM D 2113 except as otherwise specified herein or accepted by the ENGINEER.

Except as otherwise specified, core barrels shall be in accordance with ASTM D 2113, Section 4.3.4, Single Tube, Swivel-Type, WG-design or Double Tube, Swivel-Type, WM-design, or shall be equivalent barrels acceptable to the ENGINEER. Each core barrel shall have a core lifter suitable for catching and retaining cores in soft formations.

Air used during drilling to remove the rock cuttings shall be filtered to remove organic contaminants from the air prior to the air entering the boring. A minimum of two air filtering devices shall be provided in the air supply line. Certification of the absence of organics in the air shall be provided to the Engineer.

Core bits shall be in accordance with ASTM D 2113, Section 4.5, M-design, or shall be equivalent bits acceptable to the ENGINEER.

Core barrels shall not be longer than 10 feet, unless otherwise accepted by the ENGINEER. Special care shall be taken to ensure that maximum recovery is obtained on each section of core.

Core runs shall be limited to 5 feet or less, if in the opinion of the ENGINEER such limit is needed to assure acceptable core recovery. Runs of 1 or 2 feet may be required to obtain acceptable core recovery in soft or broken materials. The core shall be pulled whenever necessary to prevent loss or injury to the core. Grinding of the core after the core barrel has been blocked will not be permitted, and a blocked core barrel shall be pulled regardless of the interval desired.

The core barrel shall be decontaminated between core runs in accordance with the requirements of Article A2.14.2 unless otherwise directed by the ENGINEER.

Rock cores from each boring shall be placed in suitable durable boxes in accordance with ASTM D 2113, Section 5.1, and furnished by the CONSULTANT. The core boxes shall be provided with longitudinal spacers that will form separate compartments for each run of core. Wood blocks which fit between the spacers shall be provided to mark the beginning and end of each run and to mark core losses within each run. Under no condition shall cores from more than one boring be placed in the same core box.

The ENGINEER shall label each box for identification.

Grease and other lubricants shall not be used on the core barrels or on tools required to perform the core boring.

The ENGINEER will monitor the bedrock core as specified in the Site Safety Plan, (Attachment 1) for possible contaminants.

A2.8 SAMPLING METHOD AND FREQUENCY. Sampling shall include split barrel, continuous barrel, and thin-walled tube sampling as designated herein or specified by the ENGINEER.

A2.8.1 Continuous Barrel Sampling. Continuous barrel samples shall be obtained using a sample barrel system that will obtain a continuous soil sample while drilling with hollow stem flight augers. The sample barrel system shall be a CME or equivalent system, unless otherwise approved by the ENGINEER.

The sample barrel shall be a split barrel with a length of 5 feet, and a minimum outside diameter of 3 inches. The sample barrel shall be equipped with a sample retainer to prevent the soil in the sample barrel from sliding out of the barrel as the barrel is removed from the augers. The sample barrel shall fit within the lead hollow stem flight auger and have an outside diameter compatible with the inside diameter of the hollow stem auger. The sample barrel shoe shall extend a short but adjustable distance in front of the auger head to allow sampling to occur in advance of the augers. The sample barrel shall be installed within the lead auger in a manner that will prevent the sample barrel from rotating as the augers rotate during drilling. The

CONSULTANT shall have two complete continuous barrel sampling units on the drill rig.

The continuous barrel sampler shall be decontaminated after obtaining each sample in accordance with Article A2.14.2.

The ENGINEER will check each sample recovered using the continuous barrel sampler for evidence of contamination, as specified in the Site Safety Plan (Attachment 1).

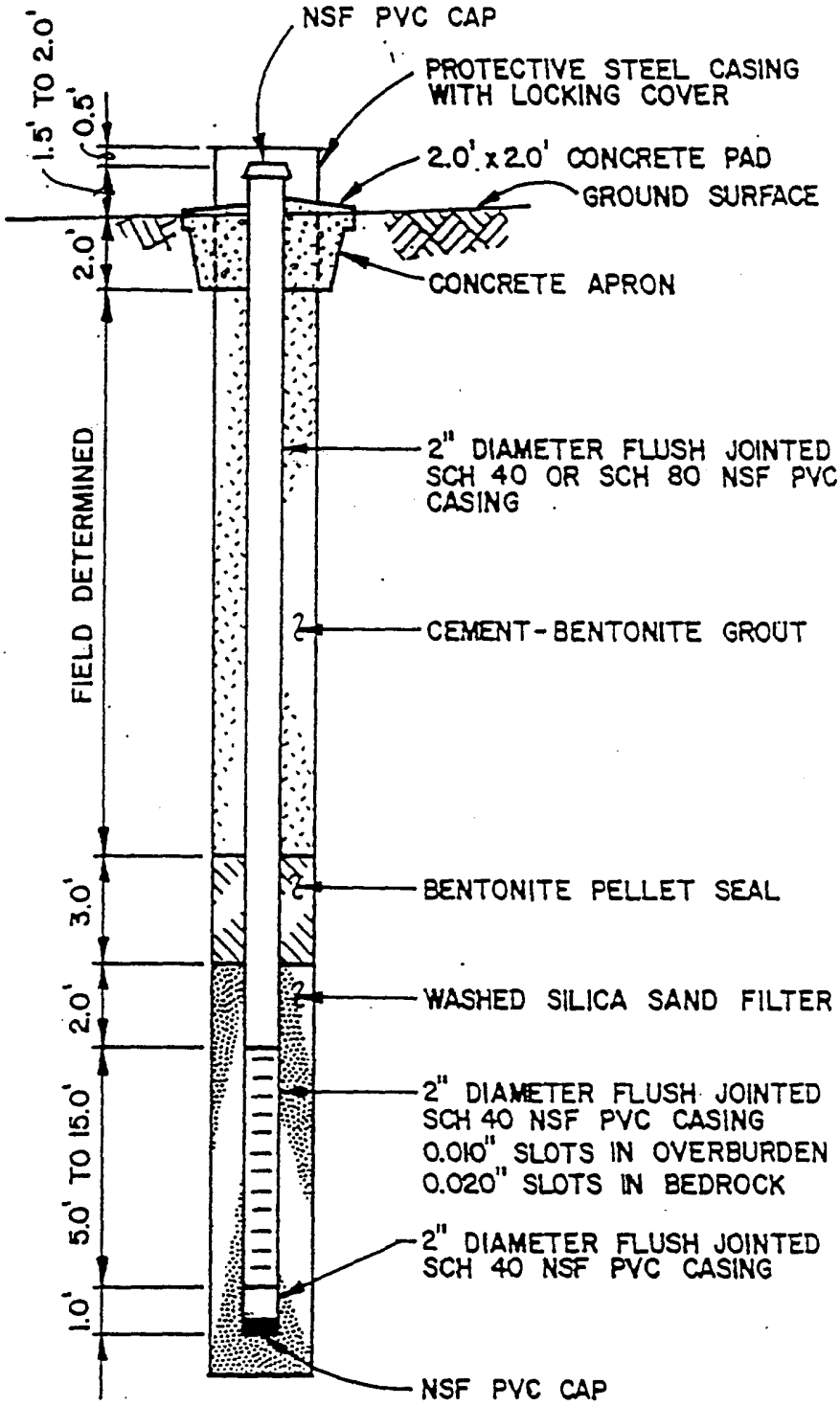
A2.9 ABANDONMENT OF BORINGS. Any boring that does not meet the depth, alignment, plumbness or other requirements, or any boring on which the CONSULTANT stops work prior to completion, will be considered as an abandoned boring. A new boring shall be started in the immediate vicinity at a location designated by the ENGINEER. An abandoned boring shall be backfilled and sealed with cement-bentonite grout in accordance with Article A2.11, as approved by the ENGINEER.

A2.10 MONITORING WELLS. The CONSULTANT shall furnish all labor, materials, and equipment required for installing monitoring wells specified herein. No solvents or lubricants shall be used before or during the installation of the wells. All wells shall be vertical.

A typical monitoring well construction diagram is shown on Figure 1.

PVC pipe and screen sections required for wells shall include threaded flush joints that are acceptable to the ENGINEER. Riser pipe and screen shall not be joined using solvent welding or glue. All PVC pipe and screen shall be new.

Each well installation shall be provided with a protective casing with a locking cover. The standard protective casing shall be a steel riser pipe (6-inch outer diameter) with a lockable steel cap and heavy duty padlock acceptable to the ENGINEER. All padlocks shall be keyed alike. The steel protective casing shall have a 1/4-inch diameter vent hole drilled in it 1 foot above the ground surface. The casing shall be embedded 33 inches below ground surface and shall extend at least 28 inches above



NOT TO SCALE

FIGURE 1
TYPICAL MONITORING WELL

the ground surface. The well casing shall be painted by the CONSULTANT and labeled by the ENGINEER. The well casing shall be cleaned and primed prior to painting with a minimum of two coats of rust inhibiting paint acceptable to the ENGINEER. In addition, the CONSULTANT shall provide a plastic tag that shall be labeled with the well number, and attached to the well head inside the protective steel casing.

Before setting the protective casing and when the monitoring well is unattended, the monitoring well shall be secured to prevent the introduction of any foreign material into the well or borehole.

A concrete surface seal shall be placed from a depth of approximately 2 feet below ground surface to 4 inches above ground surface to secure the protective surface casing. The concrete shall create a pad 2-foot by 2-foot around the protective steel surface casing. Concrete shall be formed with uniform radius or true and square sides.

All riser pipe and screen, bailers, nylon retrieval cord, and top and bottom caps for the wells shall be decontaminated in accordance with the requirements of Article A2.14. Clean gloves shall be used when installing the riser pipe and screen for the wells. The riser pipe and screen shall not be allowed to touch the ground following decontamination and prior to installation in the well.

Risers for monitoring wells shall be 2-inch diameter, Schedule 40 National Sanitation Foundation (NSF) tested and approved PVC pipe. Screen shall be factory slotted, Schedule 40 tested and approved PVC with 0.010-inch or 0.020-inch wide slots, and shall be furnished in 5-foot lengths. The length of the screened interval shall be 5 to 15 feet or as directed by the ENGINEER. A one-foot section of blank riser pipe shall be provided below the bottom of the screen as required by the ENGINEER. An NSF tested and approved PVC bottom cap shall be provided that shall be threaded and flush jointed to the bottom of the well. Certification of conformance to the specifications of the PVC riser pipe and screen and the manufacturer's descriptive data indicating the configuration of the screen shall be submitted by the CONSULTANT for review by the ENGINEER.

Washed silica sand shall be used as a backfill around the slotted section and shall extend up to 2 feet above the top of the screen section as shown on Figure 1 as directed by the ENGINEER. The washed silica sand shall be placed in a slow, steady stream around the well screen. The washed silica sand shall conform to screen gradation analysis requirements of not less than 95 percent of the sand passing U.S. Standard sieve #8 and not more than 5 percent passing U.S. Standard sieve #20 unless otherwise accepted by the ENGINEER. All silica sand shall be washed prior to bringing it onsite and shall be approved by the ENGINEER prior to use.

Directly above the silica sand shall be a 3-foot bentonite pellet seal, as specified by the ENGINEER. If water is not present in the borehole, the bentonite pellets shall be hydrated after placement above the silica sand by pouring clean potable water, from a source approved by the ENGINEER, in the hole and allowing the bentonite to set for 15 minutes prior to grouting. If conditions are such that a bentonite pellet seal cannot be placed, Volclay grout, manufactured by the American Colloid Company, or an equivalent approved by the ENGINEER, may be used as a substitute for the bentonite pellet seal. The Volclay grout or equivalent shall not be used unless verbal approval is given by the ENGINEER at the time of well installation. The Volclay grout or equivalent shall be mixed according to the manufacturer's specifications, and shall be placed using the tremie method to form a minimum 5-foot seal. The tremie method shall consist of pumping the Volclay grout down the annular space through a pipe. The bottom of the pipe shall be placed as close as possible to the top of the silica sand filter but not so close that the filter will be damaged when the Volclay grout is pumped. Pumps, piping and other materials for mixing and pumping Volclay grout or an equivalent shall be provided by the CONSULTANT.

Above the bentonite pellet or Volclay grout seal to approximately 2 feet below ground surface, the entire length of the annulus around the well shall be backfilled with a cement-bentonite grout slurry. The grout slurry shall be in accordance with the requirements of Article A2.11. The grout slurry shall be tremied into place.

The riser pipe for monitoring wells shall extend a minimum of 24 inches above the ground surface and shall have a "V" notch cut into the top of the riser. An NSF

tested and approved PVC cap or other suitable cap, approved by the ENGINEER shall be provided for the top of the riser.

For auger boring, the monitoring wells shall be installed as the augers, or temporary casing is removed from the bore hole. Only one monitoring well shall be installed in each boring.

The CONSULTANT shall furnish one new NSF tested and approved PVC bailer for each monitoring well. The bailers shall be permanently installed in the wells, and shall be TIMCO Manufacturing Company, Inc. standard bailers, or an acceptable substitute that is approved by the ENGINEER. The bailers shall be 3 feet long with an outside diameter of 1.5 inches and have a bottom emptying device. The retrieval cord for the bailers shall be new nylon rope of sufficient length for the bailer to reach the bottom of the monitoring well. A stainless steel eyebolt shall be installed on the inside of the protective cap for the riser pipe to be used for suspending the bailer retrieval cord and bailer in the well.

A2.11 CEMENT-BENTONITE GROUT SLURRY. The cement-bentonite grout slurry used to backfill borings not completed as monitoring wells and around well riser pipe above the bentonite seal to approximately 2 feet below ground surface shall be as required herein.

The cement-bentonite grout slurry shall consist of 95 percent (by weight) cement to 5 percent high-swelling bentonite mixed with 7 to 8 gallons of water per 100 pounds of cement and bentonite to yield a liquid grout weighing approximately 14 pounds per gallon. Cement shall conform to ASTM C 150, Type I. The grout shall be thoroughly mixed and shall be used before any stiffening occurs.

Cement-bentonite grout slurries shall be installed by the tremie method. This shall consist of pumping the slurry down the well or annular space through a pipe. The bottom of the pipe shall be placed near the bottom of the zone to be grouted and shall be raised as the slurry is placed, always keeping the bottom of the tremie pipe below the top of the slurry. Pumps, piping, and other materials for mixing and pumping such slurries shall be provided by the CONSULTANT.

A2.12 WELL DEVELOPMENT. When required by the ENGINEER, the monitoring wells shall be developed by bailing or pumping water from the wells until a minimum of three to five casing volumes of water have been removed from the well and the discharge water is clear, as determined by the ENGINEER, and sounding indicates all loose material has been removed from the bottom of the monitoring well. The CONSULTANT shall not develop the wells by removing the water from the wells using compressed air. The CONSULTANT shall dispose of all discharge water in accordance with the requirements of Article A2.14. All equipment and tools, including hoses and pumps, required for well development shall be decontaminated in accordance with the requirements of Article A2.14.

A2.13 DRILLING REPORT. During drilling and well installation, the CONSULTANT shall prepare, on a daily basis, a detailed drilling report for the drill rig. The report shall include, but not be limited to, the following:

- Footage completed on each well or boring during each work shift, and method of drilling used.

- Summary of quantities of materials used to construct each well.

The detailed drilling report shall be prepared and maintained, on a daily basis, by the CONSULTANT regardless of records and logs prepared by the ENGINEER.

The ENGINEER shall have access to the CONSULTANT's drilling report at all times and one carbon copy shall be signed by the CONSULTANT's authorized representative and furnished to the ENGINEER for each day while the work is in progress.

A2.14 DECONTAMINATION. The CONSULTANT shall be required to decontaminate the equipment and materials needed to perform the work in accordance with the requirements in Articles A2.14.1, A2.14.2, and A2.14.3.

Following the second phase of initial decontamination and intermediate decontamination, if the decontaminated equipment touches the ground it will be considered contaminated, and shall require additional decontamination prior to use.

The CONSULTANT shall construct a decontamination station at a location on-site designated by the ENGINEER. The decontamination station area shall be lined with minimum 6-mil plastic sheeting that shall be sloped to collect the water in one area of the decontamination station. Water collected at the decontamination station shall be managed in accordance with Article A2.15.

The detergent used for decontamination shall be Liquinox produced by Alconox, Inc. or an equivalent approved by the ENGINEER.

A2.14.1 Initial Decontamination. The initial decontamination shall be performed by the CONSULTANT in two separate phases.

The first phase of initial decontamination shall be performed prior to mobilizing the equipment to the site. In the first phase of initial decontamination, the CONSULTANT shall thoroughly clean the equipment required to drill the borings, to construct and develop the wells, using a high-pressure wash with potable water to remove any encrusted soil, mud, or organic matter which may be present on the equipment and well construction materials. This will include but not be limited to the drill rigs, pumps, drill rods, augers, drill bits, threads, casing, sampling equipment, and other tools and materials required to perform the work.

Riser pipe, screen bailers, nylon retrieval cord, and top round bottom caps for the wells shall be decontaminated as required. If the factory packaging around the riser pipe, screen, bailers, retrieval cord and caps has not been opened prior to use, decontamination shall not be performed; however, if the factory packaging has been removed or opened prior to use, the riser pipe, well screen, bailer, retrieval cord or caps shall be decontaminated.

The second phase of initial decontamination shall be performed with CONSULTANT provided equipment and materials at the decontamination station located onsite, and shall be performed following mobilization of equipment and materials to the site, and

prior to performing any work. The following decontamination procedure shall be used for the second phase of initial decontamination for sampling equipment:

- Wash sampling equipment with laboratory detergent and potable water.
- Rinse sampling equipment with potable water.
- Rinse with reagent grade ethanol or isopropanol if grease or oil is observed on sampling equipment as directed by the ENGINEER.
- Rinse with distilled water.
- Allow sampling equipment to air dry.

The second phase of initial decontamination for drilling equipment consist of the following:

- Wash with a high pressure steam cleaner using laboratory detergent and potable water.
- Rinse with high pressure steam cleaner using potable water.
- If necessary, rinse with reagent grade ethanol or isopropanol as directed by the ENGINEER.
- Rinse with potable water.

All spent decontamination solutions from the second phase of initial decontamination shall be collected and managed in accordance with Article A2.15 by the CONSULTANT.

A2.14.2 Intermediate Decontamination. Intermediate decontamination shall be performed by the CONSULTANT and shall be required to prevent cross contamination of split barrel, continuous barrel, and thin-walled tube samples, core barrels, wells, and borings. Intermediate decontamination between wells shall be performed at the decontamination station located onsite.

The procedure used during the second phase of initial decontamination for drilling equipment shall be utilized during intermediate decontamination.

Intermediate decontamination of the sampling equipment shall be required between sampling attempts, as well as between different boring locations. The intermediate decontamination procedures for sampling equipment are the same as those outlined in the second phase of initial decontamination.

Decontamination of drilling equipment between monitoring wells and borings shall include, but not be limited to, augers, drill rods, drill bits, core barrels, threads, sampling equipment, casing, hoses and pump for well development, and all other tools that might contaminate the soil or water samples.

Decontamination of equipment between split barrel, core barrel, continuous barrel, and thin-walled tube samples, shall include, but not be limited to, the split barrel sampler, core barrel, continuous barrel sampler, the thin-walled sampling head, and all other equipment that might be contaminated in the sampling process.

A2.14.3 Final Decontamination. Final decontamination shall be required to prevent movement of contaminants to areas offsite, and shall be performed prior to demobilizing the equipment. Final decontamination shall be performed at the decontamination station located onsite.

For final decontamination, the CONSULTANT shall follow the decontamination procedure set forth for intermediate decontamination, Article A2.14.2. All spent decontamination solutions shall be managed by the CONSULTANT in accordance with Article A2.15. Final decontamination of equipment shall include, but not be limited to, the drill rigs, pumps, core barrel, drill rods, drill bits, threads, casing, sampling equipment, and all other tools that might have been contaminated during the work.

A2.15 MANAGEMENT OF DRILLING FLUID, DISCHARGE WATER, EARTH CUTTINGS, AND WASTE. Drill cuttings, plastic sheeting, and visibly contaminated disposable health and safety materials will be segregated according to sampling location and material type and placed in DOT 17H 55-gallon drums. The disposal of these materials will be based on the results of chemical analyses performed on water samples. Disposal of these drums shall be the responsibility of the CONSULTANT. Disposable sampling equipment and health and safety materials

that are not visibly contaminated will be double bagged using plastic trash bags and will be disposed of in the landfill.

Decontamination fluids, ground water removed from wells during development and purging and liquid source materials removed from source areas during sampling will be placed in DOT 17-H 55-gallon drums. When filling these drums, at least 6 inches of freeboard will be allowed. These drums will have a new gasket. Both of these measures will prevent inadvertent spilling during drum handling. Disposal of these drums shall be the responsibility of the CONSULTANT.

A2.16 PROTECTIVE GUARD POSTS. The CONSULTANT shall install protective guard posts around each monitoring well as required by the ENGINEER. Prior to the installation of the guard posts CONSULTANT shall check for any utilities that may be in the vicinity. The protective guard posts shall consist of a 4 inch diameter concrete filled steel pipe placed in a minimum 8-inch diameter concrete filled hole that is 3 1/2 feet deep. The 4 inch steel pipe shall be 7 feet long and shall be set so that the bottom of the pipe is located 3 feet below ground surface. The concrete at the top of the 4 inch diameter pipe shall be cone shaped to provide for positive drainage of water. The concrete at the ground surface shall be sloped to provide positive drainage of water away from the steel pipe. Following installation, the exposed 4 feet of the steel pipe shall be primed and painted with two coats of yellow paint.

Guard posts shall be installed following well installation and prior to mobilizing to the next well location, or as directed by the ENGINEER.

A2.17 CLEANUP. At the conclusion of the work at each well and boring location, the CONSULTANT shall remove all equipment, tools, material, and supplies, and shall leave the site clean and clear of all debris generated by his work. All earth cuttings and drilling fluid generated while advancing the borings and discharge water from well development shall be collected and managed in accordance with the requirements of Article A2.15.

A2.18 RESTORATION OF DAMAGED PROPERTY. The CONSULTANT shall conduct all work in a manner to prevent any destruction, scarring or defacing of the

work site. At the completion of the Subsurface Exploration work the CONSULTANT shall be required to restore each location to its original condition.

In the event that property is damaged while accessing the drill sites and performing the work, the CONSULTANT shall, at his own expense, restore the damaged property.

The restoration work shall include, but not be limited to, repair of fences and roads, and leveling of ruts produced by driving to the wells or borings.

A2.19 WATER. Water required for work may be obtained onsite by the CONSULTANT, if available. The CONSULTANT shall furnish all hoses and temporary storage tanks required to obtain and transport the water.

All water used shall be clean, potable, and free from oil, acids, organic materials, or other deleterious substances. In addition, clean potable water shall be used for mixing grout. Water for drilling, decontamination, and other work shall come from a source approved by the ENGINEER.

ATTACHMENT C

Material Safety Data Sheets

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 5
Chromic Acid and Chromates

Issued: 10/77 Revision: C, 7/91

Section 1. Material Identification 34

Chromic Acid (CrO_3) Description: Produced by roasting chromite ore with alkali or lime, leaching with calcium oxide, crystallizing the chromate or dichromate, and then treating it with an excess of sulfuric acid. Used in ceramic glazes, colored glass, dyes, batteries, explosives, water treatment, wood treatment and preservatives, refractories, copper stripping, aluminum anodizing, photomechanical processing, chromium metal plating, purifying oil and acetylene, hardening microscopic preparations, and manufacturing chromated copper arsenate; and as a corrosion inhibitor, a catalyst, an oxidizing agent in organic chemistry, and an etchant for plastics.

R	1
I	4
S	3*
K	0

* Percutaneous (broken skin)

NFPA: 0 / 3 / 1 / OXY

HMIS: H 3, F 0, R 1, PPG† († Sec. 8)

Other Designations: CAS No. 1333-82-0; chromic acid; chromic acid, solid (DOT); chromium anhydride; chromium (VI) oxide; chromium trioxide; chromium (6+) trioxide; monochromium trioxide; puratronic chromium trioxide. Chromic acid is the commonly used name, although true chromic acid (CrH_2O_4, CAS No. 7738-94-5) cannot be isolated from solution. Chromic acid and chromates (as CrO_3, CAS No. 7440-47-3).

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

Caution: A powerful oxidizer, chromic acid may explode on contact with reducing agents and cause ignition on contact with organic materials. This poison and human carcinogen is corrosive to skin and irritating to mucous membranes. Eye contact may cause permanent blindness.

Section 2. Ingredients and Occupational Exposure Limits

Chromic acid, 99% CrO_3

1990 OSHA PEL
Ceiling: 0.1 mg(CrO_3)/m³

1987 IDLH Level
30 mg/m³

1990-91 ACGIH TLVs
TWA: 0.05 mg(Cr)/m³
Ceiling: 0.1 mg/m³

1990 NIOSH REL
TWA: 0.025 mg(Cr(VI))/m³
Ceiling: 0.05 mg/m³/15 min (Cr(VI))

1985-86 Toxicity Data*
Rat, oral, LD_{50}: 80 mg/kg
Mouse, oral, LD_{50}: 127 mg/kg
Human, inhalation, TC_{Lo}: exposed continuously to 110 µg over 3 years. Toxic effects include tumorigenic (carcinogenic by *RTECS* criteria); sense organs and special senses (olfaction tumors); lungs, thorax, or respiration (tumors).
Dog, subcutaneous, LD_{Lo}: 330 mg/kg

* See NIOSH, *RTECS* (GB6650000), for additional mutative, reproductive, toxicity and tumorigenic data.

Section 3. Physical Data*

Boiling Point: Decomposes at 482 °F (250 °C) to $Cr_2O_3 + O_2$
Melting Point: 385 °F (196 °C)
Molecular Weight: 99.98
Specific Gravity: 2.7
Water Solubility: Soluble
Heat of Fusion: 37.7 cal/g
Appearance and Odor: Dark, purplish-red, prismatic, deliquescent (absorbs all moisture from air) crystals, or a granular powder with no detectable odor.

* These physical data apply only to chromic acid (CAS No. 1333-82-0).

Section 4. Fire and Explosion Data

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

Extinguishing Media: Chromic acid is noncombustible, but accelerates burning of combustibles (wood, paper, oil). For small fires, *use only water*, not dry chemical, carbon dioxide (CO_2), or halon.

Unusual Fire or Explosion Hazards: A powerful oxidizer, chromic acid ignites on contact with acetic acid and alcohol. It may react rapidly enough with organic materials to cause ignition. Containers may explode if involved in fire.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool fire-exposed containers with flooding amounts of water since the decomposing material may form a hot, viscous foam that can cause containers to rupture and explode. *Use caution!* For large fires, flood area from a safe distance, and cool containers from the side with a water spray until after fire is well out. If possible without risk, move containers. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holder. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

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

Chemical Incompatibilities: This material is incompatible with acetic acid, acetic anhydride, acetone, alcohols, alkali metals, ammonia, arsenic, anthracene, benzene, bromine penta fluorine, butyric acid, camphor, chromous sulfide, diethyl ether, glycerol, hydrogen sulfide, methyl alcohol, naphthalene, peroxyformic acid, phosphorus, potassium hexacyanoferrate, pyridine, selenium, sodium, and turpentine. Chromic acid ignites ethyl alcohol and many hydrocarbons.

Conditions to Avoid: Avoid excess heat and contact with combustible or organic materials.

Hazardous Products of Decomposition: Thermal oxidative decomposition of chromic acid can produce carbon dioxide, smoke, and irritating toxic fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP list chromic acid and other forms of hexavalent (VI) chromium as human carcinogens.

Summary of Risks: Chromic acid is a poison and a powerful irritant to skin, eyes, and respiratory tract. Skin or lung sensitization (allergic reactions) may occur. Exposure can cause dermatitis (skin rash), asthma, pulmonary edema (fluid in lungs), kidney damage, a "chrome hole," or a perforation of the nasal septum (tissue between nostrils).

Medical Conditions Aggravated by Long-Term Exposure: Any chronic lung or skin condition.

Target Organs: Skin, respiratory tract (including nose, throat, airways, and lungs), and kidney.

Primary Entry Routes: Eyes, skin contact, inhalation, and ingestion.

Acute Effects: Inhalation may cause irritation or burning of nose, throat, and air passages, cough, wheezing, and shortness of breath. Higher exposures may cause pulmonary edema (fluid in lungs). Skin exposure may cause dermatitis (skin rash), irritation, burning, itching, redness, and ulceration (skin destruction) which may penetrate. Eye contact can cause irritation, burning, lacrimation (watering), loss of sight and permanent blindness if not removed quickly.

Chronic Effects: Chronic inhalation of excessive levels may cause epistaxis (nosebleed), "chrome holes," nasal congestion, tooth enamel erosion, chest pain, asthma (via allergic sensitization), bronchitis, or respiratory tract cancer. Chronic eye exposure may cause conjunctivitis. Skin contact

Continue on next page

Copyright © 1991 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

can cause irritant or allergic contact dermatitis, or skin ulceration. Chronic systemic absorption could cause liver or kidney damage.

FIRST AID

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

Skin: Rinse with flooding amounts of water for at least 15 min, and wash with a gentle soap. Promptly remove contaminated clothing. For redness, blistering, or persistent irritation, consult a physician.

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

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water. *Do not induce vomiting* since this worsens the victim's condition. *Do not* neutralize this acid.

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

Note to Physicians: After decontamination and neutralization, treatment of acid burns is similar to that of thermal burns, although bullae and loose necrotic tissue should be debrided. Update tetanus status. *For severe acid burns*, fluid resuscitation is critical to prevent mortality from hypovolemia and renal failure. Monitor serial vital signs, urine output, electrolytes, blood count, and urinalysis as clinically indicated. Neurovascular compromise distal to a circumferential extremity burn may require escharotomy or fasciotomy. *For inhalation exposures to acids*, a CXR, EKG, ABGs, PFTs, SMA, and CBC may aid in treatment. Evaluate and treat as indicated for reactive airways, upper airway obstruction and noncardiogenic pulmonary edema (possibly delayed onset). Although literature documentation is inadequate, a burst of steroids may help prevent development of sequelae such as reactive airways dysfunction syndrome or bronchilitis obliterans. For ocular exposures to acids, ensure adequate decontamination. Determination of pH may be helpful. A Morgan Lens© and topical anesthesia may aid in irrigation. Perform fluorescein staining and slit lamp evaluation and consult an opthamalogist. Antibiotic ointments, mydriatic/cycloplegics, topical corticosteroids (after epithelial recovery), patching, and possibly anterior chamber paracentesis may be indicated depending on clinical presentation. Acutely and in follow-up, evaluate as indicated for intraocular pressure, lacrimal and lid function, corneal integrity and infection. Urinary chromium is of questionable value.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and eye contact. Do not handle broken packages unless wearing appropriate personal protective equipment. Keep combustibles (wood, paper, etc.) away from spilled material. Whenever possible, use wet cleanup methods; if not, use vacuum cleanup. Remove spills immediately to prevent dust dispersion. For a water spill, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. For a land spill, dig a pit, pond, or lagoon to contain material. If time permits, seal these with an impermeable, flexible membrane liner. Dike surface flow with soil, sand or foamed concrete. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: If allowed contact with soil, chromic acid, solid, lowers pH and may leach into water sources, causing an effect similar to acid rain's on water sources. This material's carcinogenicity makes it hazardous to the environment in its hexavalent state.

Environmental Degradation: The recommended disposal means are reduction, precipitation, or ion exchange. Landfill disposal is not recommended since it raises soil acidity.

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

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.22): Corrosive waste

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [*per Clean Water Act, Sec. 311(b)(4)]†

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

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

† Chromic acid (CAS No. 7738-94-5) is listed.

Section 8. Special Protection Data

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

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For 0.5-g/m³ concentrations (if not fumes), use any dust and mist respirator except single-use and quarter-mask respirators. For 1.25-g/m³ concentrations, use any powered air-purifying respirator with a high-efficiency particulate filter. For 2.5-m/m³ concentrations, use any air-purifying full facepiece respirator with a high-efficiency particulate filter. For 30-g/m³ concentrations, use any supplied air respirator with a full facepiece and operated in a pressure-demand or other positive-pressure mode. All concentrations may require eye protection. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

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

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below occupational exposure levels. Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]

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

Contaminated Equipment: Contact lenses may minimize or worsen eye injuries. In some cases, soft lenses can actually protect eyes, not worsen corneal damage, due to strong chemicals. In other cases, chemical entrapment is presumed a possible hazard. Since contact lens use in industry is controversial, establish your own policy. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in glass bottles, cans, or drums. Protect against physical damage. Separate from combustible, organic, or other easily oxidizable materials. Protect from excess moisture which could cause containers to rust. Do not store on wooden floors. Store away from foodstuffs and flammable liquids and solids.

Engineering Controls: Avoid dust inhalation and skin or eye contact. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good housekeeping procedures.

Other Precautions: Institute preplacement and periodic medical exams of exposed workers with attention to the skin and respiratory tract. Consider preplacement and periodic chest radiographs.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Chromic acid, solid
DOT Hazard Class: Oxidizer
ID No.: NA1463
DOT Label: Oxidizer
DOT Packaging Exceptions: 173.153
DOT Packaging Requirements: 173.164

IMO Shipping Name: Chromium trioxide, anhydrous
IMO Hazard Class: 5.1
ID No.: UN1463
IMO Label: Oxidizer, Corrosive
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 85, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 142, 145, 148, 159

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

Copyright © 1991 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 12

CUPROUS CYANIDE
(Revision C)
Issued: May 1984
Revised: November 1987

SECTION 1. MATERIAL IDENTIFICATION

24

Material Name: CUPROUS CYANIDE

Description (Origin/Uses): Used as an insecticide, fungicide; as a polymerization catalyst; and as an antifouling agent in marine paints.

Other Designations: Copper Cyanide; Copper (I) Cyanide; Cupricin; CuCN; NIOSH *RTECS* No. GL7150000; CAS No. 0544-92-3

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

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

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

Ingredients and Hazards	%	Exposure Limits
Cuprous Cyanide, CAS No. 0544-92-3 Cu - C≡N *Immediately dangerous to life and health **This material can be absorbed through intact skin, which contributes to overall exposure.	ca 100	IDLH* Level: 50 mg/m³ (NaCN and KCN, Specifically) **ACGIH TLV (Skin**), 1987-88** TLV-TWA: 5 mg CN/m³ (NaCN and KCN, Specifically) **OSHA PEL (Skin**)** 8-Hr TWA: 5 mg CN/m³ **NIOSH REL** 10-Min Ceiling: 5 mg CN/m³

SECTION 3. PHYSICAL DATA

Water Solubility: Insoluble
Specific Gravity: 2.92 at 68°F (20°C)
Melting Point: 885°F (474°C)
Molecular Weight: 89.6 Grams/Mole
pH: Aqueous solutions are strongly alkaline.

Appearance and Odor: White to cream-colored powder, colorless or dark green orthorhombic crystals, or dark red monoclinic crystals. Slight, bitter-almond odor of hydrogen cyanide; can be odorless if kept perfectly dry.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Combustible	Not Found	% by Volume	Not Applicable	Not Applicable

Extinguishing Media: Unreacted cyanide salts like cuprous cyanide, sodium cyanide, or potassium cyanide are not combustible; however, contact with acids will liberate highly toxic, flammable hydrogen cyanide (HCN) gas. Use water spray to fight fires in areas containing this material. Cool fire-exposed metal containers with large amounts of water. Do *not* use carbon dioxide (CO_2) extinguishers; this can liberate HCN by the action of the dissolved CO_2.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fight fires involving cuprous cyanide from the safest maximum distance.

SECTION 5. REACTIVITY DATA

Cuprous cyanide is stable in closed, dry containers. It does not undergo hazardous polymerization.

Chemical Incompatibilities; Warning: This material is incompatible with strong oxidizing agents and especially acids. Contact with acids liberates extremely toxic and flammable hydrogen cyanide (HCN) gas.

Conditions to Avoid: Avoid exposure to excessive heat, moisture, chemical incompatibilities, and especially any acids.

Hazardous Products of Decomposition: Toxic gases such as HCN and nitrogen oxides.

Caution: Toxic concentrations of HCN by reaction with CO_2 and moisture may form when cuprous cyanide is in prolonged contact with air in a closed system.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Cuprous cyanide is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Cyanide anions (CN^-) inhibit the body cells' use of oxygen by causing metabolic asphyxiation. Prolonged anoxia (reduced level of oxygen in the blood) causes central nervous system (CNS) damage. Early symptoms of exposure to cuprous cyanide are typical CNS effects like weakness, headache, and confusion. Continued exposure causes a weak and irregular heartbeat, unconsciousness, convulsions, coma, and death. Cyanides are fast acting and highly poisonous by ingestion. As little as a few breaths of HCN vapor may stop respiration and cause collapse. Cuprous cyanide is strongly alkaline and is thus corrosive to body tissues. CuCN usually acts less rapidly than NaCN or KCN.
Medical Conditions Aggravated by Long-Term Exposure: Diseases of kidneys, heart, lungs, and the CNS.
Target Organs: Cardiovascular system, CNS, liver, kidneys, skin. **Primary Entry:** Skin absorption/contact, inhalation.
Acute Effects: Eye and skin irritation, nausea, and vomiting. **Chronic Effects:** Dermatitis and skin ulcers.
FIRST AID
Eye Contact: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin Contact: Immediately wash the affected area with soap and water because of the increased exposure hazard from absorption.
Inhalation: Remove victim to fresh air; restore and/or support his breathing as needed.
Ingestion: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing.
Comments: Preparation for emergency first aid treatment involving cuprous cyanide or any cyanide salt must be done before the exposure situation occurs. All workers involved with cyanides must receive detailed training in safe handling, first aid procedures, and the use of commercially available cyanide antidote kits.

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

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel. Provide adequate ventilation. Scrupulously avoid the addition of any acid to the spill or leak area. Cleanup personnel need protection against contact and inhalation (see sect. 8). Decontaminate trace cyanide in the spill area with a strong sodium or calcium hypochlorite solution and flush waste to a holding area for copper removal. Scoop up spilled cuprous cyanide into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust. Preplan and train personnel for emergency response.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z, for cyanides as CN)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P029
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full faceshield as a supplementary protective measure. Follow the eye- and face-protection guidelines of 29 CFR 1910.133. **Gloves:** Wear impervious gloves. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. IDLH or unknown concentrations require an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient or poisoned atmospheres. **Other Equipment:** Wear impervious boots, aprons, gauntlets, etc., as required by the specific work environment to prevent any possibility of skin contact or exposure. **Ventilation:** Install and operate both general and local exhaust-ventilation systems of sufficient power to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation should be the primary removal system to eliminate dispersion of this material into the general work area. Local exhaust hoods must have a minimum face velocity of 100 lfm (linear feet per minute). **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Install and maintain in a ready-to-use state emergency first aid cyanide antidote kits in all work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles may cling to contact lenses and cause corneal injury. Do *not* wear contact lenses in any work area. Remove and launder contaminated clothing before wearing it again; clean this material from shoes and equipment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep this material off of your clothing and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store cuprous cyanide in a cool, dry, well-ventilated, airtight area away from acids, weak alkalies, and oxidizing materials.
Special Handling/Storage: Protect containers against physical damage. All handling and storage facilities must be designed to prevent accidental contact with acids. **Warning:** Solutions combining cuprous cyanide (CuCN), sodium cyanide (NaCN), and potassium cyanide (KCN) are very corrosive to the skin and eyes and may cause deep ulcers that are slow to heal.
Comments: Prevent this material's contact with skin and eyes. Do not taste it or breathe its dust or solution mist. Regularly inspect and maintain the cyanide first aid kits that must be available in all work and storage areas. Prevent contact of this material with acids.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Copper Cyanide	**DOT ID No.** UN1587
DOT Hazard Class: Poison B	**IMO Label:** Poison
IMO Class: 6.1	**DOT Label:** Poison

References: 1-12, 14, 38, 47, 73, 84-94, 103. PJI

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals
Indust. Hygiene/Safety
Medical Review

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © November 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 13

POTASSIUM CYANIDE
(Revision D)
Issued: February 1987
Revised: November 1987

SECTION 1. MATERIAL IDENTIFICATION

24

Material Name: POTASSIUM CYANIDE

Description (Origin/Uses): Used for gold and silver extraction; in electroplating baths; and in manufacturing various cyanides.

Other Designations: Cyanide of Potassium; Potassium Salt of Hydrocyanic Acid; KCN; NIOSH *RTECS* No. TS8750000; CAS No. 0151-50-8

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

HMIS
H 3
F 1
R 1
PPG*
*See sect. 8

R 1
I 2
S 3
K 0

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Potassium Cyanide, CAS No. 0151-50-8 K - C≡N *Immediately dangerous to life and health **This material can be absorbed through intact skin, which contributes to overall exposure. ***See NIOSH *RTECS* for additional data with reference to reproductive and mutagenic effects.	ca 100	IDLH* Level: 5 mg CN/m³ **ACGIH TLV (Skin**), 1987-88 (NaCN and KCN)** TLV-TWA: 5 mg CN/m³ **OSHA PEL (Skin,** for Cyanide)** 8-Hr TWA: 5 mg CN/m³ **NIOSH REL** 10-Min Ceiling: 5 mg CN/m³ **Toxicity Data***** Human, Oral, LD_{Lo}: 2.857 mg/kg Rat, Oral, LD_{50}: 10 mg/kg

SECTION 3. PHYSICAL DATA

Water Solubility: Complete
Specific Gravity: 1.52 at 68°F (20°C)
Melting Point: 1173°F (634°C)
Molecular Weight: 65.12 Grams/Mole
pH: Aqueous solutions are strongly alkaline.

Appearance and Odor: White crystalline powder or lumps; slight, bitter-almond odor of hydrogen cyanide; can be odorless if kept perfectly dry.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Combustible	Not Found	% by Volume	Not Applicable	Not Applicable

Extinguishing Media: Unreacted cyanide salts like potassium cyanide, sodium cyanide, or cuprous cyanide are not combustible; however, contact with acids will liberate highly toxic, flammable hydrogen cyanide (HCN) gas. Use water spray to fight fires in areas containing this material. Cool fire-exposed metal containers with large amounts of water. Do *not* use carbon dioxide (CO_2) extinguishers; this can liberate HCN by the action of the dissolved CO_2.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fight fires involving potassium cyanide from the safest maximum distance.

SECTION 5. REACTIVITY DATA

Potassium cyanide is stable in closed, dry containers. It does not undergo hazardous polymerization.

Chemical Incompatibilities; Warning: Violent reactions can occur with oxidizing agents such as nitric acid, nitrates, and peroxides. Contact with acids liberates extremely toxic and flammable hydrogen cyanide (HCN) gas.

Conditions to Avoid: Avoid exposure to excessive heat, moisture, chemical incompatibilities, and especially to any acids.

Hazardous Products of Decomposition: Toxic gases such as HCN and nitrogen oxides.

Comments: Potassium cyanide is deliquescent; i.e., it may absorb enough moisture from the air to dissolve into a liquid.
Caution: Toxic concentrations of HCN may form by reaction with CO_2 and moisture when this material is in prolonged contact with air in a closed system.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

Summary of Risks: Cyanide anions (CN^-) inhibit the body cells' use of oxygen by causing metabolic asphyxiation. Prolonged anoxia (reduced level of oxygen in the blood) causes central nervous system (CNS) damage. Early symptoms of exposure to potassium cyanide are typical CNS effects like weakness, headache, and confusion. Continued exposure causes a weak and irregular heartbeat, unconsciousness, convulsions, coma, and death. Cyanides are fast acting and highly poisonous by ingestion. As little as a few breaths of HCN vapor may stop respiration and cause collapse. This material is strongly alkaline and is thus corrosive to body tissues.
Medical Conditions Aggravated by Long-Term Exposure: Diseases of kidneys, heart, lungs, and the CNS.
Target Organs: Cardiovascular system, CNS, liver, kidneys, skin. **Primary Entry:** Skin contact or absorption, inhalation.
Acute Effects: Eye and skin irritation, nausea, and vomiting. **Chronic Effects:** Dermatitis and skin ulcers.
FIRST AID
Eye Contact: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin Contact: Immediately wash the affected area with soap and water because of the increased exposure hazard from absorption.
Inhalation: Remove victim to fresh air; restore and/or support his breathing as needed.
Ingestion: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing.
Comments: Preparation for emergency first aid treatment involving potassium cyanide or any cyanide salt must be done before the exposure situation occurs. All workers involved with cyanides must receive detailed training in safe handling, first aid procedures, and the use of commercially available cyanide antidote kits.

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

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel. Provide adequate ventilation. Scrupulously avoid the addition of any acid to the spill or leak area. Cleanup personnel need protection against contact and inhalation (see sect. 8). Decontaminate trace cyanide in the spill area with a strong sodium or calcium hypochlorite solution and flush waste to a holding area for potassium removal. Scoop up spilled potassium cyanide into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust. Preplan and train personnel for emergency response.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z, for cyanides as CN)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P098
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full faceshield as a supplementary protective measure. Follow the eye- and face-protection guidelines of 29 CFR 1910.133. **Gloves:** Wear impervious gloves. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. IDLH or unknown concentrations require an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient or poisoned atmospheres.
Other Equipment: Wear impervious boots, aprons, gauntlets, etc., as required by the specific work environment to prevent skin contact or exposure.
Ventilation: Install and operate both general and local exhaust-ventilation systems of sufficient power to maintain airborne levels of potassium cyanide below the OSHA PEL standard cited in section 2. Local exhaust ventilation should be the primary removal system to eliminate dispersion of this material into the general work area. Local exhaust hoods must have a minimum face velocity of 100 lfm (linear feet per minute). **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Install and maintain in a ready-to-use state emergency first aid cyanide antidote kits in all work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles may cling to contact lenses and cause corneal injury. Do *not* wear contact lenses in any work area. Remove and launder contaminated clothing before wearing it again; clean this material from shoes and equipment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep this material off of your clothing and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store potassium cyanide in a cool, dry, well-ventilated, airtight area away from acids, weak alkalies, and oxidizing materials.
Special Handling/Storage: Protect containers against physical damage. All handling and storage facilities must be designed to prevent accidental contact with acids. **Warning:** Solutions combining potassium cyanide (KCN), sodium cyanide (NaCN), and cuprous cyanide (CuCN) are very corrosive to the skin and eyes and may cause deep ulcers that are slow to heal.
Comments: Prevent this material's contact with skin and eyes. Do not taste it or breathe its dust or solution mist. Regularly inspect and maintain the cyanide first aid kits that must be available in all work and storage areas. Prevent contact of this material with acids.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Potassium Cyanide, Solid
DOT Hazard Class: Poison B
IMO Class: 6.1
DOT ID No. UN1680
IMO Label: Poison
DOT Label: Poison

References: 1-12, 14, 38, 47, 73, 84-94, 103. PJI

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals
Indust. Hygiene/Safety 5/88
Medical Review

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © November 1, 1987

Genium Publishing Corp.
One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Cobalt Acetate **MSDS No. 18**

Date of Preparation: 10/93

Section 1 - Chemical Product and Company Identification 42

Product/Chemical Name: Cobalt Acetate
Chemical Formula: $(CH_3COO)_2Co$
CAS No.: 71-48-7
Synonyms: acetic acid, cobalt (2+) salt; bis(acetato)cobalt; cobalt (2+) acetate; cobalt (II) acetate; cobaltous acetate.
Derivation: Prepared commercially from cobaltous hydroxide or carbonate and an excess of dilute acetic acid.
General Use: Used as a bleaching agent, a drier for lacquers and varnishes, an anodizing agent, a mineral supplement in feed additives, an esterification and oxidation catalyst, and in sympathetic inks. Formerly used as a foam stabilizer for malt beverages.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Cobalt Acetate, ca 100 % wt

OSHA PELs
8-hr TWA: 0.1 mg/m^3 (as Co metal, dust, and fume)
8-hr TWA: 0.05 mg/m^3 (as Co metal, dust, and fume), [vacated]

ACGIH TLVs
TWA: 0.05 mg/m^3 (as Co metal, dust, and fume)
Notice of Intended Changes: TWA: 0.02 mg/m^3 (as Co, elemental and inorganic compounds), A3 (Animal Carcinogen)

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (as Co metal, dust, and fume)

IDLH Level
20 mg/m^3 (as Co metal, dust, and fume)

DFG (Germany) MAK
Danger of sensitization (cobalt and its compounds, inspirable dusts/aerosols)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Cobalt acetate exists as light-pink or red (tetrahydrate) crystals with a vinegar-like odor. Cobalt acetate dust is irritating to the skin, eyes, and respiratory tract. Skin contact may cause allergic dermatitis. Avoid dust inhalation and contact. Absorption of cobalt acetate may produce systemic poisoning.

Wilson Risk Scale	
R	1
I	4
S	1
K	1

HMIS	
H	2
F	0
R	0

PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and/or eye contact, ingestion.
Target Organs: Skin, eyes, respiratory tract.
Acute Effects
Inhalation: Inhalation may cause coughing and shortness of breath. Inhalation of cobalt dust has produced an asthma-like disease and fibrotic pulmonary lesions.
Eye: Eye contact may cause irritation.
Skin: Skin contact may cause dermatitis; allergic dermatitis has been reported in workers exposed to cobalt.
Ingestion: Ingestion causes pain and vomiting, digestive tract irritation, and systemic effects including flushing of the face and ears, mild hypotension, rash, tinnitus (ringing in the ears), and nerve deafness. Ingestion of beer with cobalt additives produced myocardial (heart wall) disorders.
Carcinogenicity: IARC, NTP, and OSHA do not list cobalt acetate as a carcinogen. However, the IARC, DFG, and ACGIH list cobalt, elemental and inorganic compounds, as possibly carcinogenic to humans (IARC-2B), unmistakably carcinogenic in animal experimentation (MAK-A2), and an animal carcinogen (ACGIH-A3).
Medical Conditions Aggravated by Long-Term Exposure: Skin and respiratory disease.
Chronic Effects: None reported.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. If irritation and pain persist, consult an ophthalmologist immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Copyright © 1993 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

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

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

Note to Physicians: Treatment is symptomatic and supportive.

Section 5 - Fire-Fighting Measures

Flash Point: Not flammable.

Autoignition Temperature: Not flammable.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Cobalt oxide fumes may form in fire.

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

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

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Cleanup personnel should protect against dust inhalation and skin or eye contact.

Small Spills: For liquid spills, take up with an inert, noncombustible absorbent material and scoop into an appropriate container for disposal. For dry spills, remove by vacuuming or wet mopping and place into an appropriate container for disposal or reclamation.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Flush liquid spills with water and channel to a treatment system or holding tank for reclamation or proper disposal. Do not release into sewers or waterways.

Cleanup: *Do not* sweep! To minimize dust dispersion, clean with vacuum pickup or wet mopping.

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

Section 7 - Handling and Storage

Handling Precautions: Avoid generating dusty conditions.

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from heat and ignition sources and strong oxidizers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To reduce potential health hazards, use sufficient ventilation to reduce any airborne dust concentrations. Enclose any operations that disperse dust into the workplace.

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

Administrative Controls: Institute programs that emphasize good personal hygiene. Consider periodic medical examinations with emphasis on the skin and respiratory tract.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. The following respirator recommendations are for cobalt metal, dust, and fume (as Co). For concentrations ≤ 0.25 mg/m^3, use any dust and mist respirator (if not present as a fume); ≤ 0.5 mg/m^3 use any dust and mist respirator except single-use and quarter-mask respirators (if not present as a fume and may require eye protection), or any dust, mist, and fume respirator (may require eye protection), or any supplied-air respirator (may require eye protection), or any self-contained breathing apparatus (SCBA); ≤ 1.25 mg/m^3 use any powered air-purifying respirator with a dust and mist filter, or any supplied-air respirator operated in a continuous flow mode, or any powered air-purifying respirator with a dust, mist, and fume filter (all may require eye protection); ≤ 2.5 mg/m^3 use any air-purifying full facepiece respirator with a high-efficiency particulate filter or any SCBA with a full facepiece or any supplied-air respirator with full facepiece; ≤ 20 mg/m^3 use any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Copyright © 1993 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Hydrophobic barrier creams may be helpful in preventing dermatitis. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Light-pink or red (tetrahydrate) crystals; vinegar-like odor.
Formula Weight: 177.03; (tetrahydrate) 249.08
Density (H_2O=1, at 4 °C): (tetrahydrate) 1.705 at 66 °F (19°C)
Water Solubility: Readily soluble
Other Solubilities: (tetrahydrate) alcohols, dilute acids, pentyl acetate
pH (0.2 molar aqueous solution): (tetrahydrate) 6.8
Refraction Index: (tetrahydrate) 1.542

Section 10 - Stability and Reactivity

Stability: Cobalt acetate is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Strong oxidizers.
Conditions to Avoid: Contact with strong oxidizers.
Hazardous Decomposition Products: Thermal oxidative decomposition of cobalt acetate can produce irritating cobalt oxide fumes and acrid smoke.

Section 11- Toxicological Information

Toxicity Data:*

Acute Oral Effects:
Rat, oral, LD_{50}: 503 mg/kg; toxic effects include somnolence (general depressed activity), shortness of breath, and weight loss or decreased weight gain.
Genetic Effects:
Oncogenic transformation, hamster embryo: 200 µmol/L

* See NIOSH, *RTECS* (AG3150000), for additional toxicity data.

Section 12 - Ecological Information

Soil Absorption/Mobility: Cobalt uptake and phytotoxicity are affected by soil pH; more acidic soils absorb cobalt less strongly.

Section 13 - Disposal Considerations

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

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not regulated

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
RCRA Hazardous Waste Classification (40 CFR 261.21-24): Not classified
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (as cobalt metal, dust, and fume) (29 CFR 1910.1000, Table Z-1-A)

Copyright © 1993 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 16 - Other Information

References: 26, 73, 103, 126, 127, 132, 136, 139, 148, 168, 181, 183, 186

Prepared by ..... MJ Wurth, BS
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... AC Darlington, MD

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Copyright © 1993 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 26

MERCURY
(Revision C)
Issued: September 1981
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: MERCURY

Description (Origin/Uses): Used in barometers, thermometers, hydrometers, and pyrometers; in mercury arc lamps producing ultraviolet rays; in switches and fluorescent lamps; as a catalyst in oxidations of organic compounds; in alloys; in explosives; and for extracting gold and silver from ore.

Other Designations: Colloidal Mercury; Metallic Mercury; Quicksilver; Hg; Hydrargyrum; CAS No. 7439-97-6

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

Comments: Inorganic and organic mercury compounds are highly toxic, as is pure mercury.

Genium

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

SECTION 2. INGREDIENTS AND HAZARDS

INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Mercury, CAS No. 7439-97-6	Ca 100	**OSHA PEL** Ceiling: 1 mg per 10 m³ **ACGIH TLV (Skin*), 1987-88** TLV-TWA: 0.05 mg/m³ as Hg (Mercury Vapor) **Toxicity Data**** Rabbit, Inhalation, LC_{Lo}: 29 mg/m³ (30 Hrs)

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

**See NIOSH, *RTECS* (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 673°F (357°C)
Specific Gravity (H_2O = 1): 13.546 at 68°F (20°C)
Vapor Pressure: 0.0018 Torr at 77°F (25°C)
Water Solubility (%): Insoluble
Molecular Weight: 201 Grams/Mole
Melting Point: -37.93°F (-38.85°C)

Appearance and Odor: A silver, heavy liquid; odorless. **Danger:** Mercury vapor has no warning properties.

SECTION 4. FIRE AND EXPLOSION DATA

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

Extinguishing Media: *Mercury does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes.

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

SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref. 84).

Conditions to Avoid: Do not expose mercury to incompatible chemicals.

Hazardous Products of Decomposition: Extremely toxic mercury metal fumes are likely to be produced during fires.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

Summary of Risks: Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure:** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs:** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. Inhalation of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects:** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Note to physician: If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with d-penicillamine may also be indicated.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills; if large quantities of mercury are used in the workplace, detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).

Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 19010.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste No. U151

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a); Clean Air Act, § 112; and Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.

Ventilation: Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.

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

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.

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

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.

Special Handling/Storage: Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.

Comments: Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Mercury, Metal
DOT Hazard Class: ORM-B
DOT Label: None
DOT ID No. NA2809
IMO Class: 8
IMO Label: Corrosive

References: 1, 2, 8, 26, 38, 84-94, 100.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 38
LEAD MONOXIDE
(Revision B)
Issued: November 1979
Revised: February 1986

SECTION 1. MATERIAL IDENTIFICATION 19

MATERIAL NAME: LEAD MONOXIDE

OTHER DESIGNATIONS: Lead (II) Oxide, Plumbous Oxide, Litharge, Massicot, PbO, CAS # 1317-36-8

MANUFACTURER/SUPPLIERS: Available from several suppliers, including:
NL Baroid, Inc., PO Box 1675, Houston, TX 77251; Telephone: (713) 527-1100
Eagle-Picher Industries, Inc., Chemicals Division, 580 Walnut Street, Cincinnati, OH 45202; Telephone: (513) 721-7010

HMIS	Not Found
H: 2	
F: 0	R 0
R: 0	I 4
PPE: *	S 0
* See Sect. 8	K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
LEAD MONOXIDE, PbO	>99	ACGIH TLV*: 8-hr TWA: 0.15 mg/m^3
		OSHA PEL**: 8-hr TWA: 0.05 mg/m^3
		Rat, Intraperitoneal, LDLo: 430 mg/kg
		Dog, Oral, LDLo: 1400 mg/kg

* Current (1985-86) ACGIH TLV, as Pb

** Current OSHA PEL (as Pb) with an action level of 0.03 mg/m^3 (29 CFR 1910.1025)

SECTION 3. PHYSICAL DATA

Melting Point ... 1646.6°F(897°C) (Begins to Sublime before Melting)
Boiling Point ... 2681.6°F(1472°C) (Decomposes)
Molecular Weight ... 223.2

	Litharge	Massicot
Density	9.53 g/cc	9.6 g/cc
Solubility in Water (@ 25°C)	0.0504 g/L	0.1065 g/L

Appearance and odor: Lead monoxide exists in two crystalline forms: litharge and massicot. The reddish litharge transforms to yellow massicot at 912.2°F(489°C). Lead monoxide is odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
NA	NA	NA		

This material is nonflammable. Use whatever extinguishing agents are appropriate for the surrounding fire.

When hot, lead monoxide can act as an oxidizing agent and may intensify combustion.

Toxic dust and fumes may be generated in a fire situation. Fire fighters should wear self-contained breathing apparatus and full protective gear.

SECTION 5. REACTIVITY DATA

Lead monoxide is stable at room temperature. It does not polymerize. When heated and cooled in air it can undergo transitions between crystalline and oxide forms.

Mixtures of lead oxide and chlorinated rubber may react violently when heated. A lead oxide-glycerol mixture (used as cement/jointing compound) can ignite when exposed to fluorine gas and may explode after exposure to perchloric acid fumes. Violent reactions can occur when lead monoxide is heated with aluminum, sodium, zirconium, titanium, boron, or silicon. Other incompatibles include hydrogen trisulfide, metal acetylides, and peroxyformic acid.

Toxic lead fumes can form at high temperatures.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION | TLV

Lead compounds are toxic when inhaled or ingested. Lead is a cumulative poison. The chief effects of excessive lead intake are anemia, neurological disorders, and kidney damage. Symptoms of the neurological effects may include irritability, headaches, insomnia, delirium, convulsions, muscular tremors, and palsy of the extremities. Excessive lead exposure may also have adverse effects on human reproduction. Symptoms of acute lead poisoning by ingestion include headache; abdominal pain; nausea; vomiting; diarrhea; and, in severe cases, coma and death.
The IARC concludes that the evidence for carcinogenicity of lead and lead compounds to humans is inadequate. The NTP does not list lead monoxide in its third annual report on carcinogens.

FIRST AID: Any worker who experiences symptoms of lead poisoning should be removed from exposure and receive prompt medical care. EYE CONTACT: Flush eyes (including under the eyelids) with running water for at least 15 minutes. Obtain medical attention. SKIN CONTACT: Flush affected area with plenty of water. If irritation persists, seek medical attention. INHALATION: Remove victim from exposure. Get medical attention for treatment of symptoms. INGESTION: If person is conscious, give him/her plenty of milk or water to drink. Induce vomiting. Keep victim warm and at rest. Get medical assistance immediately.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety/environmental personnel of large spills. Ventilate spill area. Cleanup personnel should wear respiratory protection, gloves, and protective clothing. Carefully vacuum up spilled material. Place collected material in a suitable container that can be tightly sealed for reclaim or disposal. Avoid dusting conditions at all stages of handling.

DISPOSAL: Salvage material when possible. PbO requires disposal as a hazardous waste. Contact supplier or a licensed chemical waste disposal contractor for treatment, packaging, and disposal requirements. Follow Federal, state, and local regulations.

EPA Hazardous Waste No.: D008 (EP TOXIC; 40 CFR 261.24)

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide local exhaust ventilation and/or other engineering controls to meet the PEL requirement. NIOSH-approved respirators should be worn where engineering controls and work practices do not reduce exposures to or below the PEL. Half-mask air-purifying respirators with high-efficiency filters are acceptable for concentrations up to 0.5 mg/m^3 (2.5 mg/m^3 with full facepiece). Protective clothing and equipment such as coveralls, gloves, hats, and shoes should be worn when exposures exceed the PEL or where the possibility of skin and eye contact exist. Provide clean body-covering work clothing weekly to workers exposed to above the PEL (daily if exposed above 0.2 mg/m^3) and arrange for special handling and laundering of contaminated clothing. Changing rooms (with separate storage facilities for street and work clothing) and showers are required for employees exposed to above the PEL. Prevent dust from being transported to lunchroom by way of the ventilation system or contaminated clothing. Consult the OSHA lead standard (29 CFR 1910.1025) for detailed requirements.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers away from incompatibles. Protect containers from physical damage. Keep away from food or feed. Use good housekeeping procedures (vacuuming and/or wet cleanup) to prevent accumulation of dust. DO NOT use compressed air for cleaning surfaces or clothing (use vacuum). Follow good personal hygiene practice. Wash face and hands thoroughly after handling and before eating, drinking, or smoking. Do not eat, drink, or use tobacco in areas where this material is used.
Exposure monitoring, biological monitoring, and medical surveillance should be provided in accordance with the OSHA Lead Standard (29 CFR 1910.1025).
Prevent dust generation. Use with adequate ventilation. Avoid inhalation and contact. Do not ingest!

DOT Classification: Not listed in Hazardous Materials Table, 49 CFR 172.101.
Data Source(s) Code: 2, 4, 5, 12, 14, 25, 55, 57, 58, 61, 62, 82, 84. CV

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	J.C. Accrocco
Indust. Hygiene/Safety	6/86
Medical Review	2/4/86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © February 1, 1986

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 62
OXYGEN
(Revision A)

Issued: April 1980
Revised: April 1986

SECTION 1. MATERIAL IDENTIFICATION

21

MATERIAL NAME: OXYGEN
DESCRIPTION: Compressed gas (2100 psig) supplied in cylinders or cold liquid supplied in Dewar containers.
OTHER DESIGNATIONS: O_2; CAS #7782-44-7.
MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Airco Industrial Gases of the BOC Group, Inc., 575 Mountain Avenue, Murray Hill, NJ 07974; Telephone: (201) 464-8100

Union Carbide Corporation, Linde Div., 39 Old Ridgebury Road, Danbury, CT 06817;Telephone: (203) 794-5300

HMIS
H: 3
F: 0
R: 0 (Liq.)
PPE*
*See Sect. 8

0 / 3 / 0 / OXY (Liquid)

R 1
I -
S 2 (Liquid)
K -

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Oxygen, CAS #7782-44-7	>99.5	No TLV Established.*

* The minimum oxygen content in workplace air is 18 % by volume (ACGIH 1985-86).

Note: Ambient air contains 21% O_2 by volume.

SECTION 3. PHYSICAL DATA

Boiling Point, 760 mm Hg ... -297.4°F (-183°C)
Vapor Presure @ -199°C, mm Hg ... ca 100
Vapor Density (Air = 1) ... 1.1
Solubility in Water, cm^3/100g, @ 25°C ... 3.16
Expansion Ratio, Liquid to Gas @ 70°F ... 1:860
Specific Gravity @ -183°C ... 1.14

Freezing Point ... -361.1°F (-218.4°C)
Viscosity, cpa, @ 25°C ... 0.0206
Critical Temperature ... -245°F (-118.38°C)
Critical Pressure, Atm ... 50.14
Molecular Weight ... 32.00

Appearance and odor: Colorless gas, bluish liquid, or blue solid with hexagonal crystals. Odorless and tasteless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Found	Not Found

EXTINGUISHING MEDIA: Stop flow if you can do so without risk. Use media that are appropriate to the surrounding fire. Immediately cool fire-exposed container, standing at a safe distance and using a water spray. If feasible, remove oxygen containers from fire area. Containers may explode in the heat of fire. Though not flammable itself, oxygen vigorously supports combustion. Materials that do not burn in air may burn in oxygen-enriched air. Materials can become spontaneously flammable at high oxygen levels. Oxygen released in a fire situation greatly increases fire and explosion hazards. (Oxygen cylinders are equipped with safety devices to release O_2 at excessive temperature or pressure.) Liquid oxygen can explode on contact with flammables. Do not direct water spray into liquid oxygen.

SECTION 5. REACTIVITY DATA

Oxygen is stable when kept isolated as a compressed gas in cylinders or as a cold liquid in vented, insulated containers. Stainless steel, aluminum, copper, and its alloys are useful materials for oxygen or liquid oxygen service. This material is an oxidizing agent that vigorously accelerates combustion. Oxygen will undergo highly exothermic reactions or explosions with many materials. The greater the concentration of O_2 in contact with a fuel or reducing agent, the greater the violence of the reaction. Air contains 21% oxygen; reactivity with environmental materials is substantially increased at above 23% oxygen by volume.

Oxygen reacts explosively with phosphine, hydrazine, hydrogen sulfide, ethers, alcohols, hydrocarbons, etc. Liquid oxygen mixed with powdered metals can be detonated. Red-hot steel burns in an oxygen atmosphere. This material is incompatible with oils, grease, lubricants, and flammable materials.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

SUMMARY OF RISKS: Adults can satisfactorily breathe pure oxygen for extended periods at 0.33 atm, or at 1 atm for several days at less than 5 hours a day. However, irritation to mucous membranes may occur when 100% oxygen is inhaled continuously for several hours. Chest pains and cough can result from breathing O_2 at 1 atm for 8 to 24 hours or 2 atm for 2 to 3 hours or from an atmosphere of 60% oxygen for several days. A variety of central nervous system effects can occur from breathing oxygen at partial pressures greater than 2 atm, including dizziness, impaired coordination, visual and hearing disturbances, and seizures. Contact with liquid oxygen can cause severe frostbite/freeze burns. Prolonged breathing of very cold atmospheres can produce lung damage. Prolonged exposure to cold areas can result in hypothermia.

PRIMARY ENTRY: Inhalation

FIRST AID: EYE AND SKIN CONTACT: Contact with liquid oxygen: Remove victim from the source of contact. Flush affected areas with lots of tepid water. (Do not apply direct heat to affected area!) Do not rub frozen area. Loosely apply dry, sterile, bulky dressings to protect area from infection/injury. Get medical help.* INHALATION: Get medical help for overexposure.* INGESTION: Get medical help.* HYPOTHERMIA: Remove victim to a warm (not hot) area. Remove contaminated clothing, if possible. Wrap him in blankets. Slowly restore his body temperature. Get medical help*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of significant leaks or spills. Evacuate all personnel from the danger area. Provide optimum exhaust ventilation. Shut off the source of the oxygen leak if you can do so without risk. Remove sources of heat, ignition and, if feasible, separate combustibles from the leak. Small leaks in an oxygen system in an enclosed, unventilated area can build up a hazardous oxygen level.

To increase the rate of controlled evaporation of spilled liquid oxygen (when desired), spray the spill with large amounts of water. (This may generate a fog and reduce visibility.)

DISPOSAL: Remove waste containers or leaking cylinders to an open outdoor area away from combustibles and allow the oxygen to discharge at a moderate rate. Tag a leaking cylinder to indicate a defect, close the valve, and return the cylinder to its supplier.

SECTION 8. SPECIAL PROTECTION INFORMATION

Where oxygen may be released, provide adequate ventilation to prevent excessive oxygen enrichment of the workplace atmosphere (holding at <23% O_2 by volume is recommended for fire safety). Personnel who have been exposed to high concentrations of oxygen should stay in a well-ventilated or open area for 15 minutes before going into a confined space or near an ignition source.

Workers handling liquid oxygen should wear safety glasses; clean, approved insulated gloves; and other approved protective clothing as required to prevent skin contact. (Gloves and protective clothing must be of material that is resistant to ignition on contact with liquid oxygen; leather gloves and safety shoes have been recommended.) Safety shoes and safety glasses are recommended when handling cylinders of compressed gas. Clothing that has been overexposed or contaminated with oxygen should be removed and considered unsafe (highly flammable) to wear for at least 30 minutes. If oxygen-enriched clothing catches fire, extinguish the flame under a safety shower; a fire blanket may not be effective in this situation. Use a continuous water spray to soak the clothing of a rescuer who must operate in an oxygen-enriched fire area.

Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store oxygen containers in a clean, cool, dry, well-ventilated, low fire-risk area, away from combustible materials and acetylene cylinders or other flammable gases or gas mixtures. Protect containers against physical damage. Follow general safety procedures for handling compressed-gas cylinders. Never expose any part of a cylinder to temperature above 125°F (51.5°C). Ground equipment to eliminate buildup of static charge. Make sure that containers of liquid oxygen are properly vented to prevent pressure buildup and that suitable materials are used to contact liquid oxygen and high-purity oxygen. Some materials are unsuitable for service at low temperatures because they become brittle and can be easily shattered by impact. Many materials are unsuitable for oxygen service; do not use oil or grease to lubricate the valves on oxygen cylinders.

DOT Classification: Nonflammable Gas UN1072 (Compressed Gas);UN1073 (Cryogenic Liquid)

Data Source(s) Code: 1, 2, 4-12, 17, 24, 25, 51, 63, 82, 84. CK

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

1

Approvals J. O. Acevedo 1/87.

Indust. Hygiene/Safety DJW 12-86

Medical Review [illegible]

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © April 1, 1986

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 73
Zinc Metal/Powder

Issued: 7/80 Revision: A, 11/89

Section 1. Material Identification

30

Zinc Metal/Powder Description: A metallic element extracted from ores which are first roasted to form zinc oxide and then: 1) the zinc oxide is leached from the roasted material with sulfuric acid to form a zinc sulfate solution which is electrolyzed in cells to deposit zinc on cathodes and 2) the zinc oxide is reduced with carbon in retorts (distilling vessels) to yield distilled and condensed zinc. Used as ingredient in alloys such as brass, bronze, and die-casting alloys; galvanizing sheet iron; for electrical apparatus, especially castings, building materials, dry cell batteries, automotive equipment, household utensils, railroad car linings; as a fungicide; in nutrition (essential growth element); as reagent in analytical chemistry; in bleaching bone glue, manufacturing sodium hydrosulfite, and insulin zinc salts.
Other Designations: Blue powder; spelter; granular zinc; jasad; merrillite; pasco; Zn; CAS No. 7440-66-6.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 1
S 1
K 1

NFPA

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

Section 2. Ingredients and Occupational Exposure Limits

Zinc metal/powder, ca 99%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
None established*	None established*	None established*	Human, inhalation, TC_{Lo}: 124 mg/m³/50 min, pulmonary system effects

* The current OSHA standard and ACGIH (1989-1990) TWA for zinc oxide (ZnO) fumes is 5 mg/m³. The ACGIH TWA for zinc oxide dust is 10 mg/m³, providing that total contains no asbestos and is <1% crystalline silica. NIOSH has recommended a 10-hr TWA of 5 mg/m³ and a ceiling level of 15 mg/m³ (15-min sample) for zinc oxide fume. The TLV-TWA level was set to prevent metal fume fever.
† See NIOSH, *RTECS* (ZG8600000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 907 °F (1663 °C)
Melting Point: 419 °F (787 °C)
Vapor Pressure: 1 mm Hg at 909 °F (487 °C)
Brinell Hardness: 31
Atomic Weight: 65.37 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.13 at 77 °F (25 °C)
Water Solubility: Insoluble
Index of Explosibility, Zn Powder (<0.1 weak, >10 severe): 0.1

Appearance and Odor: Bluish-white lustrous metal, also finely divided forms.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1256 °F (680 °C);* dust layer, 860 °F (460°C);* powder, 650 mJ*	LEL: Dust cloud explosion, 0.5 oz/ft³	UEL: None reported

Extinguishing Media: Use special dry chemical or clean dry sand. *Never* use CO_2. Using a direct stream of water may scatter the fire or disperse dust, creating a potentially explosive mixture if exposed to heat or ignition sources. A water spray may be used to cool fire-exposed containers and disperse vapors.
Unusual Fire or Explosion Hazards: Flammable hydrogen gas is liberated by reaction with alkali hydroxides (sodium, potassium, and calcium hydroxides), acids, or even water (when material is in dust form) and is an explosion hazard in a confined space. In a fire, zinc may melt, vaporize, and burn to form ZnO fumes (Sec. 2).
Special Fire-fighting Procedures: For major fires, or if large quantities of this material are involved, fire fighters should wear appropriate protective clothing and respiratory protection. Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Zinc dust refers to the product of zinc vapor condensation, and zinc powder to the product of molten zinc atomization (*Zinc Dust and Zinc Powder: Their Production, Properties, and Applications*, B.C. Hafford, W.E. Pepper, and T.B. Lloyd, 1982). Dust 100% thru 74-µm sieve; a 0.96-J spark can ignite a cloud. The ignition temperature in CO_2 is 896 °F (480 °C). The reaction temperature in a nitrogen atmosphere is 1112 °F (600 °C).

Section 5. Reactivity Data

Stability/Polymerization: Zinc is stable in dry air at room temperature. Moist zinc dust can react exothermically and ignite spontaneously in air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Zinc dust is an explosion hazard when reacted with acids, chlorates, oxidizing agents (sulfur and oxygen), halogenated hydrocarbons, hydrazine mononitrate, hydroxylamine, ammonium nitrate, barium dioxide, barium nitrate, cadmium, performic acid, manganese chloride, nitric acid, ethyl acetoacetate and tribromoneopentyl alcohol, tellurium, carbon disulfide, lead azide, magnesium and barium nitrate and barium dioxide, selenium, sodium peroxide, potassium nitrate, and water. In humans, a toxic effect results from inhaling 124 mg/m³ of zinc metal/powder for 50 min.
Hazardous Products of Decomposition: Thermal oxidative decomposition of zinc can produce highly toxic fumes. Above 999 °F (537 °C) vaporized zinc burns in air with a blue-green flame to produce zinc oxide fumes.

Copyright © 1989 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists zinc as a carcinogen.
Summary of Risks: Zinc is relatively nontoxic, but when combined with other materials such as oxygen or mineral acids, the resulting compounds can have toxic effects. It is not readily absorbed through the skin, gastrointestinal (GI tract), or lungs. Although most inorganic zinc compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Zinc is considered essential to life. Ingestion of soluble salts may cause nausea and vomiting, sluggishness, and light-headedness. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause *metal fume fever*, which is accompanied by throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching that generally passes within 24 hr. These symptoms usually begin 3 to 10 hr after exposure and resolve within 24 to 48 hr. Inhalation of zinc dust may cause mild irritation to the upper respiratory tract. Prolonged skin contact with zinc may cause a mild, drying dermatitis.
Medical Conditions Aggravated by Long-Term Exposure: Since metallic zinc particulates can be considered a niusance dust, repeated inhalation of zinc dust could lead to respiratory complications.
Target Organs: Respiratory system.
Primary Entry: Inhalation, ingestion.
Acute Effects: Metal fume fever is an acute, self-limiting condition, without recognized complications, aftereffects, or chronic forms. Symptoms appear several hours after exposure. Removal from exposure normally alleviates symptoms with no residual or chronic effects. A degree of tolerance may result from continued exposure, but is quickly lost after a day or two of nonexposure.
Chronic Effects: Zinc and zinc powder have little history of causing chronic effects.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. **Physician's Note:** Calcium disodium edetate ($CaNa_2$-EDTA) has been used medically to increase the rate of zinc removal from the body; however, this usually results from chronic fume exposure or exposure to zinc salts, not to zinc metal powders.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Eliminate all heat and ignition sources. Cleanup personnel should protect against dust inhalation and eye contact. Use nonsparking tools for cleanup. Sweep or otherwise place the spilled material in an appropriate, pressure-vented, dry-metal container (with lid) for later disposal. Container should be pressure vented. Avoid creating airborne dust conditions.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Zinc (fume or dust) is listed as SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: For zinc oxide dust or fume concentrations up to 50 mg/m^3 and 250 mg/m^3, use, respectively, a fume (high-efficiency particulate) respirator or an air-supplied or self-contained respirator with a full facepiece. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below established TLVs-TWAs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. Wash thoroughly before changing to street clothes.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in covered metal containers in a dry, well-ventilated, low fire risk area. Protect containers from physical damage. Never store with acids, halogenated hydrocarbons, or strong alkalis.
Engineering Controls: Avoid breathing dust or fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide suitable training in personal hygiene and in the cause and effect of metal fume fever. Prevent exposure of workers with respiratory problems or gastrointestinal disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Zinc, powder or dust, nonpyrophoric	**IMO Shipping Name:** Zinc, powder or dust, pyrophoric
IMO Hazard Class: 4.3	**IMO Hazard Class:** 4.2
IMO Label: Dangerous when wet	**IMO Label:** Spontaneously combustible
IMDG Packaging Group: II	**IMDG Packaging Group:** II

MSDS Collection **References:** 2, 4-11, 24, 31, 39-41, 80, 81,84,85,91, 109
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 74
Tin Metal/Powder

Issued: 9/80 Revision: A, 11/89

Section 1. Material Identification 30

Tin Metal/Powder Description: A metallic element recovered from a naturally occurring ore (cassiterite) by: 1) smelting in an electric furnace, or 2) roasting the ore to remove arsine and oxidize sulfates, then reducing with coal in a reverberatory furnace (heat is radiated from the roof). Used chiefly for tin-plating, soldering alloys, manufacturing tin salts; in collapsible tubes, tinned wire, chemicals, and babbitt metal; as anodes for electrotin plating, dental amalgams, corrosion-resistant coatings, and low-melting alloys for fire control.

Other Designations: Gray tin (α); white tin (β); silver matt powder; tin flake; tin powder; Sn; CAS No. 7440-31-5.

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

R 1
I 2
S 1
K 1

Genium

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

Section 2. Ingredients and Occupational Exposure Limits

Tin,* ca 99.8%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data
None established	TLV-TWA: 2 mg/m^3	None established	Rat, implant, TD_{Lo}: 395 g/kg Mouse, implant, TD_{Lo}: 840 g/kg

Section 3. Physical Data

Boiling Point: 4545 °F (2507 °C)
Melting Point: 449.4 °F (231.9 °C)
Vapor Pressure: 1 mm Hg at 2718 °F (1492 °C)
Atomic Weight: 118.71 g/mol

Specific Gravity (H_2O = 1 at 39 °F (4 °C)): α–form (gray tin) : 7.31
Water Solubility, hot water: Slight
cold water: Insoluble

Appearance and Odor: Silver-white, lustrous, ductile metal, also in powdered form.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1166 °F (630 °C); dust layer, 806 °F (430 °C)	LEL: 0.19 oz/ft^3	UEL: None reported

Extinguishing Media: Dry sand, graphite, dolomite, sodium chloride. *Never* use water, halogenated agents, or class A, B, or C extinguishers.

Unusual Fire or Explosion Hazards; When exposed to heat or ignition sources, powdered tin is a moderate fire and explosion hazard. Particle size and dispersion in air determine reactivity.

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

* Ninety-eight percent of dust goes through a 74-μm sieve. A 0.080-J spark can ignite a tin dust cloud. Its ignition temperature in nitrogen is 1652 °F (900 °C) and its reaction temperature in carbon dioxide is 1328 °F (720 °C).

Section 5. Reactivity Data

Stability/Polymerization: Tin is stable at room temperature, but its powder oxidizes (especially in the presence of moisture). Hazardous polymerization cannot occur.

Chemical Incompatibilities: Tin is incompatible with halogens, cupric nitrate, sodium and potassium peroxide. It can produce incandescence with sulfur. Tin reacts slowly with cold dilute hydrochloric (HCl), dilute nitric (HNO_3), hot dilute hydrosulfuric acids (H_2SO_4); readily with concentrated HCl and aqua regia; and very slowly with acetic acid. Oxidizing salt solutions that dissolve tin are potassium peroxysulfate, ferric chloride and sulfate, and aluminum and stannic chlorides.

Conditions to Avoid: Tin dust is combustible when exposed to heat or by spontaneous chemical reaction with bromine (Br_2), potassium dioxide (K_2O_2), bromine trifluoride (BrF_3), copper nitrate ($Cu(NO_3)$), or chlorine trifluoride (ClF_3).

Copyright © 1989 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists tin as a carcinogen.
Summary of Risks: Elemental tin has low toxicity, but most of its compounds are toxic. Chronic exposure to tin dust or tin fumes (oxide) may cause a mild, entirely asymptomatic, benign pneumoconiosis (known as stannosis). Early diagnosis is possible with a chest x-ray since tin is readily radio-opaque. Tin deposits in lungs may not alter function; and reports indicate that dust exposures cause no massive fibrosis, disability, or special complicating factors. Tin is poorly absorbed from the alimentary canal. Tin compounds may cause local irritation to the eyes, nose, and skin. However, tin salts in the blood stream are highly toxic and produce paralysis and other neurologic damage.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Lungs.
Primary Entry: Inhalation.
Acute Effects: Exposure to tin fumes may cause "metal fume fever," a flu-like syndrome characterized by fever, cough, fatigue, and muscle ache. Symptoms usually resolve within 48 hr of onset.
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Remove heat and ignition sources and minimize airborne dust.
Disposal: Tin is a valuable scrap metal. Recovered particulates from an electrostatic precipitator are recyclable. Waste slag (inert and insoluble) may be buried in an approved landfill. Maximum concentration of tin discharge to waterways is 2.0 ppm. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Tin (organic and inorganic compounds, except oxides) is listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in a dry, well-ventilated, low fire-risk area. Avoid heat and ignition sources. Store tin powder in a closed container.
Engineering Controls: Avoid breathing tin dust or its fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide employee training and both preplacement and periodic medical examinations for those regularly exposed to tin and tin compounds, with emphasis directed toward chest x-ray (Sec. 2).
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 1, 2, 4-7, 9-12, 40-42, 80, 81, 84, 88, 89, 100, 124, 126
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M8

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 80

THALLIUM METAL
(Revision A)
Issued: December 1980
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: THALLIUM METAL

Description (Origin/Uses): Used in semiconductor research; also alloyed with mercury for the manufacture of switches and closures that operate at subzero temperatures.

Other Designations: Tl; NIOSH *RTECS* No. XG3425000; CAS No. 7440-28-0

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

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

Not Found

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

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Thallium Metal, CAS No. 7440-28-0	Ca 100	IDLH* Level: 20 mg/m³ (Soluble Compounds) **OSHA PEL (Skin**)** 8-Hr TWA:*** 0.1 mg/m³ **ACGIH TLV, 1987-88** TLV-TWA:*** 0.1 mg/m³ **Toxicity Data**** Man, Oral, TD_{Lo}: 5.714 mg/kg

*Immediately dangerous to life and health (soluble).
**This material or its salts can be absorbed through intact skin, which contributes to overall exposure.
***Exposure limit defined for soluble thallium compounds as Tl.
****See NIOSH, *RTECS*, for additional data.

SECTION 3. PHYSICAL DATA

Boiling Point: 2655°F (1457°C)
Melting Point: 579°F (304°C)
Specific Gravity (H_2O = 1): 11.85
Water Solubility (%): Insoluble
Molecular Weight: 204 Grams/Mole

Appearance and Odor: A bluish white, very soft, easily fusible heavy metal; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

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

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

Unusual Fire or Explosion Hazards: Thallium metal dust particles suspended in the air can explode. If a thallium dust cloud forms, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and spray the area with a water mist or fog. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workplace.

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

SECTION 5. REACTIVITY DATA

Thallium metal is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. In air, a poisonous coating of thallium oxide (Tl_2O) can develop on the exposed surface of thallium metal.

Chemical Incompatibilities: This material reacts violently with fluorine.

Conditions to Avoid: Prevent contact with fluorine. Avoid exposure to sources of ignition such as open flame, sparks, and lighted tobacco products.

Hazardous Products of Decomposition: During fires thallium can form thallium oxide.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

Summary of Risks: Thallium is a cumulative poison. It or its salts can be absorbed through intact skin; if they are ingested they are rapidly absorbed by the gastrointestinal (GI) tract. Thallium acts as a mitotic (affecting cell division) agent and a general cellular poison. Acute poisoning chiefly affects the central nervous system (CNS) and the GI tract. The ingestion of soluble thallium salts causes more serious effects than the ingestion of the pure metal. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the CNS, GI tract, kidneys, liver, and eyes may be worsened by exposure to thallium. Administer preplacement and periodic medical exams emphasizing these organs' functions. **Target Organs:** Eyes, CNS, lungs, liver, kidneys, GI tract. **Primary Entry:** Skin absorption or contact, inhalation. **Acute Effects:** Nausea, vomiting, diarrhea, tingling or pain in the extremities, weakness, coma, convulsions, and death. **Chronic Effects:** Weakness, pain in the extremities (polyneuritis); loss of hair (alopecia, the most visible sign); and disorders of the cardiac, renal, and endocrine systems. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased hazard from absorption. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. **Ingestion.** *Treat as an emergency.* Never give anything by mouth to someone who is unconscious or convulsing. If the exposed person is responsive, give him or her several glasses of milk or water to drink and then induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. The treatment recommended in Genium reference 100 (p. 529) includes the following: Maintain fluid and electrolytic balance; administer potassium chloride to replace thallium intracellularly; and use hemoperfusion and hemodialysis as warranted by the specifics of the incident. Various chelating therapies have been recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

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

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for soluble thallium compounds as Tl)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Listed without Number

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

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

Other: Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. Barrier creams may be useful to limit the effects of skin contact.

Ventilation: Install and operate general and local ventilation systems powerful enough to maintain airborne levels of thallium below the OSHA PEL standard cited in section 2.

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

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

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

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store thallium metal in a cool, dry, well-ventilated area in closed containers away from oxidizing agents, fluorine, and sources of ignition.

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

Transportation Data (49 CFR 172.101-2):

DOT Shipping Name: Thallium Salt, Solid, NOS **DOT Label:** Poison **IMO Label:** Poison or St. Andrew's Cross (X)*

DOT ID Nos. UN1707; NA1707 **DOT CLass:** Poison B **IMO Class:** 6.1

*Harmful-Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

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

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 100
Aluminum Metal/Powder

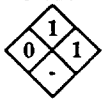
Issued: 12/81 Revision: B, 4/90

Section 1. Material Identification

Aluminum Metal/Powder Description: The primary sources of aluminum are the ores cryolite and bauxite. Produced by electrolysis of bauxite in a bath of molten cryolite, or made synthetically from fluorspar. As pure metal or as alloys, aluminum is used for aircraft, building and construction materials, die-cast auto parts, highway products, permanent magnets, photoengraving plates, corrosion-resistant chemical equipment, machinery and accessory equipment, and electrical conductors; tubes for ointments, toothpaste, and shaving cream; containers and flexible packaging; in dental alloys, manufacturing printing inks; testing for gold, arsenic, and mercury; the jewelry industry; as reducers for determining nitrates and nitrites; for precipitating copper and coagulating colloidal solutions of arsenic or antimony; and in the manufacture of aluminum powder for aluminum paints, explosives, fireworks, flashlights in photography, and for absorbing occluded gases in the manufacture of steel.
Other Designations: CAS No. 7429-90-5; Al; alumina fibre; aluminum flake; aluminum dehydrated; metana aluminum paste.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2
K 1

NFPA



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

Section 2. Ingredients and Occupational Exposure Limits

Aluminum metal/powder, ca 100%*

OSHA PELs
8-hr TWA: 5 mg/m³ (respirable fraction, pyro powders, welding fumes)
8-hr TWA: 15 mg/m³ (total dust)

ACGIH TLVs, 1989-90
TLV-TWA: 5 mg/m³ (pyro powders, welding fumes)
TLV-TWA: 10 mg/m³ (metal dust)

NIOSH REL, 1987
None established
Toxicity Data†
None reported

* Since commercially "pure" Al may contain up to 1% iron (Fe), silicon (Si), and copper (Cu), exposure may also be to a mixture of these and other materials.
† Monitor NIOSH, *RTECS* (BD0330000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 4221 °F/2327 °C
Melting Point: 1220 °F/660 °C
Vapor Pressure: 1 mm Hg at 2343 °F/1284 °C
Molecular Weight: 26.98 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 2.70
Water Solubility: Insoluble in hot and cold water

Appearance and Odor: Silvery-white, metallic solid, foil, particulate. No odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: 1202 °F/650 °C (cloud); 1440 °F/760 °C (dust layer)*	LEL: >0.04 oz/ft³	UEL: None reported

Extinguishing Media: If possible, isolate and permit large fires to burn out while controlling smaller fires with sand, talc, or sodium chloride. Use nonsparking tools to ring small fires. *Do not use water, carbon tetrachloride (CCl_4), or halon!* A mixture of aluminum powder and water slowly forms hydrogen that can be hazardous if confined.
Unusual Fire or Explosion Hazards: Bulk aluminum is not combustible, but powdered aluminum can be a severe fire and explosion hazard when exposed to heat and ignition sources or by chemical reaction with powerful oxidizers. Aluminum forms explosive mixtures in air. When bulk dust is damp, it may heat spontaneously. Particles size, coating, and dispersion in air determine reactivity. The hazard increases with fineness.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Evacuate all unnecessary personnel upwind and isolate hazard area. Prevent dust clouds and eliminate drafts. Cool exposed containers with water, but be careful not to get water inside container. Be aware of runoff from fire control methods. Runoff to sewers may cause fire, explosion hazard, or pollution. Do not release to sewers or waterways.

* One hundred percent of dust goes through a 44-µm sieve. A 0.05-J spark can ignite an Al dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Stable at room temperature in closed containers under normal storage and handling conditions, aluminum corrodes rapidly in contact with other metals since it is strongly electropositive. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Aluminum is incompatible with perchlorate/nitrate/water mixtures, powdered silver chloride, ammonium peroxodisulfate + water, peroxides, halocarbons, halogens, acids, hydrogen chloride gas, molten silicon steels, phosphorus, sulfur, selenium, interhalogens, oxidants, perchlorate salts, and chlorates. Potentially explosive reaction with carbon tetrachloride during ball milling operations with chloroform amidinium nitrate, and sodium acetylide. Violent or explosive 'thermite' reaction when heated with metal oxides, oxosalts (nitrates, sulfates), or sulfides; hot copper oxide worked with an iron or steel tool; or with antimony, arsenic, and anitmony trichloride vapor. An explosive reaction (above 1472 °F/600 °C) of Al with iron powder + water releases explosive hydrogen gas; interaction with sodium hydroxide also releases explosive hydrogen gas; and a violent exothermic reaction occurs above (1112 °F/600 °C) with sodium diuranate. Al reacts with diborane to form a pyrophoric product. Bulk Al may undergo dangerous interactions with alcohols. Reaction with arseneic trioxide + sodium arsenate + sodium hydroxide produces the toxic arsine gas.
Hazardous Products of Decomposition: Inhalation of metallic oxide smoke (Al_2O_3) at 15 mg/m³ or greater can cause "metal fume fever."

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists aluminum as a carcinogen.
Summary of Risks: Its powder and dust are the most dangerous forms. Most hazardous exposures to aluminum occur in refining and smelting processes. Aluminum dust is a respiratory and eye irritant. Lung fibrosis is reported in aluminum welders and polishers, aluminum smelting (potroom) workers, and in workers involved in manufacturing alumina abrasives or explosives from stamped aluminum powders. A single case was reported of fibrosis occuring with encephalopathy (alterations of the brain's structure) after 13.5 years of working with fine powder. Death resulted from bronchopneumonia following progressive encephalopathy. Particles of aluminum deposited in the eye may cause necrosis (localized tissue death) of the cornea. Repeated aluminum contact with skin has been associated with skin telangiectases (bleeding into the tissues and mucous surfaces because of the abnormal fragility and dilatation of the capillary vessels and arterioles), delayed hypersensitivity, and granulomas. Acroanesthesia (numbness of the fingers) is reported in cotton mill operations where there is long contact with wet Al during bobbin winding. Mortality analysis of Al production workers showed malignant tumors of the nervous system, cancer of the pancreas, bronchus, and lung, and leukemia, especially in potroom workers.
Medical Conditions Aggravated by Long -Term Exposure: Symptoms of long-term overexposure are weakness, cough, and shortness of breath with generalized interstitial fibrosis and emphysema.
Target Organs: Respiratory tract, eyes, skin.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Signs and symptoms of inhalation of aluminum powder or dust are dyspnea, cough, lethargy, anorexia, and an increased respiration rate.
Chronic Effects: Chronic inhalation of aluminum dust is associated with pulmonary fibrosis, asthma, emphysema, dyspnea, cough, and chronic obstructive lung disease.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water. For cuts, abrasive irritation or thermal burns, get medical attention.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Since aluminum is poorly absorbed through the gastrointestinal tract, vomiting is seldom necessary. However, if large amounts of aluminum are ingested, contact a physician.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Chronic exposure may lead to fibrosis with large bleb formation and risk of spontaneous pnuemothorax.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice an aluminum powder spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel upwind and remove all heat and ignition sources. Cleanup personnel must use protection against airborne dust and threat of fire. Promptly clean spill using conductive, nonsparking scoops and soft brushes with natural bristles. Use approved, grounded vacuum cleaners only in final cleanup. Place powder in closed, pressure-vented, dry, metal containers. Mix dry sand with scrap and tightly seal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Use tight-weave, nonstatic generating, protective clothing (no metallic fasteners, cuffs, or pockets) and nonsparking safety shoes when working with Al powder. Special protective clothing is needed to work with hot or molten aluminum.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in sealed containers in a dry, low fire risk area away from all heat and ignition sources, oxidizing agents, combustibles, acids, alkalis, halogens, carbon disulfide, halogenated hydrocarbons, and all other incompatible materials (Sec. 5). Protect containers from physical damage; exclude moisture and humid air.
Engineering Controls: Avoid generation of airborne dust. Use good housekeeping to prevent dust accumulation. Electrically ground and bond all equipment used with aluminum metal powder. Give preemployment and periodic medical examinations, with particular emphasis on the skin, eyes, and lungs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Aluminum metallic, powder
DOT Hazard Class: Flammable solid
ID No.: UN1396
DOT Label: Flammable solid
DOT Packaging Requirements: 173.232
DOT Packaging Exceptions: 173.232

MSDS Collection **References:** 2, 4-11, 14-20, 26, 37, 38, 41, 73, 84, 85, 87, 89, 100, 103, 109, 124, 126, 127, 133
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 124
Vanadium Metal/Powder

Issued: 10/83 Revision: A, 11/90

Section 1. Material Identification

Vanadium Metal/Powder (V) Description: Occurs ubiquitously in the earth's crust. Its principle ores are patronite, roscoelite, carnolite, and vanadinite. There are more than 65 different vanadium-containing ores. Also found in crude petroleum, in flue-gas deposits from oil-fired furnaces, or in slags from ferrovanadium production. Vanadium production includes roasting ores and electrolytic refining using a molten salt electrolyte containing vanadium chloride. Used to manufacture rust-resistant vanadium steel, alloy steels, vanadium compounds; as a target material for x-rays; and as a catalyst for sulfuric acid and synthetic rubber.

Other Designations: CAS No. 7440-62-2

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

Cautions: Vanadium is a primary irritant of the mucous membranes of the respiratory tract and the conjunctiva (eye).

R 0
I 4
S 1
K 0

Genium

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

Section 2. Ingredients and Occupational Exposure Limits

Vanadium, ca 100%

1989 OSHA PEL
Vanadium, as V_2O_5, Respirable Dust and Fume
8-hr TWA: 0.05 mg/m³

1990-91 ACGIH TLV
Vanadium, as V_2O_5, Respirable Dust and Fume
TWA: 0.05 mg/m³

1985-86 Toxicity Data*
Human, inhalation, TD_{Lo}: 4 µg/kg; affected the lungs, thorax, or respiration (sputum, cough); and sense organs and special senses (changes in circulation)

1987 IDLH Level
Vanadium Pentoxide Dust or Fume (as V)
70 mg/m³

1988 NIOSH REL
Vanadium, as V_2O_5, Respirable Dust and Fume
15-min Ceiling: 0.05 mg/m³

* Monitor NIOSH, *RTECS* (YW1630000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 6116 °F (3380 °C)
Melting Point: 3434 + 10 °F (1890 + 10 °C)
Vapor Pressure: 1.5 mm Hg at 4172 °F (2300 °C)
Atomic Weight: 50.92
Specific Gravity: 5.96
Water Solubility: Insoluble in hot or cold water

Appearance and Odor: Light gray powder or white, lustrous bulk solid; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature:* layer 914 °F (490 °C), cloud 932 °F (500 °C)	LEL: 0.22 oz/ft³*	UEL: None reported

Extinguishing Media: Use dry chemical powder or CO_2 to extinguish a metal fire.

Unusual Fire or Explosion Hazards: Very hot vanadium can burn in air. When dispersed in air as dust, it can be exploded by an ignition source.* However, it has a low explosibility index (0.1) and low ignition sensitivity (0.3) on a scale of 10.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective gear. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

* Vanadium metal dust whose particle size is 100% below 75 µm. Reported minimum ignition energy is 60 mJ for dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Vanadium is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Massive metal is relatively inert to O_2, N_2, H_2, and H_2O at ambient conditions, but vanadium reacts when heated, and still more readily if powdered. When heated in air, vanadium oxidizes to brownish-black trioxide, blue-black tetroxide or yellow-red pentoxide, depending on temperature.

Chemical Incompatibilities: Vanadium is incompatible with bromine trifluoride, chlorine, nitryl fluoride, lithium, and oxidants. Some samples of vanadium prepared by magnesium reduction of vanadium dichloride or vanadium trichloride are pyrophoric (ignite spontaneously).

Conditions to Avoid: Avoid creating airborne dusty conditions.

Hazardous Products of Decomposition: Thermal oxidative decomposition of vanadium can produce toxic fumes of vanadium oxides (VO_x).

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list vanadium metal powder as a carcinogen.
Summary of Risks: Elemental vanadium is considered relatively nontoxic and the risks noted in mining operations are usually limited. However, toxic vanadium compounds form easily with the addtion of heat, and may be present in many occupational settings. Vanadium compounds are very irritating to mucous membranes including the respiratory tract. Although no specific lesions are noted, inflammation of all portions of the airways, as well as pulmonary edema, pneumonia, and emphysema are described. The presence of vanadium compounds in areas where residue from the burning of fuel oil may accumulate presents particular problems with unrecognized risk.
Medical Conditions Aggravated by Long-Term Exposure: No permanent effects are reported, but respiratory symptoms may persist for years.
Target Organs: Respiratory system, skin, and eyes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: *Skin*: eczema-like reaction with intense itching. Sensitization or generalized hives may occur. Green discoloration of the hands and groin area is noted. *Eyes*: severe irritation with burning and tearing may occur. *Airway*: nasal congestion, throat irritation, dry mouth, green discoloration of the tongue, metallic taste, coughing, bronchitis, pneumonia, chest pain, and pulmonary edema are noted. *Cardiovascular*: constriction of blood supply to the lungs, spleen, kidneys, and intestines. *CNS*: headaches, decreased constriction mentation in severe exposures. *GI*: diarrhea, black stools, cramping.
Chronic Effects: The lung effects may last up to two weeks following exposure. Skin and tongue discoloration may develop gradually.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Notes to Physician: Include diagnostic tests such as vanadium in urine (normal <1 μg/g creatine), patch (eczema), and pulmonary function (FEV_1 and FVC).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For concentrations less than or equal to 70 mg/m^3, use a powered air-purifying respirator with full facepiece and high-efficiency particulate filter. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks) or concentrations >70 mg/m^3, wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations just below the exposure limits (Sec. 2). Exhaust ventilation systems discharging to outside air must conform with applicable local, state, and federal air pollution regulations. Ventilation systems need to be cleaned and their effectiveness tested with airflow measurements taken at least every 3 months. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area. Protect containers from damage. Use good housekeeping practices to prevent accumulation of dust and follow cleaning techniques that minimize airborne particulate.
Engineering Controls: Avoid dust, vapor, or fume inhalation when generated. Prevent contact with eyes and skin. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and periodical medical examinations that emphasize the eyes, skin, and lungs. For biological monitoring of exposed workers use urinary vanadium excretion. Include pulmonary function tests in periodical medical examinations.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 2-10, 12, 14, 20, 26, 40, 41, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

MSDS # N 144
CADMIUM CHLORIDE, ANHYDROUS

Issued: August, 1985
Revised:

From Genium's MSDS Collection, to be used as a reference.

SECTION 1. MATERIAL IDENTIFICATION

17

MATERIAL NAME: CADMIUM CHLORIDE, ANHYDROUS*
OTHER DESIGNATIONS: Cadmium Dichloride, $CdCl_2$, CAS #10108-64-2
SUPPLIER: Available from several suppliers, including:
J.T. Baker Chemical Co.
222 Red School Lane
Phillipsburg, NJ 08865 Phone: (201) 859-2151
* NOTE: This material is also available in hydrated form, commonly $CdCl_2 \cdot 2\frac{1}{2}H_2O$

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
CADMIUM CHLORIDE, $CdCl_2$	99%	ACGIH TLV: 8 hr TWA: 0.05 mg/m^3*
* Current (1985-86) TLV for Cadmium dust & salts, as Cd ** Current OSHA PELs for Cadmium dust, as Cd The NIOSH recommended TWA (10 hr.) and ceiling concentrations for Cadmium (as Cd) are 0.04 mg/m^3 and 0.2 mg/m^3, respectively.		OSHA PEL**: 8 hr TWA: 0.2 mg/m^3 Ceiling = 0.6 mg/m^3
		Oral, rat: LD50: 88 mg/kg
		Oral, mouse LD50: 60 mg/kg
		Inhalation, dog: LC90: 420 mg/m^3/30 min.

SECTION 3. PHYSICAL DATA

Melting point 1054°F (568°C) ~~568°F (1054°C)~~
Boiling point 1760°F (960°C) ~~960°F (1760°C)~~
Specific gravity @ 25°C 4.05
pH of 5% solution @ 25°C ... 5.5-6.5

Solubility in water, g/100cc
@ 20°C 140
@ 100°C 150
Molecular weight 183.3

APPEARANCE & ODOR: Fine white crystals. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
N/A	N/A	N/A		

EXTINGUISHING AGENT: This material is not combustible. Use extinguishing agents suitable for the surrounding fire.

Firefighters should wear full protective gear including a self-contained breathing apparatus to prevent inhalation of dust, mists and fumes.

SECTION 5. REACTIVITY DATA

This material is stable under normal conditions of use and handling. It is soluble in water and slightly soluble (1.52 g/100cc) in alcohol. It is insoluble in acetone and ether.

$CdCl_2$ does not undergo hazardous polymerization. Toxic fumes (CdO) may be evolved under extreme fire conditions.

Copyright © on issue date, Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

TLV See Section 2

$CdCl_2$ is toxic by ingestion and inhalation. Acute inhalation exposure to excessive concentrations of Cd may result in irritation of the respiratory tract, cough, dyspnea, chest pain, fever and chills, and in severe cases, pulmonary edema. The onset of these symptoms may not appear until several hours after the exposure. These effects have been observed primarily in workers exposed to cadmium fumes. The primary effects of chronic exposure to cadmium containing dust are pulmonary emphysema and changes in kidney function. The renal dysfunction is characterized initially by urinary excretion of proteins, particularly low molecular weight proteins. Ingestion of $CdCl_2$ can cause excessive salivation, nausea, persistent vomiting, diarrhea, and abdominal pain. Liver and kidney injury may occur. Symptoms of Cd poisoning can occur on ingestion of as little as 10-15mg. In a 1984 Current Intelligence Bulletin (#42), NIOSH recommends that Cd and its compounds be regarded as "potential carcinogens" based partly on evidence that inhalation of $CdCl_2$ produced lung tumors in rats. The IARC also identifies Cd compounds, including $CdCl_2$, as suspect carcinogens.
FIRST AID: EYE CONTACT: Flush eyes with large amount of running water. Obtain medical attention (Inplant, paramedic, community). SKIN CONTACT: Promptly wash contaminated area with soap and water. Seek medical attention if irritation develops. INHALATION: Remove person to fresh air. If necessary, aid/restore breathing. Get prompt medical assistance. INGESTION: If person is conscious, drink large quantities of water/milk immediately, then induce vomiting (vomiting may occur spontaneously). Get medical assistance immediately!!!

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety/environmental personnel of large spills. Ventilate spill area. Clean-up personnel should wear respiratory protective equipment and protective clothing. Carefully pick up spilled material in a manner which minimizes dust generation, such as vacuuming. Small spills of aqueous solutions may be covered with soda ash or sodium bicarbonate and the resulting slurry scooped into a suitable container for reclaim or disposal. Prevent release to drains and waterways.
DISPOSAL: Reclaim scrap material when possible. Unsalvageable waste requires disposal as a hazardous waste in an approved chemical waste landfill. Contact supplier or a licensed chemical waste disposer for treatment/disposal instructions. Follow Local, State and Federal regulations.
EPA HAZARDOUS WASTE NUMBER: D006 (EP Toxicity, 40 CFR 261.24)
REPORTABLE SPILL QUANTITY: 100 lbs/45.4 kg (40 CFR 117)

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation to meet the TLV requirements wherever cadmium chloride dust may be generated. Where exposures are or may be above the TLV, workers should wear NIOSH-approved respiratory protection appropriate for the level of exposure.
Avoid eye contact by wearing dust-resistant safety goggles where dusty conditions exist. Wear protective clothing appropriate for the work situation to avoid skin contamination. Showering after work, with a complete change of street clothes, is desirable if contamination is likely. Contaminated clothing should be laundered before reuse.
Eyewash stations and washing facilities should be readily accessible.

Contact lenses pose a special hazard; soft lenses absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers in a dry location. Protect containers from physical damage. Use with adequate ventilation. Maintain good housekeeping practices to prevent accumulation of dust. Use procedures that minimize dust generation. Follow good hygiene practice. Wash thoroughly after handling and before eating or smoking and after each workshift. Do not eat, drink or smoke in areas where cadmium chloride is handled.
In addition to preplacement and periodic medical exams, recommended medical surveillance procedures include urinary cadmium and protein determinations and pulmonary function testing.
DO NOT INGEST! AVOID INHALATION AND SKIN/EYE CONTACT!
DOT CLASSIFICATION: ORM-E
DOT ID NO.: NA 2570
DATA SOURCE(S) CODE (See Glossary) 2, 4, 11, 12, 14, 19, 27, 30, 44, 49, 58, 61.V.

Judgements as to the suitablity of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitablity of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS JO Accrocco 11/85
INDUST. HYGIENE/SAFETY 11-85
MEDICAL REVIEW: Dec 85

 Copyright © August 1, 1985

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 148
Manganese Metal/Powder

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

Section 1. Material Identification 30

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

R 1
I 3
S 1
K -

Genium

HMIS
H 3
F 2
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Manganese, ca 100%

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

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

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

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

Section 3. Physical Data

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

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

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

Section 4. Fire and Explosion Data

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

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

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

Section 5. Reactivity Data

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

Copyright © 1989 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists manganese as a carcinogen.
Summary of Risks: Although an essential element for man, manganese is also toxic to humans in several ways. Acute or chronic manganese poisoning can result from excessive inhalation or ingestion. The immune system reacts to acute exposures with "metal fume fever," characterized by: fever, chills, nausea, weakness, body aches, frontal headache, occasional blurred vision, low back pain, muscle cramping, shallow respiration, throat dryness and irritation, a dry cough, a sweet or metallic taste, and chest tightness occurring over several hours. Progressive and permanent injury can result from chronic, untreated Mn poisoning. Its most notable effects are the neurological disorders caused by its ability to inhibit the chemical transmission of electrical impulses in the central nervous system. The lungs may become inflammed (manganese pneumonititis), as reported in workers exposed to manganese ores and compounds. Sufficient evidence proves that in several species, manganese is embryolethal at toxic doses. Impotence is a common symptom in grossly contaminated men.
Medical Conditions Aggravated by Long-Term Exposure: Degenerative brain changes, muscle weakness, change in motor activity.
Target Organs: Central nervous system (CNS), respiratory system, kidneys, blood.
Primary Entry: Inhalation, ingestion.
Acute Effects: High-concentration exposures may cause metal fume fever, with its onset occurring over several hours. Inhalation of large concentrations may cause managanese pneumonitis. This material is a skin and eye irritant leading to dermatitis, conjunctivitis, and corneal damage.
Chronic Effects: Exposure to manganese fume over 6 months to 2 years may harm the central nervous system, with symptoms progressing from headache, restless sleep or sleepiness, personality changes, irritability and inappropriate laughing or crying to visual hallucinations, double vision, uncontrolled impulse behavior, euphoria, and to abnormal reaction to painful stimuli, excess salivation, trembling in the extremities and head, impaired walking, and other signs similar to Parkinson's disease.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Remove heat and ignition sources. Ventilate spill area. Cleanup personnel should wear appropriate respiratory protective equipment. Carefully scoop spilled material, avoiding dust generation, into a suitable salvage container.
Disposal: Return scrap material to supplier or processor for recovery. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Wear a NIOSH-approved respirator where airborne concentrations exceed the ceiling limit. Fume or high-efficiency particulate filter respirators are acceptable for concentrations up to 50 mg/m^3 (250 mg/m^3 with full facepiece). Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA, ACGIH, and NIOSH standards. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). Consider the dust explosion potential of finely divided Mn powder when designing exhaust ventilation systems and other process equipment to contain heavily dust-laden air.
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from ignition sources, acids, alkali, and other incompatible materials. Protect containers from physical damage.
Engineering Controls: Use with adequate ventilation. Avoid breathing dust and fumes. Maintain good housekeeping practices to prevent dust accumulation. Use cleanup procedures that minimize dust generation. Practice good personal hygiene. Examine exposed personnel at regular intervals with emphasis on the respiratory and central nervous systems.
Transportation Data (49 CFR 172.101, .102): Not listed

***MSDS Collection* References:** 2, 4, 7, 8, 9, 12, 14, 20, 25, 27, 38, 44, 47, 55, 58, 81, 89, 90, 100, 124, 126
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD F5

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

MSDS # N 150
LEAD CHLORIDE

Issued: September, 1985
Revised:

From Genium's MSDS Collection, to be used as a reference.

SECTION 1. MATERIAL IDENTIFICATION

17

MATERIAL NAME: LEAD CHLORIDE
OTHER DESIGNATIONS: Lead (II) Chloride; Lead Dichloride; Plumbous Chloride; $PbCl_2$; CAS #7758-95-4.
SUPPLIER: Available from several suppliers including:

J.T. Baker Chemical Co.
222 Red School Lane
Phillipsburg, NJ 08865
(201) 867-2151

Fisher Scientific Company
Chemical Manufacturing Div.
PO Box 375, 1 Reagent Lane
Fair Lawn, NJ 07410

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Lead Chloride, $PbCl_2$	>99%	ACGIH TLV:* 8 hr. TWA: 0.15 mg/m^3 OSHA PEL** 8 hr TWA: 0.05 mg/m^3 Oral, guinea pig LDLo: 1500 mg/kg

* Current (1985-86) ACGIH TLV, as Pb

** Current OSHA PEL (as Pb) with an action level of 0.03 mg/m^3 (29 CFR 1910.1025).

SECTION 3. PHYSICAL DATA

Melting point ..... 501°C
Boiling point @ 1 atm ... 950°C
Specific gravity 5.85

Solubility in water, g/100cc:
@ 20°C 0.99
@ 100°C 3.34
Molecular weight 278.10

APPEARANCE & ODOR: White crystalline powder. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
N/A	N/A	N/A		

EXTINGUISHING AGENTS: This material is not combustible. Use extinguishing agents that are suitable for the surrounding fire. Minimize the spread of lead contamination.

Toxic fumes may be emitted under fire conditions. Firefighters should wear self-contained breathing apparatus and full protective gear to prevent inhalation and contact with dust, mist, and fumes.

SECTION 5. REACTIVITY DATA

This material is stable at room temperature under normal conditions of use and handling. It does not polymerize.

Lead chloride is soluble in water, hydrochloric acid, solutions of ammonium chloride and alkali hydroxides. On heating in air or oxygen, lead oxychlorides are formed. Toxic fumes may be emitted on heating. An explosive reaction can occur when lead chloride is heated with calcium.

Copyright © on issue date, Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

TLV See Section 2

Lead chloride is toxic on inhalation and ingestion. It is a cumulative poison. The chief effects of excessive lead intake are anemia, neuological disorders and kidney damage. Symptoms of the neurological effects may include irritability, headaches, insomnia, delirium, convulsions, muscular tremors and palsy of the extremities. Excessive lead exposure may also have adverse effects on human reproduction. Symptoms of acute lead poisoning by ingestion include headache, abdominal pain, nausea, vomiting, diarrhea, and in severe cases, coma and death.

FIRST AID: Any worker who experiences symptoms of lead poisoning should be removed from exposure and receive prompt medical care.

EYE CONTACT: Flush eyes, including under eyelids, with running water for at least 15 minutes. Obtain medical attention.

SKIN CONTACT: Flush affected area with plenty of water. If irritation develops, seek medical attention.

INHALATION: Remove person from exposure. Keep them warm and at rest and get medical help promptly.

INGESTION: If person is conscious, give them plenty of milk or water to drink. Induce vomiting. Keep person warm and at rest. Get immediate medical assistance.

GET MEDICAL ATTENTION = Paramedic, In-plant, community.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety/environmental personnel of large spills. Ventilate spill area. Clean-up personnel should wear respiratory protection, gloves and protective clothing. Carefully vacuum up spilled material. Place collected material in a suitable container that can be tightly sealed for reclaim or disposal (damp or wet clean-up can be used where more effective than vacuuming). Avoid dusting conditions at all stages of handling.

DISPOSAL: Salvage material when possible. $PbCl_2$ requires disposal as a hazardous waste. Contact a licensed chemical waste disposal contractor for treatment, packaging and disposal requirements. Follow Local, State and Federal regulations.

EPA HAZARDOUS WASTE NUMBER: D008 (EP Toxicity; 40 CFR 261.24).

REPORTABLE SPILL QUANTITY: 5000lbs/2270kg (40 CFR 117.3).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide local exhaust ventilation to meet PEL requirements. NIOSH-approved respirators should be worn where engineering controls and work practices controls do not reduce exposures to at or below the PEL. Half-mask air purifying respirators with high efficiency filters are acceptable for concentrations up to 0.5 mg/m^3 (2.5 mg/m^3 with full facepiece). Protective clothing and equipment such as coveralls, gloves, hats, shoes should be worn when exposures exceed the PEL or where the possibility of skin and eye contact exist. Provide clean, body-covering work clothing weekly to workers exposed above the PEL (daily if exposed above 0.2 mg/m^3) and arrange for special handling and laundering of contaminated clothing. Change rooms (with separate storage facilities for street and work clothing) and showers are required for employees exposed above the PEL. Prevent dust from being transported to lunch room via the ventilation system or contaminated clothing. Consult OSHA lead standard (29 CFR 1910.1025) for detailed requirements. Eyewash stations and safety showers should be readily accessible.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers. Protect containers from physical damage. Use good housekeeping procedures (vacuuming and/or wet clean-up) to prevent accumulation of dust. Do not use compressed air for cleaning surfaces. Follow good personal hygiene practice: Wash face and hands thoroughly before eating, drinking or smoking. Do not eat, drink or use tobacco in areas of use.

Exposure monitoring, biological monitoring and medical surveillance should be provided in accordance with the OSHA lead standard (29 CFR 1910.1025) where applicable.

Prevent dust generation. Use with adequate ventilation. Avoid inhalation and contact. DO NOT INGEST!!!!

DOT CLASSIFICATION: ORMB (49 CFR 172.101)

DOT ID NUMBER: NA 2291

DATA SOURCE(S) CODE (See Glossary) 2, 4, 12, 14, 25, 55-58.V.

Judgements as to the suitablity of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitablity of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS JO Accrocco 11/85

INDUST. HYGIENE/SAFETY DW 11-85

MEDICAL REVIEW: Dec 85

Copyright © September 1, 1985

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

34

Manganese Sulfate ($MnSO_4$) Description: Produced as by-product of hydroquinone production; by addition of sulfuric acid to manganous hydroxide or carbonate (lower valence manganese compounds). Used as a feed additive, a catalyst in viscose process, and an ingredient in metal alloys, batteries and bleaches; in chemical synthesis; in glass and ceramic processes (red glaze on porcelain); in mining, smelting, and steel manufacture; in fertilizers for vines and tobaccos; and in boiling oils for varnishes.

Other Designations: CAS No. 7785-87-7, manganous sulfate, manganese (II) sulfate, Man-Gro,® Sorba-Spray manganese.®

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

Cautions: Manganese sulfate normally presents little acute health hazard, except at very high exposure levels. Chronic exposure may cause severe neurologic and behavioral disorders (manganism). Neurological damage can be permanent if exposure is unrecognized early on and continues.

R	1
I	2
S	1
K	0

Genium

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

Section 2. Ingredients and Occupational Exposure Limits

Manganese sulfate, ca 100%

1990 OSHA PELs
8-hr TWA: 5 mg/m³ (as Mn)
Ceiling: 5 mg/m³

1990-91 ACGIH TLV
TWA: 5 mg/m³ (as Mn)

1990 NIOSH RELs
TWA: 1 mg/m³ (as Mn)
STEL: 3 mg/m³ (as Mn)

1985-86 Toxicity Data*
Mouse, oral, LD_{100}: 305 mg/kg
Mouse, intraperitoneal, LD_{50}: 64 mg/kg
Mouse, subcutaneous, LD_{100}: 146 mg/kg

1987 IDLH Level
10,000 mg/m³

* See NIOSH, *RTECS* (OP1050000), for additional irritative, mutative, and toxicity data.

Section 3. Physical Data

Boiling Point: 1562 °F (850 °C)
Melting Point: 1292 °F (700 °C)
Molecular Weight: 151
Specific Gravity: 3.25 at 77 °F (25 °C)
Water Solubility: Very soluble, especially in boiling water*
Appearance and Odor: Translucent, reddish crystals with no odor.

* Forms several hydrates.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Manganese sulfate is noncombustible. Use dry chemical, halon, water spray, foam, or other absorbent, noncombustible material suitable for surrounding fire. Water spray may be useful in dispersing vapors.
Unusual Fire or Explosion Hazards: At fire temperatures manganese sulfate emits toxic fumes of sulfur oxides (SO_x).
Special Fire-fighting Procedures: Since fire does produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Manganese sulfate is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: If allowed contact, manganese sulfate can cause violent decomposition of hydrogen peroxide (52% by weight or greater).
Conditions to Avoid: Avoid exposure to manganese sulfate in conjunction with vibrations, x-rays, carbon monoxide, silicone dioxide, fluorine, copper, and lead. Combined exposure of these substances with manganese sulfate increases toxic effects.
Hazardous Products of Decomposition: Thermal oxidative decomposition of manganese sulfate can produce carbon dioxide (CO_2) and toxic fumes of sulfur oxides (SO_x).

Copyright © 1991 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC and NTP do not list manganese sulfate as a carcinogen.
Summary of Risks: Manganese sulfate is not usually considered a serious acute health hazard. Toxicity most often results from chronic poisoning, usually by inhalation. The resulting *manganism* is generally manifest after 1 to 2 years of continuous exposure, although cases have resulted after a few months. Manganism begins with nonspecific neurologic symptoms of headache, apathy, and weakness of legs, followed by psychosis, and finally appearing with neurological symptoms similar to those of Parkinson's disease. The characteristic pathological lesion is destruction of basal ganglia. Early recognition of symptoms and removal from source of exposure are critical to halting and reversing this disease's progression.
Medical Conditions Aggravated by Long-Term Exposure: Persons with neurologic, psychologic, pulmonary disorders, or anemia (especially iron deficiency) may be at increased risk of exposure. Since iron and maganese compete for the same receptor sites in the body, an iron deficiency leaves the body more susceptible to manganese buildup.
Target Organs: Central nervous system (CNS), respiratory system, possibly the blood.
Primary Entry Routes: Inhalation.
Acute Effects: Rarely occur because of poor absorption in digestive system and lungs.
Chronic Effects: Results from chronic inhalation or ingestion. Early phases of chronic manganese poisoning are difficult to recognize because symptoms are nonspecific and the onset is insidious. The disease progresses in three stages: first, with apathy, arthralgias (pain in joints), anorexia, asthenia (lack or loss of strength), headache, hypersomnia (sleepiness), spasms, and weakness of the legs; second, with psychosis, unaccountable laughter, euphoria, mental confusions, and hallucinations; and finally, with speech disturbances, Bradykinesis, muscular rigidity, mask-like facial appearance, disturbances in gait and balance, tremors, excessive salivation, and sweating. At this point the disease is irreversible and very similar to classical Parkinson's disease.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Early removal from exposure is critical to prevent neurologic sequelae. Subjective behavioral symptoms may be the only early toxicity indicator. EDTA may increase excretion, but its efficacy is not established. L-Dopa may be beneficial to treat toxicity (consult a medical toxicologist or occupational physician). Excretion is primarily biliary.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Avoiding dust generation, carefully scoop up spilled dry material in suitable container. For an aqueous solution, soak up with an absorbent, inert material (e.g., vermiculite). Isolate and ventilate area, deny entry and stay upwind. Cleanup personnel should wear protective equipment (respirator, goggles, gloves, coat). Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Lime-treated aqueous solutions can precipitate out hydroxide to allow for landfill disposal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
Environmental Transport: Aerosols, fertilizers, mine wastes, pesticides, and sewer sludge are all sources of soil contamination and can add to the manganese burden of fresh and sea water.
EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations*
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

* Designations may be listed as manganese.

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Preserve in airtight containers protected from physical damage.
Engineering Controls: Avoid inhalation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation.
Other Precautions: Preplacement and periodic examinations should emphasize neuropsychologic function and respiratory system. Obtain CBC; consider PFTs. Manganese can be detected in hair, blood, urine, and feces, but levels do not correlate well with toxicity and are not very helpful.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 132, 136, 138, 139, 143, 145, 146, 148
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; ***Edited by:*** JR Stuart, MS

Copyright © 1991 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 162
Copper

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

Section 1. Material Identification 32

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

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

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

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

R 0
I 4
S 1
K 0

Genium

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

Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

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

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

Section 3. Physical Data

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

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

Section 4. Fire and Explosion Data

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

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

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

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

Section 5. Reactivity Data

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

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

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

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

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

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

Section 7. Spill, Leak, and Disposal Procedures

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

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

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

***MSDS Collection* References:** 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 181

SILVER

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION

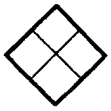
20

MATERIAL NAME: SILVER
DESCRIPTION: Elemental metal.
OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS
H:1
F:0
R:0
PPE*
*See sect. 8



Not Found

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Silver, Ag	99+	TWA 0.1 mg/m^3* TWA 0.01 mg/m^3** ---------- Rat, Implant, TD: 2570 mg/kg

* Current (1985-86) ACGIH TLV for silver dust and fume.

** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit.

SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)
Vapor Pressure ... Not Found
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... Not Found
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 10.5
Melting Point ... 1763.4°F (961.9°C)
Percent Volatile by Volume ... Not Found
Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Applicable	Not Applicable

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated.
Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode.
This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds.
Bromoazide explodes on contact with silver foil.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.
SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. TARGET ORGANS: Generally, where contact occurs. PRIMARY ENTRY: Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. ACUTE EFFECTS are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. CHRONIC EFFECTS: Argyria may be a local or general effect, depending upon previous exposure. FIRST AID: EYE CONTACT: Flush with water for 15 minutes. Get medical attention.* SKIN CONTACT: Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. INHALATION: Remove victim to fresh air. INGESTION: Dilute with water. Get medical attention.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 mg/m^3 TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 mg/m^3 to be too conservative; therefore, the ACGIH raised the TLV to 0.1 mg/m^3.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.
GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.
RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.
VENTILATION is required where air exposures exceed the TLV-TWA'S.
OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	J.O. Acuocco, 11/86
Indust. Hygiene/Safety	[signature] 10-86
Medical Review	[signature] Oct 86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © April 1, 1986

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 193

ARSENIC PENTOXIDE

Issued: June 1986

SECTION 1. MATERIAL IDENTIFICATION

21

MATERIAL NAME: ARSENIC PENTOXIDE

OTHER DESIGNATIONS: Arsenic Acid Anhydride, Arsenic Anhydride, Arsenic (V) Oxide, As_2O_5, CAS #1303-28-2.

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Aldrich Chemical Co., Inc., PO Box 355, Milwaukee, WI 53201;
Telephone: (414) 273-3850
Cerac, Inc., PO Box 1178, Milwaukee, WI 53201; Telephone: (414) 289-9800

HMIS	Not Found
H 3	
F 0	R 1
R 0	I 4
PPE*	S 2
*See Sect. 8	K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Arsenic Pentoxide, CAS #1303-28-2	>99	ACGIH TLV* 8-hr TWA: 0.2 mg/m^3 OSHA PEL** 8-hr TWA: 0.01 mg/m^3 OSHA Action Level*** 8-hr TWA: 0.005 mg/m^3 Rat, Oral, LD_{50}: 8 mg/kg Mouse, Oral, LD_{50}: 55 mg/kg

* Current (1985-86) ACGIH TLV for arsenic and soluble compounds, as As.

** Current OSHA PEL for inorganic arsenic compounds, as As.

*** Concentration that triggers certain provisions of the OSHA Arsenic Standard (29 CFR 1910.1018).

SECTION 3. PHYSICAL DATA

Melting Point ... 599°F (315°C) (Decomposes)
Specific Gravity ... 4.32
Vapor Pressure @ 20°C ... Essentially Zero
Solubility in Water, @ 16°C ... 150 g/100cc
@ 100°C ... 76.7 g/100cc
Molecular Weight ... 229.84

Appearance and odor: White amorphous lumps or powder.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Found	Not Found

EXTINGUISHING MEDIA: Arsenic pentoxide is noncombustible. Use extinguishing agents (dry chemical, CO_2, water spray, or foam) that are suitable for extinguishing the surrounding fire.
UNUSUAL FIRE/EXPLOSION HAZARDS: Highly toxic fumes and gases may be evolved in a fire situation. Oxygen, which will intensify combustion, is evolved at temperatures greater than 572°F (300°C).
SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters need self-contained breathing apparatus (positive pressure) and full protective gear. Minimize runoff of fire-control water to prevent pollution.

SECTION 5. REACTIVITY DATA

Arsenic pentoxide is stable at room temperature. It does not polymerize.

INCOMPATIBILITIES: Arsenic pentoxide arsine can be generated when arsenic compounds come in contact with nascent (freshly formed) hydrogen. This can occur by contact of acid, alkalies, or water with arsenic compounds in the presence of an active metal (zinc, aluminum, magnesium, manganese, sodium, iron, etc.). Arsine is an extremely poisonous (lethal) gas with a garlic odor.

HAZARDOUS DECOMPOSITION PRODUCTS: Arsenic pentoxide decomposes at approximately 572°F (300°C), forming arsenic trioxide fumes. Poisonous arsine gas may also form on thermal decomposition.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

CARCINOGENIC ASSESSMENT: Exposure to arsenic compounds is associated with skin, lung, and possibly liver cancer. The NTP, IARC, and OSHA have identified arsenic compounds as human carcinogens. ROUTES OF ENTRY: Arsenic pentoxide can enter the body if it is inhaled or swallowed. EFFECTS OF OVEREXPOSURE: Skin contact can cause dermatitis characterized by erythema (abnormal redness of skin caused by capillary congestion), with burning, itching, swelling, and skin eruptions. Chronic skin effects include cracking, thickening, pigmentation, and drying of the skin. Eye contact can cause conjunctivitis with redness, swelling, and pain. Acute inhalation exposure can cause severe nose and respiratory tract irritation and pulmonary edema. Prolonged or repeated exposure can cause necrosis and perforation of the nasal septem. Other effects of chronic arsenic poisoning by inhalation or ingestion may include gastrointestinal disturbances (nausea, vomiting); nervous system effects involving the extremities (numbness, tingling, burning pain, weakness, incoordination); blood disorders (anemia);liver and kidney injury; and skin and lung cancer. Acute ingestion of arsenic causes burning of the mouth and throat, vomiting, watery or bloody diarrhea, convulsions, paralysis, coma, and death. FIRST AID: EYE CONTACT: Flush eyes, including under eyelids, with a gentle flow of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Thoroughly wash affected area with mild soap and water. Prevent further exposure. If irritation or other symptoms persist, get medical help.* INHALATION: Remove victim from exposure. Keep him warm and at rest. If breathing has stopped, begin artificial respiration immediately. Get medical help promptly.* INGESTION: Immediately give victim a large quantity (2-4) glasses of water to drink, then induce vomiting. Keep him warm and at rest. Get medical help immediately!* (Note: Never give anything by mouth or induce vomiting if victim is unconscious or convulsing.)

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

CLEANUP PROCEDURES: Notify safety/environmental personnel of large spills. Ventilate spill area. Cleanup personnel should wear protective clothing (gloves, coveralls, goggles, etc.) and respiratory equipment. Carefully vacuum up spilled material (vacuum must have high-efficiency filters to prevent redispersion of dust). Do not sweep or brush material, but place it into a suitable container for reclamation or disposal. Minimize dust generation and prevent skin/eye contact throughout the cleanup process. Wash spill area to remove all residues from environmental surfaces. Use swipe tests to verify cleanliness.

DISPOSAL: This material requires disposal as a hazardous (toxic) waste. Contact supplier or a licensed chemical waste disposal contractor for treatment, packaging, and disposal instructions. Follow Federal, state, and local regulations.

Reportable Spill Quantity: 5000 lbs (2270 kg) (40 CFR 117.3)

EPA Hazardous Waste Number: P011 (40 CFR 261.33)

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation when handling this material. Ventilation rates should be sufficient to maintain airborne levels below the PEL. NIOSH-approved respirators should be worn when airborne concentrations exceed the PEL and during nonroutine and emergency operations. Half-mask air-purifying respirators with high-efficiency filters are acceptable for concentrations not greater than 0.1 mg/m^3 (0.5 mg/m^3 with full facepiece). For concentrations above 0.5 mg/m^3, powered air-purifying respirators, positive-pressure-supplied air respirators, or self-contained breathing apparatus are required depending on the concentration of the material. Respirator usage must be in accordance with appropriate provisions of the OSHA Inorganic Arsenic Standard (29 CFR 1910.1018). Dust-/splash-proof safety goggles should be worn when handling this material. Protective clothing and equipment such as coveralls, gloves, hats, and shoes should be worn when airborne concentrations exceed the PEL or where the possibility of skin and eye contact exist. Provide clean body-covering work clothing weekly to workers exposed above the PEL (daily if exposed above 0.1 mg/m^3) and arrange for special handling and laundering of contaminated clothing. OTHER CONTROLS: Changing rooms with separate storage facilities for street and work clothing and showers are required for employees who are exposed to above the PEL. Prevent dust from being transported to lunchroom through the ventilation system or on contaminated clothing. Consult the OSHA Inorganic Arsenic Standard (29 CFR 1910.1018) for detailed requirements. Eyewash stations, washing facilities, and safety showers should be readily accessible. Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store arsenic pentoxide in a cool, dry location in tightly closed containers away from incompatibles (see sect. 5). Protect containers from physical damage. Keep this material away from food products and feed. Maintain good housekeeping practices to prevent accumulation of dust. Use procedures that minimize dust generation such as vacuuming (with appropriate filter) or wet cleanup. Brushing or sweeping should be done only where vacuuming or other relevant methods are ineffective. All handling should be done in a careful manner and with appropriate controls (enclosure, ventilation) to prevent dust generation and dispersion. Practice good personal hygiene. Wash face and hands thoroughly before eating, drinking, and smoking. Showering after the workshift is required for employees exposed to above the PEL. Do not eat, drink, use tobacco, chew gum, or apply cosmetics in the work area. Remove contaminated clothing promptly. Launder it before wearing it again. Do not shake clothing to remove dust; use a vacuum cleaner. Avoid inhalation and skin/eye contact. DO NOT INGEST!

DOT Class: Poison B DOT ID No. UN1559 DOT Label: Poison

Data Source(s) Code: 2, 4, 9, 12, 14, 30, 44, 49, 55, 58, 61, 62, 84. CV

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.O. Accrocco, 1/87.

Indust. Hygiene/Safety 12/86

Medical Review

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © April 1, 1986

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 194

ARSENIC TRIOXIDE

Issued: June 1986

SECTION 1. MATERIAL IDENTIFICATION

21

MATERIAL NAME: ARSENIC TRIOXIDE

OTHER DESIGNATIONS: Arsenic Oxide, Arsenic Sesquioxide, Arsenous Oxide, Arsenous Acid Anhydride, White Arsenic, As_2O_3, CAS #1327-53-3.

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Atomergic Chemetals Corp., 100 Fairchild Ave., Plainview, NY 11803;
Telephone: (516) 349-8800
Sharpe Chemicals Co., 1116 S. Varney St., Burbank, CA 91502;
Telephone: (818) 841-7605

HMIS	Not Found
H 3	
F 0	R 1
R 0	I 4
PPE*	S 2
*See Sect. 8	K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Arsenic Pentoxide, CAS #1327-53-3	>99	ACGIH TLV* 8-hr TWA: 0.2 mg/m^3 OSHA PEL** 8-hr TWA: 0.01 mg/m^3 OSHA Action Level*** 8-hr TWA: 0.005 mg/m^3 Man, Oral, LD_{50}: 1.43 mg/kg Rat, Oral, LD_{50}: 15.1 mg/kg Woman, Oral, TDLo: 600 mg/kg (Reproductive Effect)

* Current (1985-86) ACGIH TLV for arsenic and soluble compounds, as As.

** Current OSHA PEL for inorganic arsenic compounds, as As.

*** Concentration that triggers certain provisions of the OSHA Arsenic Standard (29 CFR 1910.1018).

SECTION 3. PHYSICAL DATA

Melting Point ... 275°F (135°C) (Sublimes)*
Specific Gravity ... 3.865*
Vapor Pressure @ 20°C ... Essentially Zero
Solubility in Water, @ 2°C ... 1.2 g/100cc
@ 100°C ... 11.46 g/100cc
Molecular Weight ... 197.84
Appearance and odor: White amorphous lumps or powder.

* Values are for arsenolite. Amorphous arsenic trioxide melts at 599°F (315°C).

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Found	Not Found

EXTINGUISHING MEDIA: Arsenic trioxide is noncombustible. Use extinguishing agents (dry chemical, CO_2, water spray, or foam) that are suitable for extinguishing the surrounding fire.
UNUSUAL FIRE/EXPLOSION HAZARDS: Highly toxic fumes and gases may be evolved from this material in a fire situation.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters need self-contained positive-pressure breathing apparatus and full protective gear. Minimize the runoff of fire-control water to prevent pollution.

SECTION 5. REACTIVITY DATA

Arsenic trioxide is stable at room temperature. It does not polymerize.

INCOMPATIBILITIES: Aresenic trioxide may react violently on contact with chlorine trifluoride, fluorine, hydrogen fluoride, oxygen difluoride, sodium chlorate, and other strong oxidizers. Arsine gas (arsenic hydride) can be generated when arsenic compounds come in contact with nascent (freshly formed) hydrogen. This can occur by contact of acid, alkalies, or water with arsenic compounds in the presence of an active metal (zinc, aluminum, magnesium, manganese, sodium, iron, etc.). Arsine is an extremely poisonous (lethal) gas with a garlic odor.
HAZARDOUS DECOMPOSITION PRODUCTS: Arsenic trioxide sublimes when heated. Poisonous arsine gas may also form on decomposition.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

CARCINOGENIC ASSESSMENT: Exposure to arsenic compounds is associated with skin, lung, and possibly liver cancer. The NTP, IARC, and OSHA have identified arsenic compounds as human carcinogens. ROUTES OF ENTRY: Arsenic trioxide can enter the body if it is inhaled or swallowed. EFFECTS OF OVEREXPOSURE: Skin contact can cause dermatitis characterized by erythema (abnormal redness of skin caused by capillary congestion) with burning, itching, swelling, and skin eruptions. Chronic skin effects include cracking, thickening, pigmentation, and drying of the skin. Eye contact can cause conjunctivitis and redness, swelling, and pain. Acute inhalation exposure can cause severe nose and respiratory tract irritation and pulmonary edema. Prolonged or repeated exposure can cause necrosis and perforation of the nasal septem. Other effects of chronic arsenic poisoning by inhalation or ingestion may include gastrointestinal disturbances (nausea, vomiting); nervous system effects involving the extremities (numbness, tingling, burning pain, weakness, incoordination); blood disorders (anemia); liver and kidney injury; and skin and lung cancer. Acute ingestion of arsenic trioxide causes burning of the mouth and throat, vomiting, watery or bloody diarrhea, convulsions, paralysis, coma, and death. A dose of 120 mg of arsenic trioxide can be fatal. FIRST AID: EYE CONTACT: Flush eyes, including under eyelids, with a gentle flow of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Thoroughly wash affected area with mild soap and water. Prevent further exposure. If irritation or other symptoms persist, get medical help.* INHALATION: Remove victim from exposure. Keep him warm and at rest. If breathing has stopped, administer oxygen under low pressure. Get medical help promptly.* INGESTION: Immediately give victim a large quantity (2-4 glasses) of water to drink; induce vomiting. Keep him warm and at rest. Get medical help immediately!* (Note: Never give anything by mouth or induce vomiting if victim is unconscious or convulsing.) * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after firest aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

CLEANUP PROCEDURES: Notify safety/environmental personnel of large arsenic trioxide spills. Ventilate spill area. Cleanup personnel should wear protective clothing (gloves, coveralls, goggles, etc.) and use protective respiratory equipment. Carefully vacuum up spilled material (vacuum must have high-efficiency filters to prevent redispersion of dust). Do not sweep or brush it up. Place the waste into a suitable container for reclamation or disposal. Minimize dust generation and prevent skin/eye contact throughout the cleanup process. Wash spill area to remove all residues from environmental surfaces. Use swipe tests to verify cleanliness.

DISPOSAL: This material requires disposal as a hazardous (toxic) waste. Contact supplier or a licensed chemical waste disposal contractor for treatment, packaging, and disposal instructions. Follow Federal, state, and local regulations.

Reportable Spill Quantity: 5000 lbs (2270 kg) (40 CFR 117.3)

EPA Hazardous Waste Number: P012 (40 CFR 261.33)

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation when handling this material. Ventilation rates should be sufficient to maintain airborne levels below the PEL. NIOSH-approved respirators should be worn when airborne concentrations exceed the PEL and during nonroutine and emergency operations. Half-mask air-purifying respirators with high-efficiency filters are acceptable for concentrations not greater than 0.1 mg/m^3 (0.5 mg/m^3 with full facepiece). For concentrations above 0.5 mg/m^3, powered air-purifying respirators, positive-pressure-supplied air respirators, or self-contained breathing apparatus are required, depending on the concentration of the material. Respirator usage must be in accordance with appropriate provisions of the OSHA Inorganic Arsenic Standard (29 CFR 1910.1018). Dust-/splash-proof safety goggles should be worn when handling this material. Protective clothing and equipment such as coveralls, gloves, hats, and shoes should be worn when airborne levels exceed the PEL or where the possibility of skin and eye contact exist. Provide clean, body-covering work clothing weekly to workers who are exposed to above the PEL (daily if exposed to above 0.1 mg/m^3) and arrange for special handling and laundering of contaminated clothing. OTHER CONTROLS: Changing rooms with separate storage facilities for street and work clothing and showers are required for employees who are exposed to above the PEL. Prevent dust from being transported to the lunchroom through the ventilation system or on contaminated clothing. Consult the OSHA Inorganic Arsenic Standard (29 CFR 1910.1018) for detailed requirements. Eyewash stations, washing facilities, and safety showers should be readily accessible. Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store arsenic trioxide in a cool, dry location in tightly closed containers away from incompatibles (see sect. 5). Protect containers from physical damage. Keep this material away from food products and feed. Maintain good housekeeping practices to prevent accumulation of arsenic trioxide dust. Use procedures that minimize dust generation such as vacuuming (with appropriate filter) or wet cleanup. Brushing or sweeping should be used only where vacuuming or other relevant methods are ineffective. All handling should be done in a careful manner and with appropriate controls (enclosure, ventilation) to prevent dust generation and dispersion. Practice good personal hygiene. Wash face and hands thoroughly before eating, drinking, and smoking. Showering after the workshift is required for employees exposed to above the PEL. Do not eat, drink, use tobacco, chew gum, or apply cosmetics in the work area. Remove contaminated clothing promptly. Launder it before it is worn again. Do not shake clothing to remove dust; use a vacuum cleaner. Avoid inhalation and skin/eye contact. DO NOT INGEST THIS MATERIAL!

DOT Class: Poison B DOT ID No. UN1561 DOT Label: Poison

Data Source(s) Code: 2, 4, 9, 12, 14, 30, 44, 49, 55, 58, 61, 62, 84. CV

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.O. Cerrero, 1/87.

Indust. Hygiene/Safety 11-86

Medical Review Nov 86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © June 1, 1986

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 198

COBALT (II) NITRATE, HEXAHYDRATE

Issued: January 1987

SECTION 1. MATERIAL IDENTIFICATION

22

MATERIAL NAME: COBALT (II) NITRATE, HEXAHYDRATE

DESCRIPTION/USES: Derived from the action of nitric acid on metallic cobalt; cobalt oxide, hydroxide, or carbonate; with subsequent crystallization. Used in sympathetic inks; as catalysts; soil additives; and animal feed additives; in vitamin preparation; hair dyes; and porcelain decoration.

OTHER DESIGNATIONS: Cobaltous Nitrate, Hexahydrate; Nitric Acid, Cobalt (2+) Salt, Hexahydrate; $Co(NO_3)_2 \cdot 6H_2O$; CAS # 10026-22-9

MANUFACTURER/SUPPLIER: Available from several suppliers, including: Atomergic Chemetals Corp., 100 Fairchild Ave., Plainview, NY 11803; Telephone: (516) 349-8800

HMIS	Fire	Nonfire
H 1		
F 0	R 1	
R 0	I --	
PPE*	S 2	
*See Sect. 8	K 0	

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Cobalt Nitrate, Hexahydrate, CAS #10026-22-9	>99%	OSHA PEL: See Note. ACGIH TLV: See Note. Oral, Rat, LD_{50}: 691 mg/kg

NOTE: PEL or TLV limits have not been established for cobalt compounds. The OSHA PEL and ACGIH TLV for cobalt, metal, fume and dust is 0.1 mg/m^3, as Co.

SECTION 3. PHYSICAL DATA

Melting Point ... 131°-132°F (55°-56°C)
Boiling Point ... >165°F (74°C) (Decomposes)
Vapor Pressure @ 20°C ... Negligible
Vapor Density ... Not Found
% Volatiles ... 0
Evaporation Rate ... Not Found

Specific Gravity ... 1.87
Solubility in Water, at 0°C ... 133.8 g/100 cc
at 80°C ... 217 g/100 cc
pH of 5% Solution at 25°C ... 3.5-6.0
Molecular Weight ... 291

Appearance and odor: Red deliquescent crystals. Odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Found	Not Found	Not Found	--	--

EXTINGUISHING AGENTS: Use water spray to extinguish fires involving cobalt nitrate. Keep fire-exposed containers cool with a water spray. Remove them from the fire area if it can be done safely.

UNUSUAL FIRE/EXPLOSION HAZARDS: This material is an oxidizer and can initiate and intensify combustion of flammable and combustible materials.

SPECIAL FIRE-FIGHTING PROCEDURES: Toxic and irritating fumes/gases can evolve from this material in a fire situation. Fire fighters should use self-contained breathing apparatus and wear fully protective gear.

SECTION 5. REACTIVITY DATA

Cobalt Nitrate is stable at room temperature. It does not polymerize.

This material is an oxidizer and can react violently (possibly causing a fire and/or explosion) if mixed with reducing agents, organic matter, and other flammable and combustible materials. Examples of incompatibles include wood, paper, sulfur, aluminum, phosphorus, hydroxylamine, phosphinates, alkyl esters, ammonium hexacyanoferrate (4^-), carbon, tin (II) chloride, and flammable liquids.

Cobalt Nitrate decomposes to the oxide above 165°F (74°C) with the evolution of oxides of nitrogen (a toxic situation).

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Cobalt Nitrate has not been identified as a known or suspected carcinogen by the NTP, IARC, or OSHA.
This material can enter the body if it is inhaled or swallowed.
Excessive intake of cobalt compounds by ingestion or inhalation may cause an increase in red blood cells (polycythemia), decreased blood pressure, and heart disease (cardiomyopathy). Enlargement of the thyroid (goiter) is associated with excess ingestion. Ingestion can also cause vomiting, diarrhea, and a sensation of heat. Inhalation of cobalt dust is associated with pulmonary disease characterized by an asthmalike condition that may progress to marked fibrosis. However, this condition is generally associated with the inhalation of cobalt metal dust in the hard-metal industry.
Skin contact can cause allergic, sensitizing dermatitis with eruptions appearing in the flexural creases of the elbow, knee, ankles, and neck. Eye contact can cause irritation.
FIRST AID: EYE CONTACT: Flush eyes, including under the eyelids, with a gentle flow of water. Get medical help.* SKIN CONTACT: Wash affected area with mild soap and water. If irritation persists or recurs, prevent further contact and get medical help.* INHALATION: Remove victim from exposure. Restore/aid his breathing as necessary. Get medical help.* INGESTION: Give victim a large quantity of water to drink, then induce vomiting. Get medical help.* NOTE: Never induce vomiting if someone is unconscious or convulsing nor give him anything by mouth.
* GET MEDICAL ATTENTION: In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Ventilate the spill area. Prevent the contact of spilled cobalt nitrate with combustible and incompatible materials. Cleanup personnel must wear personal protective equipment as necessary to prevent skin and eye contact and dust inhalation. Carefully scoop or vacuum waste material into a suitable container for reclamation or disposal. Avoid generating dust during cleanup. Absorb small solution spills on an inert material such as dry sand or earth.
DISPOSAL: Cobalt Nitrate requires disposal as a hazardous waste. Reclaim it whenever possible. Contact your supplier or a licensed chemical waste disposal contractor for treatment/disposal instructions. Follow Federal, state, and local regulations.

Reportable spill quantity: None given in 40 CFR 117.3, Table 117.3, "Reportable Quantities of Hazardous Substances."
EPA Hazardous Waste Number: D001 (Ignitable, 40 CFR 261.22)

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation to minimize airborne levels of cobalt nitrate at operations when dust, mist, or fumes are generated.

Use NIOSH-approved respirators with appropriate protection factors when dust, mist, or fumes are present and during non-routine and emergency operations. Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134).

Gloves and protective clothing (apron, coveralls) should be worn as required by the work situation to prevent prolonged or repeated skin contact. Chemical safety goggles should be worn when handling this material.

Eyewash stations and washing facilities should be accessible in areas of use.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store cobalt nitrate in closed containers in a cool, dry location on a noncombustible surface. Store it away from flammable and combustible materials and reducing agents. Protect containers from physical damage. Keep this material away from food and food products.
Maintain good housekeeping procedures. Clean up spills promptly. Use procedures and techniques that minimize the generation of dust. Practice good personal hygiene. Wash thoroughly after handling cobalt nitrate and before eating, drinking, and smoking and at the end of each workshift. Remove contaminated clothing promptly and launder it before wearing it again. Do not take this material out of your work area or to your home on your clothing or equipment. Do not eat, drink, or use tobacco in the work area. Do not eat this material. Avoid inhalation of dust, mist, and fumes and contact with skin and eyes.
DOT Hazard Classification: Oxidizer (Nitrate, NOS - 49 CFR 172.101) DOT ID No. NA1477 (Nitrate, NOS)
DOT Label: Oxidizer
Data Source(s) code: 2, 4, 5, 9, 12, 14, 25, 43, 44, 47, 49, 55, 58, 61, 62, 82. CV

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	J O Acrocco 5/87
Indust. Hygiene/Safety	JW 4/87
Medical Review	May 87

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © January 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 217

POTASSIUM METAL

Issued: August 1987

SECTION 1. MATERIAL IDENTIFICATION

23

MATERIAL NAME: POTASSIUM METAL

DESCRIPTION (Origin/Uses): Natural substance. Prepared by electrolysis of fused potassium hydroxide. Used as a reagent and reducing agent in many chemical reactions; in the metallic state emits weak beta radiation; potassium 40 is a naturally occurring radioactive isotope.

OTHER DESIGNATIONS: K; Kalium; CAS #7440-09-7

MANUFACTURER/SUPPLIER: This material is available from several suppliers, including: Sharpe Chemical Co., 1116 S. Varney Street, Burbank, CA 91502; Telephone: (818) 841-7605

HMIS	
H: 3	R 3
F: 2	I -
R: 2	S 4
PPG*	K 4

* See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

INGREDIENTS AND HAZARDS	%	HAZARD DATA
Elemental Potassium, Technical Grade, CAS #7440-09-7	ca 100	Elemental Potassium: No Exposure Limits Established
*Current 1987-88 ACGIH TLV		Potassium plus Water Yields Potassium Hydroxide (CAS # 1310-58-3): TLV* 2 mg/m^3 (as Ceiling)

COMMENTS: Harmful if swallowed, inhaled, or absorbed through the skin. Causes burns. Reacts with moisture to form potassium hydroxide, which is extremely destructive to mucous membranes, upper respiratory tract, eyes, and skin.

SECTION 3. PHYSICAL DATA

Boiling Point ... 1418°F (770°C)
Vapor Pressure .. Not Found
Water Solubility ... Reacts Violently in Water
Vapor Density ... Not Found
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 0.862 at 68°F (20°C)
Melting Point ... 146.6°F (63.7°C)
% Volatile by Volume ... Not Found
Molecular Weight ... 39.10 Grams/Mole
pH ... Water Solution Alkaline (pH >7)

Appearance and odor: Malleable (soft), silvery metal, rapidly oxidized (to gray) in moist air. Odorless.

COMMENTS: Solvent Solubility: soluble in liquid ammonia, aniline, mercury, and ethylenediamine.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Flammable Solid	Not Found	Not Found	Not Found	Not Found

EXTINGUISHING MEDIA: Do not use water, foam, carbon dioxide, or halogenated extinguishing agents (such as Halon® or carbon tetrachloride). Use dry graphite (G-1® graphite powder), soda ash, powdered sodium chloride, or suitable dry powder (Met-L-X®). UNUSUAL FIRE/EXPLOSION HAZARDS: Potassium metal is extremely dangerous in contact with moisture or water, releasing hydrogen with sufficient heat to cause ignition or explosion. It ignites spontaneously in air or oxygen. It burns violently accompanied by explosions, which can cause spattering of material. It reacts with water and halogenated hydrocarbons. It may form reactive peroxides at room temperature even when stored under oil. Peroxides may be explosive. SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should move containers from the fire area, if possible (see *DOT Emergency Response Guidebook*, p. 5800.3). Burning potassium is difficult to extinguish. COMMENTS: This material is dangerous when exposed to air in a heated environment (fire); it will emit toxic potassium oxide fumes; it will react with water to produce heat, hydrogen gas, and flammable vapors. Fire fighters should use full protective equipment, including self-contained breathing apparatus (SCBA) with full facepiece operated in pressure-demand or positive-pressure mode. Fire fighters should wear heavy, chemical-resistant rubber gloves.

SECTION 5. REACTIVITY DATA

Potassium metal is not stable and may readily undergo violent chemical change. It will react violently or explosively with water and may react spontaneously with air. Hazardous polymerization cannot occur. CHEMICAL INCOMPATIBILITIES: Mixing potassium metal with air, moist air, compounds of heavy metals such as silver oxide and silver chloride, halogenated hydrocarbon (chlorinated solvents), water, alkalies, carbon dioxide, petroleum, ether, benzene, carbon monoxide and water, halogens, and acids causes hazardous reactions. It is incompatible with Teflon®. CONDITIONS TO AVOID: This material may ignite spontaneously if exposed to air or if it is in the presence of moisture. It is dangerous when exposed to moisture; keep it dry at all times. PRODUCTS OF HAZARDOUS DECOMPOSITION: Toxic fumes from hazardous decomposition of potassium include potassium oxide, which can react with moisture or steam to produce heat, potassium hydroxide (corrosive), and flammable hydrogen gas. CAUTION: Potassium metal will form explosive peroxides (K_2O_2) and the superoxide (KO_3 or K_2O_4) at room temperature even when stored under oil. Oxidized metal in storage under oil may explode violently when handled or cut; handle potassium metal with extreme care, minimizing any shocks.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Potassium metal is not listed as a carcinogen by the NTP, IARC, or OSHA.
SUMMARY OF RISKS: Potassium metal is harmful if inhaled, swallowed, or absorbed through the skin and mucous membranes. It is corrosive to skin, eyes, body tissue, and the upper respiratory tract. It may react violently and explosively on contact with wet skin tissue, causing chemical and thermal burns. TARGET ORGANS: Eyes, skin, mucous membranes, respiratory tract. PRIMARY ENTRY: Skin and eye contact. SECONDARY ENTRY: Inhalation. ACUTE EFFECTS: Corrosive to all body tissue. May cause burns, ulceration, or tissue death, severe eye damage (corneal burns or opacification), and possible blindness. Inhalation of dust or fumes (especially from a fire involving potassium) will cause shortness of breath, nausea, headache, and nose and respiratory tract irritation (pneumonitis). If swallowed, potassium will cause severe pain, vomiting, diarrhea, and possible collapse. CHRONIC EFFECTS: Possible chronic dermatitis, mucous membrane irritation, and lung damage. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: None reported.
FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, gently but thoroughly for at least 15 minutes. Get medical help.* SKIN CONTACT: Remove potassium-contaminated clothing immediately. Wash affected area with mild soap and water until all traces of the chemical are removed. In case of chemical burn, treat as indicated. Get medical help immediately.* INHALATION: Remove victim to fresh air. If he is not breathing, give him artificial respiration, preferably mouth-to-mouth resuscitation. If his breathing is difficult, give him oxygen. Get medical help promptly.*
INGESTION: If potassium has been swallowed, and victim is conscious, use gastric lavage followed by a dose of olive oil or demulcent. Never give anything by mouth to someone who is unconscious. Get medical help immediately.*
* GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Do not touch spilled potassium metal. Shut off all sources of ignition. Do not spill water on the material or inside its container. For small dry spills shovel the waste into a clean, dry container and cover it. For small liquid spills take up the waste with sand or absorbent material and contain it as described above. Wear self-contained breathing apparatus and heavy, chemical-resistant gloves and protective clothing. WASTE DISPOSAL: Do not dilute the waste with liquid or put it down any open drain or sewer. Follow Federal, state, and local regulations.
EPA Hazardous Waste No. (40 CFR 261.21, Ignitability): D001
CERCLA Ratings (Scale 0-3): Health, 3; Fire, 1; Reactivity, 2; Persistence, 2
EPA Reportable Quantity (40 CFR 117.3): Not Listed
Potassium is not designated as a hazardous substance by EPA (40 CFR 116.4).

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Wear chemical splash-proof and dust-resistant goggles and/or face shield (8-inch minimum) with approved safety glasses to prevent eye and face contact. There is always the potential for the violent splattering of potassium metal.
GLOVES: Wear appropriate heavy, chemical-resistant gloves. RESPIRATOR: Where high levels of potassium metal dusts, fumes, or potassium hydroxide may exist, wear self-contained breathing apparatus as described under special fire-fighting procedures (see sect. 4). OTHER: Wear chemical-resistant apron or clothing. WORKPLACE CONSIDERATIONS/ VENTILATION: Use this material only under a chemical fume hood, under localized ventilation, or where general dilution ventilation is adequate. SAFETY STATIONS: Eyewash stations, washing facilities, and safety showers should be available in areas of use and handling because potassium is corrosive to eyes and body tissue.
CONTAMINATED EQUIPMENT: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles may cling to contact lens surfaces and cause corneal injury.
SPECIAL CONSIDERATIONS: Avoid all contact with material. Keep material off of your clothing and equipment.
COMMENTS: Practice good personal hygiene. Avoid transferring material from hands to mouth while eating, drinking, or smoking.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store potassium away from sources of heat, ignition (sparks and open flames), water, combustible materials, and other chemical liquids. Store it away from oxidizers and acids. SPECIAL HANDLING/STORAGE: Protect containers against physical damage and shocks. Store this material in airtight containers under an inert atmosphere such as nitrogen or argon or in naphtha or another similar liquid hydrocarbon such as coal oil or kerosene. Never store under halogenated hydrocarbons such as Freon® or methylene chloride. An isolated, well-ventilated, fire-resistant building is recommended for large-quantity storage. Do not store where automatic sprinklers are present or where water or steam is available. Provide enough heat in the storage area to keep the material sufficiently dry. Provide enough appropriate fire extinguishers for storage area. COMMENTS: Remove only that amount of potassium which is immediately needed from the storage area. Use a metal container with a tight-fitting lid for transport. To prevent the formation of peroxide and oxide (an explosion hazard), follow manufacturer's shelf-life recommendations. Do not take this material out of your work area or to your home on your clothing or equipment. Dispose of containers and clean up work area adequately.
TRANSPORTATION DATA (per 49 CFR 170.101-2):
DOT Required Label: Flammable Solid and Dangerous When Wet — DOT ID No. UN2257
DOT Hazard Class: Flammable Solid; Dangerous When Wet — DOT Shipping Name: Potassium Metal
ADDITIONAL DOT REQUIREMENTS: Segregation is the same as for flammable solids labeled Dangerous When Wet.
References: 1-12, 18, 24, 37, 39, 44, 73, 82, 84, 87-102. OW

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.O. Barocco
Indust. Hygiene/Safety DW 11-18-87
Medical Review H. Feldmann 11-30-87

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © August 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 221

CALCIUM METAL

Issued: November 1987

SECTION 1. MATERIAL IDENTIFICATION 24

Material Name: CALCIUM METAL

Description (Origin/Uses): Produced by electrolysis of calcium chloride. Used in alloys of aluminum, copper, and lead.

Other Designations: Calcicat; Calcium; Ca; NIOSH *RTECS* No. EV8040000; CAS No. 7440-70-2

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

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

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Calcium Metal, CAS No. 7440-70-2 Calcium plus water yields calcium hydroxide, $Ca(OH)_2$, having the CAS No. 1305-62-0 and the NIOSH *RTECS* No. EW2800000 with the following data: ACGIH TLV, 1987-88 TLV-TWA: 5 mg/m³	100	Element Calcium: No Exposure Limits Established Artificial Isotopes: ^{45}Ca and ^{47}Ca pose a radiation hazard; they emit gamma radiation.

SECTION 3. PHYSICAL DATA

Boiling Point: 2703°F (1484°C)
Melting Point: 1542°F (839°C)
Water Solubility: Reacts Violently with Water*
Molecular Weight: 40.08 Grams/Mole
Specific Gravity (H_2O = 1): 1.5
pH: Water Solution Alkaline (pH >7)

*Soluble in water forming the hydroxide; soluble in acids forming salts.

Appearance and Odor: Silver-white, crystalline, lustrous metal; tarnishes to blue-gray-white on exposure to air. Odorless.

Comments: Calcium metal is soluble in alcohol, ammonia, and dilute acids.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Flammable Solid	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Extinguishing Media: Do *not* use water, foam, or halogenated hydrocarbons such as Halon® or carbon tetrachloride to extinguish fires involving calcium metal. Carbon dioxide and dry chemical are ineffective. Use only graphite powder, soda ash, powdered sodium chloride, or an appropriate metal-fire-extinguishing dry powder such as Met-L-X®. For large fires, withdraw from the area and let the fire burn (see Genium ref. 85). **Unusual Fire/Explosion Hazards:** Calcium metal is a flammable solid. It is extremely dangerous when wet; keep it dry. This material forms calcium hydroxide and hydrogen gas (explosion hazard) when wet. It may form toxic fumes of calcium oxide. This substance can also develop explosive pressures in closed containers. It reacts with wet extinguishing agents (water, alcohol, halogens, and possibly carbon dioxide). Its contact with alkali hydroxides or carbonates may result in detonation. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fire fighters should move containers from the fire area if this can be done without risk. Do not use water or foam! Use dry powders only. Fire fighters should wear full protective gear. This kind of fire may produce irritating or poisonous gases. **Comments:** Finely divided calcium metal particles may ignite spontaneously in air or oxygen at room temperature. Fires may reignite after they have been extinguished. Runoff of waste material into a sewer or drain may create an additional fire or explosion hazard.

SECTION 5. REACTIVITY DATA

Calcium metal is not stable. Hazardous polymerization is not known to occur.

Chemical Incompatibilities: Hazardous reactions involving this material occur with air, moist air, water, acids, strong oxidizing agents, alcohols, and halogens. Contact with alkali hydroxides or carbonates may cause detonation.

Conditions to Avoid: This material may ignite spontaneously if exposed to air or kept in the presence of moisture. Store in airtight containers or under oil (see sect. 9). Calcium metal can develop explosive pressures in containers; keep them dry at all times.

Hazardous Products of Decomposition: Toxic calcium oxide fumes, which can react with water to produce heat, calcium hydroxide (corrosive), and flammable hydrogen gas (explosion hazard).

Comments: Calcium metal reacts with water considerably less than sodium metal does.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

Summary of Risks: This material is harmful or fatal if swallowed; inhaled as a mist (calcium hydroxide), dust, or fume; or absorbed through the skin or mucous membranes. Solid calcium metal will cause skin and eye burns because it reacts with moisture to form corrosive calcium hydroxide. Fumes from burning calcium metal (calcium oxide) are highly irritating to skin, eyes, and mucous membranes, including the upper respiratory tract. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Eyes, skin, mucous membranes (upper respiratory tract). **Primary Entry:** Inhalation, ingestion, skin and eye contact. **Acute Effects:** Corrosive and irritating to body tissue. May cause skin burns and corneal damage. Inhalation of dust or fume may cause respiratory irritation, cough, difficulty in breathing (dyspnea), and chemical pneumonitis. **Chronic Effects:** Prolonged inhalation of dust or fume may cause severe mucous membrane irritation, chemical pneumonitis.

FIRST AID: Eye Contact. Flush eyes, including under the eyelids, promptly and gently with plenty of running water for 15 minutes. If burns are present seek medical help immediately. **Skin Contact.** Remove calcium metal-contaminated material immediately with a dry cloth. Wash with large amounts of water until all of the chemical is removed. In case of chemical burn, treat as indicated. **Inhalation.** Remove victim to fresh air; restore and/or support his breathing as needed. Keep him warm and at rest. **Ingestion.** If swallowed, and victim is conscious, give him large amounts of water to dilute the alkali. Do not induce vomiting. A gastric lavage can be used by trained staff. Never give anything by mouth to someone who is unconscious.

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

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Do not touch spilled calcium metal. Wear protective apparel. Do not smoke or place flame or ignition sources near a spill area. Do not allow water to touch spilled material or to get inside containers. Use a cover (plastic sheet) to prevent water or rain from dissolving spilled material or to prevent its spreading. Isolate hazard area and keep nonessential personnel away from spill or leak site. Shovel small dry spills into a dry container and cover it tightly. Move containers away from spill to a safe area. Take up small spills with sand or an absorbent material and contain it as described above. Dike the flow of large calcium metal and water spills with soil, sandbags, or concrete. Keep the waste from entering drains or open sewers. Wear fully protective gear.

Waste Disposal: You may dilute residual spilled material with water jets. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (20 CFR 1910.1000 Subpart Z): Not Listed
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. D003 (Reactivity)
CERCLA Hazardous Substance: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Follow the eye- and face-protection guidelines of 29 CFR 1910.133. Wear chemical splash-proof and dust-resistant safety goggles and/or a faceshield (8" minimum) with approved safety glasses to prevent eye and face contact with calcium metal.

Gloves: Wear appropriate, heavy-duty, chemical-resistant gloves. **Respirator:** Where uncomfortable or nuisance levels of calcium metal dust exist, a dust/mist respirator can be used. Where high levels of calcium metal dust or fume or calcium hydroxide, calcium oxide, or hydrogen may exist (as in a fire situation or spill), use only an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode.

Special Considerations: Wear protective clothing; a rubber apron may be appropriate for the particular work situation.

Ventilation: Work with this material only under a chemical fume hood with localized ventilation or where general dilution ventilation is adequate.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling because calcium metal is corrosive to eyes and body tissue.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles may cling to contact lens surfaces, causing corneal injury.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store calcium metal away from sources of heat, ignition (sparks and open flame), water, combustible material, acids, halogens, alcohols, and other liquid chemicals. Store it away from oxidizers.

Special Handling/Storage: Protect containers against physical damage. Store this material in airtight containers under an inert atmosphere such as nitrogen or argon or under liquid hydrocarbons (naphtha, kerosene, or coal oil). *Never store it under halogenated hydrocarbons* such as Freon®. Avoid high temperatures. An isolated, well-ventilated, fire-resistant building is recommended for large-quantity storage. Do not store material near automatic water sprinklers or where water or steam is present. Provide enough heat in the storage area to keep material sufficiently dry. **Comments:** Calcium metal is air sensitive. Keep it in tightly closed containers at all times when not in use. Remove only the amount of calcium metal from its storage container that is immediately necessary. Use a metal container with a tightly fitting lid or well-stoppered glass bottles for storage and transport. Scrupulously avoid water contamination of storage tanks, reactor vessels, testing areas, etc.

Transportation Data (49 CFR 172.101-2)

DOT Hazard Class: Flammable Solid	**DOT Shipping Name:** Calcium Metal	**DOT ID No.** UN1401
DOT Label: Flammable Solid; Dangerous When Wet	**IMO Label:** Dangerous When Wet	**IMO Class:** 4.3

Additional DOT Requirements: Keep Cold and Dry. Segregation is the same as for flammable solids labeled Dangerous When Wet.

References: 1-11, 12, 18, 24, 37, 39, 44, 73, 82, 84, 87-94. OW/PJI

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals [illegible] 5/88
Indust. Hygiene/Safety [illegible] 5/88
Medical Review [illegible] 5/88

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © November 1, 1987

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

Section 1. Material Identification

Acetone (CH_3COCH_3) Description: Derived by the dehydrogenation or oxidation of isopropyl alcohol with a metallic catalyst, the oxidation of cumene, the vapor phase oxidation of butane; and as a by-product of synthetic glycerol production. Used as a solvent for paint, varnish, lacquer, fat, oil, wax, resin, rubber, plastic, and rubber cement; to clean and dry parts of precision equipment; in the manufacture of chemicals (methyl isobutyl ketone, methyl isobutyl carbinol, methyl methacrylate, bisphenol-A, acetic acid (ketene process), mesityl oxide, diacetone alcohol, chloroform, iodoform, bromoform), explosives, aeroplane dopes, rayon, photographic films, isoprene; acetylene gas storage cylinders; in purifying paraffin; in nail polish remover; in the extraction of various principles from animal and plant substances; in hardening and dehydrating tissues; in cellulose acetate (especially as spinning solvent); as a solvent for potassium iodide and permanganate; as a delusterant for cellulose acetate fibers; in the specification testing of vulcanized rubber products.

R 1
I 1
S 1*
K 3
* Slight skin absorption

NFPA

HMIS
H 1
F 3
R 0
PPE*
* Sec. 8

Other Designations: CAS No. 67-64-1, AI3-01238, Chevron acetone, dimethylformaldehyde, dimethylketal, dimethyl ketone, β-ketopropane, methyl ketone, propanone, 2-propanone, pyroacetic acid, pyroacetic ether.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.
Cautions: Acetone vapor is a dangerous fire and explosion hazard. High vapor concentrations may produce narcosis (unconsciousness). Prolonged or repeated skin contact causes dryness, irritation, and mild dermatitis.

Section 2. Ingredients and Occupational Exposure Limits

Acetone, 99.5% plus 0.5% water

1991 OSHA PELs *
8-hr TWA: 750 ppm (1800 mg/m^3)
15-min STEL: 1000 ppm (2400 mg/m^3)

1990 IDLH Level
20,000 ppm

1990 NIOSH REL
TWA: 250 ppm (590 mg/m^3)

1992-93 ACGIH TLVs
TWA: 750 ppm (1780 mg/m^3)
STEL: 1000 ppm (2380 mg/m^3)

1990 DFG (Germany) MAK
1000 ppm (2400 mg/m^3)
Category IV: Substances eliciting very weak effects (MAK >500 mL/m^3)
Peak: 2000 ppm, 60 min, momentary value†, 3 peaks/shift

1985-86 Toxicity Data ‡
Human, eye: 500 ppm
Human, inhalation, TC_{Lo}: 500 ppm produced olfaction effects, conjunctival irritation, and other changes involving the lungs, thorax, or respiration.
Rat, oral, LD_{50}: 5800 mg/kg altered sleep time and produced tremors.
Mammal, inhalation, TC_{Lo}: 31500 μg/m^3/24 hr administered to pregnant female from the 1st to 13th day of gestation produced effects on fertility (post-implantation mortality).

* In the cellulose acetate fiber industry, enforcement of the OSHA TWA for "doffers" was stayed on 9/5/89 until 9/1/90; the OSHA STEL *does not* apply to that industry.
† Momentary value is a level which the concentration should never exceed.
‡ See NIOSH, *RTECS* (AL3150000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 133.2 °F (56.2 °C) at 760 mm Hg
Freezing Point: -139.6 °F (-95.35 °C)
Vapor Pressure: 180 mm Hg at 68 °F (20 °C), 400 mm Hg at 103.1 °F (39.5 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3, 0.075 lb/ft^3): 1.48 kg/m^3, .093 lb/ft^3
Refractive Index: 1.3588 at 20 °C
Appearance and Odor: Colorless, highly volatile liquid; sweetish odor.
Molecular Weight: 58.08
Specific Gravity: 0.7899 at 20 °C/4 °C
Water Solubility: Soluble
Other Solubilities: Alcohol, benzene, dimethyl formamide, chloroform, ether, and most oils.
Odor Threshold: 47.5 mg/m^3 (low), 1613.9 mg/m^3 (high)*

* Odor thresholds recorded as a range from the lowest to the highest concentration.

Section 4. Fire and Explosion Data

Flash Point: 0 °F (-18 °C), CC	Autoignition Temperature: 869 °F (465 °C)	LEL: 2.6% v/v	UEL: 12.8% v/v

Extinguishing Media: *Do not* extinguish fire unless flow can be stopped. For small fires, use dry chemical, carbon dioxide (CO_2), water spray or alcohol-resistant foam. For large fires, use water spray, fog, or alcohol-resistant foam. Use water in flooding quantities as fog because solid streams may be ineffective. **Unusual Fire or Explosion Hazards:** Acetone is a dangerous fire and explosion hazard; it is a Class IB flammable liquid. Vapors may travel to a source of ignition and flash back, fire-exposed containers may explode, and a vapor explosion hazard may exist indoors, outdoors, or in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. If feasible, remove all fire-exposed containers. Otherwise, apply cooling water to sides of containers until well after fire is extinguished. If the fire becomes uncontrollable or container is exposed to direct flame, consider evacuation of a one-third mile radius. In case of rising sound from venting safety device or any discoloration of tank during fire, withdraw immediately. For massive cargo fires, use unmanned hose holder or monitor nozzles. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Acetone is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Acetone may form explosive mixtures with hydrogen peroxide, acetic acid, nitric acid, nitric acid + sulfuric acid, chromic anhydride, chromyl chloride, nitrosyl chloride, hexachloromelamine, nitrosyl perchlorate, nitryl perchlorate, permonosulfuric acid, thiodiglycol + hydrogen peroxide. Acetone reacts vigorously with oxidizing materials and ignites on contact with activated carbon, chromium trioxide, dioxygen difluoride + carbon dioxide, and potassium-*tert*-butoxide. Other incompatibles include air, bromoform, bromine, chloroform + alkalies, trichloromelamine, and sulfur dichloride. **Conditions to Avoid:** Keep acetone away from plastic eyeglass frames, jewelry, pens, pencils, and rayon garments. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of acetone can produce CO_2 and carbon monoxide (CO).

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list acetone as a carcinogen. **Summary of Risks:** Acetone has been placed among solvents of comparatively low acute and chronic toxicities. In industry, the most common effects reported are headache from prolonged vapor inhalation and skin irritation resulting from its defatting action. Exposures to less than 1000 ppm acetone vapor produces only slight eye, nose, and throat irritation. Acetone does not have sufficient warning properties to prevent repeated exposures. It is narcotic at high concentrations, i.e., above 2000 ppm. Concentrations above 12000 ppm cause loss of consciousness.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data,*continued*

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Respiratory and central nervous systems, skin. **Primary Entry Routes:** Inhalation, skin and eye contact, ingestion. Liquid acetone is slowly absorbed through the skin. **Acute Effects:** Human systemic effects by inhalation include eye, nose and throat irritation; nausea and vomiting; changes in EEG (electroencephalogram) and carbohydrate metabolism; muscle weakness; drunken behavior; mental confusion and visual disturbance. In extreme cases, breathing high concentrations may produce coma. Human systemic effects by ingestion include gastrointestinal irritation, kidney damage (often indicated by albumin and red and white blood cells in the urine), liver damage (indicated by high levels of urobilin and early appearance of bilirubin), coma, metabolic changes, and systemic effects described for inhalation. Direct eye contact by liquid acetone may produce painful burning and stinging; watering of eyes; conjuctival inflammation; and corneal injury. Skin contact produces a cold feeling, dryness, and mild irritation.
Chronic Effects: Cases of chronic poisoning resulting from prolonged exposure to low concentrations of acetone are rare. Workers exposed to 1000 ppm, 3 hrs per day for 7-15 yrs, complained of dizziness, asthenia (lack or loss of strength), and chronic inflammation of the airways, stomach, and duodenum. Prolonged or repeated skin contact with liquid acetone may defat the skin and cause eczematoid dermatitis.
FIRST AID
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air, monitor for respiratory distress, and administer 100% humidified supplemental oxygen as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. **After first aid, get appropriate in-plant, paramedic, or community medical support.**
Note to Physicians: In symptomatic patients, monitor serum and urine acetone, fluid intake, blood glucose, and arterial pH. Because of the prolonged elimination half-life of acetone, the symptomatic patient may need medical supervision for many hours (up to 30 hrs). Patients may develop hyperglycemia and ketosis mimicking acute diabetic coma. The hyperglycemia may persist for several days following acute exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against inhalation and skin or eye contact. If feasible and without risk, stop leak. Use water spray to reduce vapor, but it may not prevent ignition in closed spaces. For small spills, take up with sand or other noncombustible absorbent material and using nonsparking tools, place into containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Toxicity:** LC_{50} *Salmo gairdneri* (rainbow trout): 5540 mg/L/96 hr at 54 °F (12 °C). LC_{50} (oral) Ring-necked pheasant: >40,000 ppm. **Environmental Degradation:** Acetone biodegrades when released into the environment. The biological oxygen demand for 5 days (BOD5) is 46-55%. **Soil Absorption/Mobility:** Acetone volatilizes, leaches, and biodegrades if released on soil. **Disposal:** Acetone is a good candidate for fluidized bed, rotary kiln incineration, or catalytic oxidation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. U002 (Ignitability), (40 CFR 261.31): F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per Clean Water Act, Sec. 311(b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations < 1000 ppm, wear any chemical cartridge respirator with organic vapor cartridge(s) and wear eye protection to avoid irritation or damage. For concentrations <6250 ppm, wear any supplied-air respirator operated in a continuous-flow mode. For concentrations < 12,500 ppm, wear any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister. For concentrations < 20,000 ppm, wear any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Polyethylene/ethylene vinyl alcohol, Teflon, or butyl rubber with breakthrough times > 8 hr is recommended for PPE . **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry well-ventilated area away from heat, sparks, flames, and other incompatibles. Keep large stocks away from inhabited buildings. Use non-sparking tools to open containers. Keep dry chemical or CO_2 extinguishers on hand in case of fire. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all containers and equipment during fluid transfer. For bulk storage rooms, install electrical equipment, Class I, Group D. **Administrative Controls:** Consider preplacement and periodic medical examinations with emphasis on the skin and respiratory tract. Also consider liver and kidney function tests and urinalysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Acetone	Packaging Authorizations	Quantity Limitations	Vessel Storage Requirements
DOT Hazard Class: 3	a) Exceptions: 173.150	a) Passenger, Aircraft, or Railcar: 5L	Vessel Stowage: B
ID No.: UN1090	b) Non-bulk Packaging: 173.202	b) Cargo Aircraft Only: 60L	Other: --
DOT Packaging Group: II	c) Bulk Packaging: 173.242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T8			

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 176, 180
Prepared by: MJ Wurth, BS; Industrial Hygiene Review: PA Roy, MPH, CIH; Medical Review: AC Darlington, MPH, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 304
METHYL ISOBUTYL KETONE
(Revision C)

Issued: September 1979
Revised: March 1986

SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: METHYL ISOBUTYL KETONE

OTHER DESIGNATIONS: MIBK, Hexone, 4-Methyl-2-pentanone, Methyl i-Butyl Ketone, Isobutyl Methyl Ketone, $CH_3COCH_2CH(CH_3)_2$, ASTM D1153, CAS #0108-10-1.

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
JT Baker, 222 Red School Lane, Phillipsburgh, NJ 08865; Telephone: (201) 859-2151

HMIS
H: 1
F: 3
R: 0
PPE*
*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Methyl Isobutyl Ketone ($C_6H_{12}O$)	ca 100	8-hr TWA 100 ppm* or 410 mg/m^3
* Current OSHA PEL. ACGIH (1985-86) TLV is 50 ppm or 205 mg/m^3.		Human, Inhalation, TCLo: 200 ppm (Irritation)
		Rat, Oral, LD_{50}: 2.08 g/kg
		Rat, Inhalation, LCLo: 4000 ppm/15 min.

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 241°F (116°C)
Vapor Pressure @ 20°C, mm Hg ... 16
Vapor Density (Air = 1) ... 3.5
Solubility in Water @ 20°C, wt. % ... 1.91

Specific Gravity, 20/20°C ... 0.80
Volatiles, % ... ca 100
Evaporation Rate (BuAc = 1) ... 1.62
Melting Point ... -119°F (-84°C)
Molecular Weight ... 100.18

Appearance and odor: Colorless, mobile liquid with a sharp, mintlike odor. Unfatigued odor recognition threshold (100% test panel) is 0.3 to 0.5 ppm. Distinct odor at 15 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
73°F (22.8°C) TCC	860°F (460°C)	% by Vol.	1.4	7.5

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, or foam. Use water with caution. Use water spray to cool fire-exposed containers and surrounding combustibles. Use of a solid stream of water can scatter and spread flames to other areas. (This material is lighter than water and only slightly soluble in water.)
Vapors are heavier than air and can flow along surfaces to distant ignition sources and flash back. Methyl isobutyl ketone is a flammable liquid that can form explosive mixtures with air when heated.

Fire fighters should use self-contained breathing apparatus and fully protective clothing.

SECTION 5. REACTIVITY DATA

Methyl isobutyl ketone is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not polymerize.
This material is an OSHA class IC flammable liquid. It is incompatible with strong oxidizing agents that can cause spontaneous ignition and violent reaction. It ignites on reaction with potassium t-butoxide.
It is a solvent capable of attacking some plastics, resins, and rubbers.
Products of thermal-oxidative degradation of this material can include carbon monoxide and carbon dioxide.
Measurement of its flash point is needed to classify this borderline material as either a class IB or a class IC flammable liquid.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION | TLV

Methyl isobutyl ketone is not listed as a carcinogen by the NTP, IARC, or OSHA.
This material can irritate the eyes, respiratory tract, and skin. Exposure to high concentrations of this material may cause nausea, headaches, dizziness, and unconsciousness. Skin contact may cause defatting and irritation. Eye contact is irritating. Ingestion causes irritation and a burning sensation to the upper digestive tract. The material is a depressant of the central nervous system.

FIRST AID:

EYE CONTACT: Flush thoroughly with running water (including under eyelids) for 15 minutes.
SKIN CONTACT: Remove contaminated clothing. Wash affected area with soap and water.
INHALATION: Remove to fresh air.
INGESTION: Get medical help!*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Seek medical assistance for further treatment, observation, and support, as indicated..

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of major spills. Provide optimum explosion-proof ventilation. Remove sources of ignition. Provide cleanup personnel with protection against contact with liquid and inhalation of vapors.

Absorb small spills on paper and allow waste to evaporate in an exhaust hood. Contain large spills and absorb waste on vermiculite. Pick this up with a nonsparking scoop and place it in a closed metal container for disposal.

Spills can be flushed with water to remove material from a hazardous area; flush it to an open area or to the ground for evaporation. Prevent the discharge of waste into sewers, drains, and waterways.

DISPOSAL: Burn waste material in an approved incinerator. Follow Federal, state, and local regulations.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and exhaust ventilation to meet TLV requirements. Exhaust hoods should have a minimum face velocity of 100 lfm (linear feet per minute). Exhaust fans and other electrical services must be of explosion-proof construction.
For emergency and nonroutine work above the TLV, an approved, full-facepiece, organic-vapor, canister gas mask is recommended; but for unknown concentrations or those above about 3000 ppm, self-contained or air-supplied respirators (positive pressure) are needed. Use safety goggles where liquid contact with the eyes is possible. Do not wear contact lenses when working with solvents. They pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Wear impervious gloves. Where splashing may occur, use a face shield, apron, and other protective clothing as needed to prevent skin contact.
An eyewash station should be available near the workplace. A safety shower is desirable when large amounts are used. Medical surveillance of workers should include preplacement and (at least) annual examinations with attention to possible peripheral neuropathies. (*Lancet*, no. 8138 [August 18, 1979], p. 363.)

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed drums or metal safety cans in a cool, well-ventilated storage area away from ignition sources and oxidizing agents. Storage facility must be of the OSHA-approved type for class IC (or IB) liquids (see sect. 5). Prevent damage to containers.
Ground and bond metal containers when dispensing. Use only nonsparking tools near the solvent. No smoking in areas of storage or use.
Avoid prolonged or repeated contact with skin. Prevent eye contact.

DOT Classification: Flammable Liquid DOT ID No.: UN1245 Label: Flammable Liquid

Data Source(s) Code: 2-4, 6-9, 12, 14, 19-21, 23, 26, 27, 38, 47, 82, 84. CK

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.O. Accrocco, 11/86
Indust. Hygiene/Safety DJW 10-86
Medical Review Oct 86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © March 1, 1986

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 310
METHYLENE CHLORIDE
(Revision F)

Issued: September 1985
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: METHYLENE CHLORIDE

Description (Origin/Uses): Used widely in paint removers, as a solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays, and as a blowing agent in foams.

Other Designations: Dichloromethane; Freon 30®; Methane Dichloride; Methylene Bichloride; Methylene Dichloride; CH_2Cl_2; CAS No. 0075-09-2

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

HMIS
H 2
F 1
R 0
PPG*
*See sect. 8

R 1
I 3
S 3
K 1

NFPA

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methylene Chloride, ca 100%

OSHA PEL
8-Hour TWA: 500 ppm
Ceiling: 1000 ppm Acceptable Maximum Peak above the Ceiling: 2000 ppm for 5 Minutes in Any 2-Hour Period

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 175 mg/m³
(Adopted 1988-89)

Toxicity Data*
Rat, Oral, LD_{50}: 2136 mg/kg
Human, Inhalation, TC_{Lo}: 500 ppm (8 Hours)

*See NIOSH, *RTECS* (PA8050000), for additional data with references to irritative, reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 103.55°F (39.75°C) at 76 Torrs
Melting Point: -142°F (-96.7°C)
Vapor Density (Air = 1): 2.9
Vapor Pressure: 440 Torrs at 77°F (25°C)

Molecular Weight: 84.94 Grams/Mole
Solubility in Water (%): 1% by Weight
Specific Gravity (H_2O = 1): 1.3255 at 68°F (20°C)
% Volatile by Volume: Ca 100

Appearance and Odor: A clear, colorless, volatile liquid; distinctive, penetrating, ethereal odor. The odor will not serve as a useful warning property because concentrations of 100 ppm are not easily perceptible. Most persons can detect this odor at above 300 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 1033°F (556°C)	LEL: 12% v/v	UEL: 19% v/v

Extinguishing Media: *Methylene chloride is not flammable under ordinary conditions. However, flammable vapor-air mixtures can form at approximately 212°F (100°C). Use water spray to cool fire-exposed containers and to flush spills away from exposures. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** Methylene chloride vapor is heavier than air and may collect and concentrate in low-lying, confined spaces. The high vapor pressure of methylene chloride means that when it is spilled, its vapor concentration in air can increase rapidly. If this vapor is heated, an explosion hazard is associated with the vapor-air mixture. Containers of this material may rupture violently if they are involved in fires. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Methylene chloride is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methylene chloride can react dangerously with nitrogen tetroxide, liquid oxygen, potassium, sodium, sodium-potassium alloys, lithium, potassium hydroxide with N-methyl-N-nitroso urea, potassium *t*-butoxide, and finely powdered aluminum and magnesium. **Conditions to Avoid:** Avoid all exposure to sources of ignition, heat, and incompatible chemicals. Prolonged exposure to water may cause hydrolysis to highly corrosive hydrochloric acid when the temperature is above 140°F (60°C). In oxygen-enriched atmospheres or when heated (>212°F [100°C]), methylene chloride vapor can be readily ignited. **Hazardous Products of Decomposition:** Exposure to high temperature (from open flame, hot surfaces, uninsulated steam lines, welding arcs, etc.) can produce toxic and corrosive thermal-oxidative products of decomposition such as hydrogen chloride, carbon monoxide, and even small quantities of phosgene gas, which is extremely poisonous.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Methylene chloride is listed as a suspected human carcinogen by the ACGIH (which classifies it as a group A2 carcinogen). **Summary of Risks:** Accidental contact of liquid methylene chloride with skin or eyes causes painful irritation and possible burns if not promptly removed. Exposure by way of contaminated gloves, clothing, or paint remover formulations can produce these same irritant effects. Long-term exposure to mild or moderate doses of methylene chloride may cause a delayed (24 to 48 hours) onset of dizziness, headache, mental confusion, slurred speech, double vision, and sleeplessness. Medical recovery can be slow. Overexposure to methylene chloride can cause elevated levels of carboxy hemoglobin in the blood (this same effect results from overexposure to carbon monoxide). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, liver, kidneys, and blood. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Headache, giddiness, stupor, irritability, fatigue, tingling in the limbs, and narcosis that is not usually fatal if the exposure is terminated before anesthetic death occurs. **Chronic Effects:** The ACGIH classification of this material as a suspected human carcinogen implies that cancer is a possible effect of chronic exposure to methylene chloride. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with

Copyright © 1988 Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water and then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Note to Attending Physician:** Do not administer adrenalin. **Ingestion.** Unlikely. Should this type of exposure occur, do not induce vomiting because of the danger of aspiration. If spontaneous vomiting should occur, position the exposed person's head below his or her trunk to resist aspiration. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Absorbed methylene chloride is stored in body fat and metabolizes to carbon monoxide. This produced carbon monoxide increases and sustains carboxyhemoglobin levels in the blood, which concommitantly reduces the oxygen-carrying capacity of the blood. NIOSH advises preplacement and annual medical exams that emphasize liver, kidney, eye, skin, CNS, and respiratory system functions and a complete blood count. Simultaneous exposure to tobacco smoke, alcohol, and carbon monoxide, along with heavy manual labor, increases the body burden of a worker as well as the toxic hazards of the methylene chloride. In significant exposures, serum methylene chloride levels are of no clinical importance. Neurologic and hepatic status as well as carboxy hemoglobin should be monitored.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

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

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, NO. U080
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), § 307 (a), and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious neoprene, PVA, or Viton gloves, boots, aprons, and gauntlets, etc., to prevent any skin contact with liquid methylene chloride. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the exposure limits cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Floor or sump ventilation may be necessary. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Other:** Because the health effects of carbon monoxide and methylene chloride are additive (see sect. 6), workplaces should be equipped with automatic sensing equipment that identifies workroom atmospheric levels of both of these materials. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methylene chloride vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store methylene chloride in closed, moisture-proof containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, caustics, and incompatible chemicals (see sect. 5). Protect containers from physical damage. **Special Handling/Storage:** Prevent moist air from entering storage containers. Provide ventilation at the floor level in storage areas because methylene chloride vapor is denser than air. Installation of a dryer and a safety seal on each tank is recommended. Aluminum is not recommended for use as a storage material; appropriate storage materials include galvanized iron, black iron, or steel. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Dichloromethane *or* Methylene Chloride
DOT Hazard Class: ORM-A
ID No. UN1593
DOT Packaging Requirements: 49 CFR 173.605
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: Dichloromethane
IMO Hazard Class: 6.1
IMO Label: Saint Andrew's Cross (X)*
IMDG Packaging Group: III

*Harmful-Stow away from Foodstuffs.

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

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

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

Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).
Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA
2 2 0 -

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	Autoignition Temperature: 788 °F (420 °C)	LEL: 8% (25 °C); 12.5% (100 °C)	UEL: 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

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

Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

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

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

Section 1. Material Identification

Perchloroethylene (C_2Cl_4) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an antihelminthic (parasitic worm removal) agent in veterinary medicine.
Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA
0
2 0
-

HMIS
H 2†
F 0
R 0
PPE‡
† Chronic effects
‡ Sec. 8

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99%. Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL
8-hr TWA: 25 ppm (170 mg/m^3)

1990 IDLH Level
500 ppm

1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation: 0.4 ppm

1992-93 ACGIH TLVs
TWA: 50 ppm (339 mg/m^3)
STEL: 200 ppm (1357 mg/m^3)

1990 DFG (Germany) MAK
TWA: 50 ppm (345 mg/m^3)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia.
Human, lung: 100 mg/L caused unscheduled DNA synthesis.
Rat, oral, LD_{50}: 3005 mg/kg; caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.
Rabbit, eye: 162 mg caused mild irritation.
Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, *RTECS* (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point: -8 °F (-23.35 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)
Viscosity: 0.84 cP at 77 °F (25 °C)
Refraction Index: 1.50534 at 68 °F (20 °C)
Molecular Weight: 165.82
Density: 1.6311 at 59 °F (15/4 °C)
Water Solubility: 0.02% at 77 °F (25 °C)
Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils.
Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate: 0.15 gal/ft^2/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.081 lb/ft^3 or 1.296 kg/m^3
Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2). For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetraoxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),[164] NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),[169] NIOSH (Class-X, carcinogen defined with no further explanation),[164] and DFG (MAK-B, justifiably suspected of having carcinogenic potential)[164]. There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders. **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system. **Primary Entry Routes:** Inhalation and skin and eye contact. **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, conjestion and granular swelling).

FIRST AID ***Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.***
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. *Never administer adrenalin!* **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalaties may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. *BEIs:* C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

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

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetrachloroethylene
DOT Hazard Class: 6.1
ID No.: UN1897
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

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

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification 32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

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

NFPA

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
%Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.
Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA: 3 / 2 / 0 / -

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/m^3
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 100 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 200 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

	Packaging Authorizations	Quantity Limitations	Vessel Stowage Requirements
DOT Shipping Name: Toluene	a) Exceptions: 150	a) Passenger Aircraft or Railcar: 5L	Vessel Stowage: B
DOT Hazard Class: 3	b) Non-bulk Packaging: 202	b) Cargo Aircraft Only: 60L	Other: --
ID No.: UN1294	c) Bulk Packaging: 242		
DOT Packing Group: II			
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

Section 1. Material Identification

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

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

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R	1
I	2
S	2
K	3

NFPA

HMIS
H 2†
F 3
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3
Appearance and Odor: Clear, sweet-smelling liquid.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

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

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC	Autoignition Temperature: 982 °F (527 °C) (*m*-)	LEL: 1.1 (*m*-, *p*-); 0.9 (*o*-)	UEL: 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated milk reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

	Packaging Authorizations	Quantity Limitations	Vessel Stowage Requirements
DOT Shipping Name: Xylenes	a) Exceptions: 173.150	a) Passenger, Aircraft, or Railcar: 5L	a) Vessel Stowage: B
DOT Hazard Class: 3	b) Nonbulk Packaging : 173.202	b) Cargo Aircraft Only: 60L	b) Other: –
ID No.: UN1307	c) Bulk Packaging: 173.242		
DOT Packing Group: II			
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

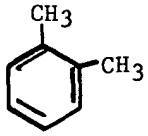
No. 318A

o-XYLENE

Date November 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: o-XYLENE
DESCRIPTION: An aromatic hydrocarbon.
OTHER DESIGNATIONS: $C_6H_4(CH_3)_2$, 1,2-Dimethylbenzene, o-Xylol, CAS #000 095 476
MANUFACTURER: Available from many suppliers, including EXXON Company USA and Shell Chemical Company.



SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Xylene (o-isomer)	> 97	8-hr TWA 100 ppm (Skin)** or 435 mg/m^3
Other C_7 to C_9 Hydrocarbons*	< 3	
*Material may contain ethylbenzene (8-hr TWA 100 ppm) and traces of toluene, C_9 aromatic and aliphatic hydrocarbons.		Rat, oral LDLo 5000 mg/kg
**Current OSHA standard and ACGIH (1980) TLV. NIOSH recommends a 10-hr workday, 40-hr workweek TWA of 100 ppm and a ceiling level of 200 ppm (10 min. sample). TLV set at a level to prevent irritant effects and CNS depression. Selected for mutagenicity and teratogenicity testing in FY80 by EPA under TSCA.		Rat, inhalation LCLo 6125 ppm/12-hr Goldfish, LD_{50} 13 mg/L, 24-hrs (ASTM D1345)

SECTION III. PHYSICAL DATA

Boiling point, deg C	143-145	Specific gravity (25/4 C)	0.876
Vapor pressure, at 25 C, mm Hg	5.2	Melting point, deg C	-23 to -25
Vapor density (Air=1)	3.7	Molecular weight	106.17
Solubility in water at 20C, g/L	0.175	Volatiles, %	ca 100

Appearance & Odor: Clear, colorless liquid. Characteristic sweet odor; recognition threshold (unfatigued) <1 ppm.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air %	LOWER	UPPER
63 F (17.2 C) (CC)	869 F		1.1	6.4

Extinguishing Media: Use dry chemical, foam, carbon dioxide. A water stream can scatter flames. A water spray may be used to cool fire-exposed containers.
This flammable liquid is a dangerous fire hazard and a moderate explosion hazard when exposed to heat or flame. Heavier-than-air vapors can flow along surfaces to distant ignition sources and flash back.
Firefighters should use self-contained breathing apparatus.

SECTION V. REACTIVITY DATA

This material is stable in closed containers at room temperature. It does not polymerize.
It is flammable (OSHA Class IB liquid) and can form explosive mixtures with air. Keep away from sources of heat, sources of ignition and strong oxidizing agents. Thermal-oxidative degradation in air can produce toxic vapors and gases, including carbon monoxide and oxides of nitrogen.

Copyright © 1984 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm or 435 mg/m^3

Xylene is toxic by all portals of entry. It is an irritant of the eyes, mucous membranes, and skin; at high conc. it causes narcosis. Percutaneous absorption is slow and can cause a dermatitis attributed to its defatting properties with prolonged contact causing formation of vesicles. Acute exposure to its vapors may cause CNS depression and minor effects upon liver and kidney functions. Conc. >200 ppm can cause anorexia, nausea, vomiting, dyspnea, vertigo, incoordination, and conjunctivitis. Very high conc. can cause chemical pneumonitis and pulmonary edema. Conc. of 10,000-30,000 ppm may produce anesthesia within one minute.

FIRST AID:

Eye Contact: Flush with running water for 15 minutes, including under eyelids.

Skin Contact: Wash with soap and water. Remove contaminated clothing promptly.

Inhalation: Remove to fresh air. Restore breathing if required.

Ingestion: Get medical attention immediately! Give white mineral oil demulcent and saline cathartic, but do not induce vomiting unless directed by a physician.

Maintain observation of patient for possible delayed onset of pulmonary edema.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel. Remove all ignition sources. Provide adequate ventilation. Use vermiculite or sand to absorb spill; scrape up with nonsparking tools and place in a covered metal container. The absorbed material may be burned in an open pit or placed in cardboard boxes and burned in an incinerator. Spilled liquid can be flushed away from sensitive locations with a water stream; flush to open area not to sewer!

DISPOSAL: Atomized into an approved incinerator, or disposed of via a licensed solvent disposal company, or Belliot process for oxidation destruction of gaseous organic cmpds (#20, pg 380). When large amounts are involved reclaimation procedures may prove economical. Follow Federal, State, and Local regulations.

May be toxic to aquatic life.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and efficient exhaust ventilation (explosion-proof equipment) to meet TLV requirements and to control heavier-than-air vapors. Use >100 lfm face velocity for exhaust hoods. Respirators to be available for nonroutine or emergency use.

Where fumes are <1000 ppm, a chemical cartridge respirator with full facepiece and organic vapor canister is warranted; at >10,000 ppm, a self-contained breathing apparatus with full facepiece operated in the positive pressure-demand mode is used. CAUTION! The lower explosive limit is approx. 11,000 ppm.

Buna-N rubber gloves and aprons should be worn to prevent contact of xylene with the skin. Safety glasses or goggles should be used for eye protection and eyewash stations should be readily accessible to use areas.

Comprehensive preplacement and biennial medical examinations to be directed toward, but not limited to, liver, kidney, gastrointestinal disorders, skin irritation, and the central nervous system.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a clean, cool, well-ventilated area, away from sources of heat, sources of ignition and strong oxidizing agents. Protect containers from physical damage. Bond and ground metal containers when transferring liquid. Use metal safety cans for small amounts. Use nonsparking tools for work in solvent areas. No Smoking in areas of use, storage, or manufacturing.

Prevent skin contact and remove contaminated clothing promptly. Avoid repeated or prolonged breathing of vapor. Do not ingest!

DATA SOURCE(S) CODE: 1-12,19-21,23,26,31,34,37-39

APPROVALS: MIS CRD J. M. Nielsen

Industrial Hygiene and Safety JW 11-26-80

MEDICAL REVIEW: December 5, 1980

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

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

Section 1. Material Identification

Vinyl Chloride (C_2H_3Cl) Description: Derived from ethylene dichloride and alcoholic potassium, by reaction of acetylene and hydrogen chloride (as gas or liquids), or by oxychlorination where ethylene reacts with hydrochloric acid and oxygen. Inhibitors such as butyl catechol, hydroquinone, or phenol are added to prevent polymerization. Used in the plastics industry for the production of polyvinyl chloride resins, in organic synthesis and formerly as a refrigerant, extraction solvent, and propellant (banned in 1974 because of its carcinogenic activity).
Other Designations: CAS No. 75-01-4, chloroethylene, chloroethene, ethylene monochloride, Trovidur, VC, VCM.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Vinyl chloride is a confirmed human carcinogen. Vapor inhalation leads to central nervous system (CNS) depression. The liquid can cause frostbite. It is a flammable gas at room temperature and polymerizes on exposure to air or sunlight. Avoid exposure to VC through engineering controls and wearing PPE

R 2
I 4
S 4
K 4

NFPA: 4 / 2 2 / –

HMIS
H 3*
F 4
R 2
PPE - Sec. 8
* Chronic effects

Section 2. Ingredients and Occupational Exposure Limits

Vinyl Chloride, ca 98 to 99%. Impurities include water, acetaldehyde, hydrogen chloride, hydrogen peroxide, methyl chloride, butane, 1,3-butadiene, chlorophene, diacetylene, vinyl acetylene, and propine.

1991 OSHA PELs
8-hr TWA: 1 ppm
Ceiling: 5 ppm; OSHA-X

1990 NIOSH REL
NIOSH-X

1992-93 ACGIH TLV
TWA: 5 ppm (13 mg/m^3)
TLV-A1

1990 DFG (Germany) TRK*
Existing Installations: 3 ppm
MAK-A1

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: Intermittent exposure to 200 ppm for 14 yr caused liver tumors.
Man, inhalation, TC_{Lo}: 30 mg/m^3/5 yr caused spermatogenesis.
Human, inhalation, TC: Continuous exposure to 300 mg/m^3 for an undetermined number of weeks caused blood tumors.
Rat, oral, LD_{50}: 500 mg/kg; toxic effects not yet reviewed

* TRK (technical exposure limit) is used in place of MAK when a material is a carcinogen. Unlike an MAK below which no adverse effects are expected, the TRK is a limit set below which adverse effects may still occur. This is based on the theory that 1 molecule of a carcinogenic substance may still produce a tumor. The TRK is set to allow for an acceptable risk (for example, 1 tumor in 1 million persons may be an acceptable risk).
† See NIOSH, *RTECS* (KU9625000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 7 °F (-13.9 °C)
Freezing Point: -245 °F (-159.7 °C)
Molecular Weight: 62.5
Specific Gravity: 0.9106 at 68 °F (20 °C)
Ionization Potential: 9.99 eV
Refraction Index: 1.370 at 20 °C/D
Surface Tension: 23.1 dyne/cm at -4 °F (-20 °C)
Odor Threshold: 2000 to 5000 ppm*
Vapor Density (Air = 1): 2.155

Water Solubility: Slightly soluble, 0.1% at 77 °F (25 °C)
Other Solubilities: alcohol, benzene, carbon tetrachloride, ether, hydrocarbon and oils.
Vapor Pressure: 2530 mm Hg at 68 °F (20 °C), 400 mm Hg at -18.4 °F (-28 °C)
Critical Temperature: 304.7 °F (151.5 °C)
Critical Pressure: 56.8 atm
Viscosity: 0.01072 cP at 68 °F (20 °C), *gas*; 0.28 cP at -4 °F (-20 °C), *liquid*
Appearance and Odor: A gas at room temperature. Usually found as a compressed/cooled liquid. The colorless liquid forms a vapor with a pleasant ethereal odor.

*The actual vapor concentration that can be detected by humans has not been adequately determined and varies from one individual to another, from impurities, and probably from exposure duration. The odor threshold is not an accurate warning of exposure.

Section 4. Fire and Explosion Data

Flash Point: -108.4 °F (-78 °C) OC	Autoignition Temperature: 882 °F (472 °C)	LEL: 3.6% v/v	UEL: 33% v/v

Extinguishing Media: For small fires, use dry chemical or carbon dioxide. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Large fires can be practically inextinguishable. Vapors may travel to an ignition source and flash back. VC may polymerize in cylinders or tank cars and explode in heat of fire. Vapors pose an explosion hazard indoors, outdoors, and in sewers. VC decomposes in fire to hydrogen chloride, carbon monoxide, carbon dioxide, and phosgene. Burning rate = 4.3 mm/min. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Stop gas leak if possible. Let tank, tank car, or tank truck burn unless leak can be stopped. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if this is impossible, withdraw from area and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Long term exposure to air may result in formation of peroxides which initiates explosive polymerization of the chloride. VC can polymerize on exposure to light or in presence of a catalyst. **Chemical Incompatibilities:** VC can explode on contact with oxide of nitrogen, may liberate hydrogen chloride on exposure to strong alkalies, and is incompatible with copper, oxidizers, aluminum, and peroxides. In the presence of moisture, VC attacks iron and steel. **Conditions to Avoid:** Exposure to sunlight, air, heat, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of vinyl chloride can produce carbon oxides, and chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: Vinyl chloride is listed as a carcinogen by the IARC (Class 1, *sufficient human evidence*),[164] NTP (Class 1, *sufficient human* evidence),[169] NIOSH (Class X, *carcinogen defined without further categorization*),[163] ACGIH (TLV-A1, *confirmed human carcinogen*),[163] DFG (MAK-A1, *capable of inducing malignant tumors in humans*),[163] and OSHA (Class X, *carcinogen defined without further categorization*).[164] Liver tumors (angiosarcomas) are confirmed from VC exposure. Other tumors of the CNS, respiratory system, blood, and lymphatic system have occurred from exposure to the polyvinyl chloride manufacture process but VC itself may not be the causative agent. **Summary of Risks:** Vapor inhalation causes varying degrees of CNS depression with noticeable anesthetic effects at levels of 1% (10,000 ppm). Studies have shown loss of libido and sperm in men exposed to VC and in Russian studies, 77% of exposed women experienced ovarian dysfunction, benign uterine growths, and prolapsed genital organs. However, no teratogenic effects have been seen in offspring of exposed workers.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

It appears that metabolism is necessary before many of VC's toxic effects occur. Some vinyl chloride is exhaled unchanged but most is metabolized to chloroacetaldehyde. Skin absorption may occur if liquid is confined on skin but absorbed amount would be small. It is possible that the phenol inhibitor may be absorbed as well. The compressed liquid can cause frostbite. Vapors are severely irritating to the eyes. Chronic exposure can cause cancer and a triad of syndromes known as *vinyl chloride disease*. **Medical Conditions Aggravated by Long-Term Exposure:** Liver, cardiac, pulmonary, and connective tissue disorders. **Target Organs:** Liver, CNS, respiratory and lymphatic systems, bone, and connective tissue of the skin. **Primary Entry Routes:** Inhalation, skin/eye contact. **Acute Effects:** CNS effects include fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, dulling of auditory cues, numbness and tingling in the extremities, narcosis, unconsciousness, and death due to respiratory failure. Respiratory problems include dyspnea, asthma, and pneumonoconiosis. **Chronic Effects:** Repeated exposure has lead to liver cancer; confirmed because of the otherwise rarity of its type (angiosarcoma). Tumors in other organs have occurred in the polyvinyl chloride industry but agents other than VC may be responsible; authorities are still debating this issue. A triad of other effects are associated with VC exposure. Acro-osteolysis is associated with hand cleaning of polymerization vessels and characterized by dissolution of bone in the hands, especially when associated with resorption. Raynaud's Phenomenon is a vascular disorder marked by recurrent spasm of the capillaries and especially those of the fingers and toes on exposure to cold. This is usually accompanied by pain and in severe cases may progress to local gangrene. Sclerodermatous skin changes (affecting the dorsal hands and distal forearms) are seen and described as a slowly progressive disease marked by deposition of fibrous connective tissue in the skin. The skin becomes thickened and raised nodules appear. Arthralgias (pain in one or more joints) and blood changes with decreased platelet number and capillary abnormalities may also occur.
FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. For frostbite, immerse affected area in 107.6 °F (42 °C) water until completely rewarmed. *Do not* use dry heat. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Unlikely! VC is a gas above 7 °F (-14°C). **Note to Physicians:** Endotracheal intubation may be required if significant CNS or respiratory depression occur. Diagnostic test: thiodiglycolic acid in urine (normally < 2 mg/g creatinine).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If possible without risk, stop gas flow. Shut off ignition sources. Report any release > 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** VC reacts with hydroxyl radicals in the trophosphere with a half-life of 1.2 days. The half-life = a few hr in photochemical smog. Reaction products in the air include chloroacetaldehyde, hydrogen chloride, chloroethylene, epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In soil, VC rapidly volatilizes. What does not evaporate will be highly mobile and may leach into groundwater. In water, VC is not expected to hydrolyze, bioconcentrate, or absorb to sediment. It will rapidly volatilize with an estimated half-life of 0.805 hr for evaporation from a river 1 meter deep with a current of 3 meter/sec and a wind velocity of 3 meter/sec. In waters containing photosensitizers such as humic acid, photodegradation will be rapid. **Soil Absorption/Mobility:** From an estimated solubility of 2,700 ppm, a Koc of 56 is established for VC which indicates high soil mobility and potential to leach into groundwater. **Disposal:** Dilute any waste compressed liquid to a 1% solution and remove phenol inhibitor as sodium. Pour onto vermiculite, sodium bicarbonate, or a sand & soda ash mixture (90/10). Add slaked lime if fluoride is present. Mix in paper boxes, place in incinerator, cover with scrap wood and paper, and ignite with excelsior train. Another method is to dissolve waste in a flammable solvent and spray in incinerator firebox equipped with an afterburner and alkali scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U043
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 307 (a); CAA, Sec. 112, & RCRA, Sec. 3001]

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. According to NIOSH[148], for any detectable concentration use a SCBA or supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode. See 29 CFR 1910.1017 for detailed OSHA respirator recommendations. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or chlorinated polyethylene to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL's (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate work clothes from street clothes, launder before reuse and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area in clearly labeled containers. Outside or detached storage is preferred. Large amounts should be stored in steel containers under pressure. Keep separate from incompatibles (Sec. 5). Venting, under pressure should be safety relief. At atm, venting should be pressure vacuum. Regularly monitor inhibitor levels. To avoid static sparks, electrically ground and bond all equipment used with VC. Avoid open flames, spark formation and electric discharges around VC. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Install Class 1, Group D electrical equipment. **Administrative Controls:** Inform VC exposed personnel of hazards associated with its use. Preplacement and periodic medical exams of workers exposed above the action level is mandatory under OSHA 29 CFR (1910.1017). Monitor for liver cancer, scleroderma, pneumonitis, clotting abnormalities, and acro-osteolysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Vinyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1086
DOT Packing Group: --
DOT Label: Flammable Gas
Special Provisions (172.102): B44

Packaging Authorizations
a) **Exceptions:** 173.306
b) **Non-bulk Packaging:** 173.304
c) **Bulk Packaging:** 173.314 & 173.315

Quantity Limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** 150 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

37

Polytrifluorochloroethylene, Liquid [$(CF_2CFCl)_n$] Description: A polymer of chlorotrifluoroethylene, usually including vinylidine fluoride. Used in chemical piping, gaskets tank linings, connectors, valve diaphragms, wire and cable insulation, and electronic components.
Other Designations: CAS No. 9002-83-9, chlorotrifluoroethylene polymer, fluorothene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R	1
I	1
S	1
K	1

Genium

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

Overview: Polytrifluorochloroethylene is a nonflammable, relatively inert liquid that is slightly irritating to eyes and skin.

Section 2. Ingredients and Occupational Exposure Limits

Polytrifluorochloroethylene, ca 100%

1990 OSHA PEL	1991-92 ACGIH TLV	1990 DFG (Germany) MAK	1990 NIOSH REL	1985-86 Toxicity Data*
None established	None established	None established	None established	None listed

* Monitor NIOSH, *RTECS*, for future toxicity data.

Section 3. Physical Data

Vapor Pressure: <0.00001 mm Hg at 100 °F (38 °C)
Refraction Index: 1.43
Molecular Weight: Varies
Appearance and Odor: Clear to cloudy, colorless, odorless liquid.
Density: 2.10 to 2.15 at 77 °F (25 °C)
Water Solubility: Insoluble

Section 4. Fire and Explosion Data

Flash Point: Nonflammable	Autoignition Temperature: Not reported	LEL: Not reported	UEL: Not reported

Extinguishing Media: Extinguishing media suitable for surrounding fire. For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: None reported.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also wear fully protective clothing. If possible without risk, remove container from fire area. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Polytrifluorochloroethylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. It is impervious to corrosive chemicals, resistant to most organic solvents, heat resistant, and thermoplastic (capable of softening and fusing when heated, and hardening again upon cooling).
Chemical Incompatibilities: Polytrifluorochloroethylene reacts exothermically (producing heat) with alkali metals (sodium and potassium) and aluminum and magnesium under pressure, and is reactive with amines and liquid fluorines.
Conditions to Avoid: Heating above 500 °F (262 °C) and contact with hot surfaces or open flame.
Hazardous Products of Decomposition: Thermal oxidative decomposition of polytrifluorochloroethylene [above 575 °F (301.9 °C)] can produce toxic, irritating, and sensitizing thermal breakdown products, including organic and inorganic fluorine compounds.

Copyright © 1992 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[142] and OSHA,[164] do not list polytrifluorochloroethylene as a carcinogen.
Summary of Risks: Polytrifluorochloroethylene can be slightly irritating to skin and eyes. Due to polytrifluorochloroethylene's extremely low vapor pressure, inhalation is not an important hazard unless this material is heated or misted.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin and eyes.
Primary Entry Routes: Skin and eye contact.
Acute Effects: There are no specific symptoms described other than slight irritation to skin and eyes.
Chronic Effects: None reported.
FIRST AID
Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Consult a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Position to avoid aspiration of vomitus.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against contamination. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spills for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection plan that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in cool, dry, well-ventilated area away from incompatibles (Sec. 5).
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control the airborne contaminants and to maintain concentrations at the lowest practical level.
Administrative Controls: Consider preplacement and periodic medical examinations of exposed workers. Avoid contact with hot surfaces or open flame.

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

MSDS Collection **References:** 73, 103, 132, 149
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 393

ELECTRICAL INSULATING OIL

Date September 1978

SECTION I. MATERIAL IDENTIFICATION

Reviewed: December 1981

MATERIAL NAME: ELECTRICAL INSULATING OIL
DESCRIPTION: Highly refined light mineral oil which is suitable for electrical insulation
OTHER DESIGNATIONS: ANSI/ASTM D3487, GE Material A13A3, UNIVOLT 60 and N61, DIALA A and AX Oils, Transformer Oil; formerly known as IOC and IOCA oils.
MANUFACTURER: Material available from several suppliers, including:

Exxon Company, USA
P.O. Box 2180, Houston, TX 77001
Telephone: (713) 221-3424

Shell Oil Company
One Shell Plaza, Houston, TX 77002
Telephone: (713) 473-9461

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Highly Refined Mineral Oil	ca 100	8-hr TWA 5 mg/m^3* (as mist)
Stabilizer: 2,6-Diteriarybutyl-p-cresol or 2,6-Ditertiarybutylphenol	<0.3	8-hr TWA 10 mg/m^3** None Established

* Current OSHA and ACGIH TLV for mineral oil mist.

**ACGIH (1981) TLV

SECTION III. PHYSICAL DATA

Boiling range at 1 atm, deg F ----- ca 540-750
Vapor pressure at 20 C, mm Hg ----- < 0.01
Vapor density (Air=1) ---------- ca 9
Water solubility ---------- Negligible

Specific gravity (H_2O=1) --- <0.91
Volatiles ---------- Negligible
Evaporation rate -------- Negligible
Viscosity at 0 C, cstk -- < 76
Pour point, deg C, max -- -40

Appearance & Odor: Nearly colorless, clear oil with a slight petroleum odor

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air Volume % in air (approx.)	LOWER	UPPER
> 145 C (COC)			1	7

Extinguishing Media: Carbon dioxide, foam, dry chemical, or water fog or spray. Use water spray to cool fire-exposed containers. A direct stream of water on burning oil can spread fire; water can cause frothing and splattering of hot oil. Dry chemical or carbon dioxide should be used for extinguishing fire in electrical equipment.

Firefighters should use self-contained breathing apparatus when fighting fires of this material in enclosed areas.

SECTION V. REACTIVITY DATA

This combustible liquid is stable for long-term storage and use. It does not polymerize. It is low in fire hazard, even when moderately heated. However, it will burn vigorously when hot. Thermal-oxidative decomposition products include toxic vapors and gases, such as carbon monoxide.

As a combustible material it is incompatible with strong oxidizing agents, such as concentrated oxygen, chlorine, or nitric acid.

Copyright © 1984 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

No. 393

SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 mg/m^3 (as mist)

The low vapor pressure of this material eliminates the inhalation hazard, unless the material is heated (vapors and thermal-oxidative degradation products) or misted; such inhalation can be irritating or toxic.

Liquid contact causes irritation of the eyes, and, when repeated or prolonged, of the skin. Do not ingest!

FIRST AID:

Eye contact: Flush eyes thoroughly with plenty of running water until irritation stops.

Skin contact: Wipe oil off skin with paper towel or cloth. Then cleanse the skin with approved cleaning aid and/or soap and water. Promptly remove oil-contaminated clothing.

Inhalation: Remove to fresh air. Get medical help if discomfort persists.

Ingestion: Do not induce vomiting (aspiration hazard)! Contact a physician.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Provide ventilation. Contain spill and pick up free liquid. Absorb small spills and residues with inert solid such as clay, diatomaceous earth, dry sand, etc. Personnel involved in clean-up should use protection against liquid contact. When spill is large, safety personnel should be involved in clean-up. Keep out of sewers and waterways.

Disposal - Burn waste material in an approved incinerator in accordance with Federal, State, and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and local exhaust ventilation when required to meet TLV levels of mist.

Use butyl rubber or polyethylene gloves to avoid repeated or prolonged contact with oil Use safety goggles, impervious apron, and protective clothing as needed to prevent eye or skin contact when material is sprayed or splashed.

Special ventilation may be needed if material is heated or oxidized.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store and handle as a combustible hydrocarbon fluid. Keep away from heat, ignition sources and strong oxidizing agents.

Follow good hygienic practice in using this material. Avoid frequently repeated or prolonged skin contact. Avoid inhalation of mists or vapors. Do not wear oil-soaked clothing.

When using this material, wash exposed skin areas with soap and water several times during the day. Be sure work clothing is laundered at least weekly.

DATA SOURCE(S) CODE: 1, 2, 6, 12

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

Corporate Medical Staff

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

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

Material Safety Data Sheets Collection:
Sheet No. 397
***n*-Hexane**
Issued: 10/78 Revision: D, 9/92

Section 1. Material Identification

***n*-Hexane ($CH_3(CH_2)_4CH_3$) Description:** Derived by fractional distillation from petroleum (molecular sieve process). Used as a solvent for glues, cements, adhesives, fats, and oils; a lab reagent; liquid in low temperature thermometers (instead of mercury); thinner, cleaning agent; polymerization reaction medium; an alcohol denaturant; in retreading tires for determining the refraction index of minerals.
Other Designations: CAS No. 110-54-3, dipropyl, Gettysolve-B, hexyl hydride, NCI-C60571, Skellysolve-B.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

NFPA
R 1
I 3
S 2*
K 3
* Skin absorption

HMIS
H 2†
F 3
R 0
PPE-Sec. 8
† Chronic effects

Cautions: *n*-Hexane is highly flammable. It is irritating to the eyes, skin, and mucous membranes. Vapor inhalation produces central nervous system (CNS) depression, becoming anesthetic at high concentrations. Chronic exposure may result in polyneuropathy.

Section 2. Ingredients and Occupational Exposure Limits

n-Hexane; commercial hexane is a mixture of *n*-hexane and isomers of methyl pentane and heptane. 1 to 6% benzene may also be present.

1991 OSHA PEL
8-hr TWA: 50 ppm (180 mg/m^3)

1990 IDLH Level
5000 ppm

1990 NIOSH REL
TWA: 50 ppm (180 mg/m^3)

1992-93 ACGIH TLV
TWA: 50 ppm (176 mg/m^3)

1990 DFG (Germany) MAK
TWA: 50 ppm (180 mg/m^3)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 5000 ppm/10 min caused hallucinations and distorted perceptions.
Rat, oral, LD_{50}: 28,710 mg/kg; no toxic effect noted
Rat, inhalation, TC_{Lo}: 1000 ppm/6 hr from the 8th to 16th day of pregnancy produced effects on newborn growth.
Rabbit, eye: 10 mg caused mild irritation.

* See NIOSH, *RTECS* (MN9275000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 156 °F (69 °C)
Freezing Point: -139 °F (-95 °C)
Vapor Pressure: 150 mm Hg at 77 °F (25 °C)
Refraction Index: 1.37486 at 68 °F (20 °C)
Critical Temperature: 453.2 °F (234 °C)
Critical Pressure: 29.7 atm
Liquid Surface Tension: 18.4 dyne/cm
Odor Threshold: 65 ppm

Molecular Weight: 86.17
Density: 0.66 at 20/4 °C
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.1049 lb/ft^3 or 1.678 kg/m^3
Water Solubility: Slightly, 0.014 mg/ml at 68 °F (20 °C)
Other Solubilities: Alcohol, acetone, chloroform, ether, and most non-polar solvents.
Ionization Potential: 10.18 eV
Viscosity: 0.334 cP at 35 °F (2 °C), 0.306 cP at 80 °F (27 °C), 0.276 cP at 145 °F (62.5 °C)
Appearance and Odor: A colorless, volatile liquid with a gasoline-like odor.

Section 4. Fire and Explosion Data

Flash Point: -7.6 °F (-22 °C)	Autoignition Temperature: 437 °F (225 °C)	LEL: 1.2% v/v	UEL: 7.5% v/v

Extinguishing Media: *n*-Hexane is a Class 1B Flammable Liquid. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. *n*-Hexane poses a vapor explosion hazard indoors, outdoors, and in sewers. Burning rate = 7.3 mm/min.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing appar-atus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. If possible without risk, move container from fire area. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Discoloration may indicate danger of BLEVE (boiling liquid expanding vapor explosion). Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: *n*-Hexane is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Incompatible with strong oxidizers and may explode at 82.4 °F (28 °C) when mixed with dinitrogen tetraoxide. **Conditions to Avoid:** Contact with heat and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of *n*-hexane can produce acrid smoke and irritating vapors.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list *n*-hexane as a carcinogen. Although there is no data on human carcinogenicity specifically caused by n-hexane, there is an increase in association between Leukemia risk in the rubber industry and exposure to a variety of sub-stances including hexane. **Summary of Risks:** Vapors are irritating to the skin, eyes, and respiratory tract. Inhalation produces varying degrees of CNS depression depending on concentration. High concentrations may lead to asphyxia (oxygen displacement). Chronic exposure (usually at least 60 to 240 ppm) results in neurotoxicity characterized by sensory loss, pain, and neurogenic atrophy of skeletal muscle. Peripheral neuropathy is mostly of the 'stocking & glove' type. *n*-Hexane is ultimately converted to 2,5-hexanedione during metabolism and is considered to be the metabolite respon-sible for toxicity. Evidence exists that *n*-hexane accumulates in fatty tissue which would explain its affinity for the blood, liver, and brain where lipids are prevalent. After exposure has ceased, the half-life is 64 hrs. Metabolism is inhibited by co-exposure to toluene, methylethyl ketone, or methyl *n*-butyl ketone. *n*-Hexane is absorbed through the skin in both liquid and vapor form. Therefore, dermal vapor absorption raises biological levels above those reached during inhalation of or below the TLV concentration. This is why it is imperative that protective clothing be used so that the TLV levels are sufficient to prevent over-exposure. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, CNS, PNS, and respiratory diseases. **Target Organs:** Eyes, skin, respiratory system, central and peripheral nervous system. **Primary Entry Routes:** Inhalation, skin contact/absorption, eyes, ingestion. **Acute Effects:** Vapor inhalation produced marked vertigo and hallucinations at 5000 ppm/10 min; drowsiness, fatigue, appetite loss, and paresthesia in the distal extremities at 1000 to 2500/12 hrs; muscle weakness, cold pulsation in extremeties, blurred vision, headache, anorexia and onset of polyneuropathy at 500 to 2500 ppm (time not given).

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Skin contact causes immediate irritation with redness, painful burning and possible blisters. Eye contact produces irritation, watering, and burning. Ingestion poses a serious aspiration hazard. If aspiration into the lungs occurs, asphyxiation from oxygen displacement may lead to brain damage and cardiac arrest. Cardiac sensitization to epinephrine (the body's adrenalin) may cause rhythm disturbances with potentially fatal consequences. **Chronic Effects:** Polyneuropathy occurs from repeated exposure to levels typically in the 400 to 600 ppm range; there is a case of polyneuropathy after exposure to 54 to 200 ppm/1 year. Initial symptoms include muscle weakness, motor loss, sensation disturbances (numbness and pain without stimulus), and distal symmetric leg pain after 2 to 6 months exposure. Clinical studies indicate muscle atrophy (wasting away), foot drop, decreased muscle tone and strength, and paresthesias of the arms and legs. Vision problems including changes in color vision, retinal pigmentation, and in perifoveal capillaries were found in workers exposed to 420 to 1280 ppm for > 5 years. Progression of neuropathy may continue for several months after exposure has ceased, followed by slow recovery taking on the average of 9 to 10 months and rarely, up to 2 years. Residual spinal cord damage was noted in most severely injured victims.

FIRST AID ***Emergency personnel should protect against exposure***

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and administer supplemental oxygen as needed. Intubation may be necessary in severe cases (aspiration of liquid). **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of severe aspiration hazard. If spontaneous vomiting occurs, position head to avoid aspiration of vomitus.

Note to Physicians: BEI = 2,5-hexanedione in urine, sample at end of shift at workweeks end, 5 mg/g creatine. Also measure *n*-hexane in expired air. Analgesics may be necessary for pain management, there is no specific antidote. Monitor arterial blood gases in cases of severe aspiration.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. Dike far ahead of large spill for later disposal or reclamation. For water spills, use oil skimming equipment to lift spill. Absorbent foams can be applied to slick. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Degradation:** If released on soil, *n*-hexane will readily volatilize from moist surfaces although some may absorb to soil. In water, *n*-hexane will volatilize rapidly although some will absorb to sediment. The log bioconcentration factor (log BCF) estimated at 2.24 to 2.89 suggests bioconcentration is not an important factor in aquatic systems. The estimated Koc of 1250 to 4100 indicates that *n*-hexane absorbs to carbon/organic matter. Volatilization half-life from a model river is 2.7 hr at 77 °F (25 °C), 1 meter deep flowing at 1m/sec with a 3 m/sec wind speed. Volatilization from a model pond (which considers effect of absorption) is estimated at 6.8 days. In the atmosphere, it is expected to exist entirely in the vapor phase. It does not absorb UV light in the environmentally significant range (> 290 nm). It reacts with photochemically produced hydroxyl radicals. Estimated lifetime under photochemical smog conditions is 5.9 hr (SE England). **Disposal:** Spray into an incinerator (may burn quicker by addition of another flammable solvent). Evaporation in a suitable hood may be used for smaller amounts. Landfill is *not* recommended. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
Listed as a RCRA Hazardous Waste (40 CFR 261.21): D001, *Characteristic of ignitability*
Listed as 'Unlisted hazardous Waste, *Characteristic of ignitability*' a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001]

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 500 ppm, use a supplied-air respirator (SAR) or SCBA. For < 1250 ppm, use a SAR operated in continuous-flow mode. For 2500 ppm, use a SAR with a tight-fitting facepiece operated in continuous-flow mode or a SCBA with a full facepiece. For < 5000 ppm, use a SAR operated pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of nitrile, Viton, polyvinyl chloride, or chlorinated polyethylene to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 5).

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Purge all vessels previously containing *n*-hexane with steam before entering for the purpose of repair (cutting, welding). Refer to OSHA's Confined Space Standard (29 CFR 1910.119). **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the central and peripheral nervous systems, skin, eyes, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Hexanes	**Packaging Authorizations**	**Quantity Limitations**	**Vessel Stowage Requirements**
DOT Hazard Class: 3	**a) Exceptions:** 173.150	**a) Passenger Aircraft or Railcar:** 5L	**a) Vessel Stowage:** E
ID No.: UN1208	**b) Non-bulk Packaging:** 173.202	**b) Cargo Aircraft Only:** 60L	**b) Other:**
DOT Packing Group: II	**c) Bulk Packaging:** 173.242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T8			

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 397A
HEXANE ISOMERS
(Other Than n-Hexane)
Revision A
DATE August 1983

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: HEXANE ISOMERS (Other Than n-Hexane)
DESCRIPTION: This material is a single hexane isomer or a mixture of hexane isomers with a very low or negligible level of n-hexane. (See CAS Nos. Sect. II) C_6H_{12}
MANUFACTURER: Available from many sources.

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
2,2-Dimethylbutane or Neohexane (CAS# 000 075 832) 2,3-Dimethylbutane or Diisopropyl (CAS# 000 079 298) 2-Methylpentane or Isohexane (CAS# 000 096 835) 3-Methylpentane (CAS# 000 096 140)	> 95	8-hr TWA 500 ppm*
n-Hexane (CAS# 000 110 543) (See MSDS #397)	< 1	8-hr TWA 50 ppm*
Other Saturated Hydrocarbons (C_5 to C_7)	Trace	
Unsaturated Hydrocarbons	Trace	
Aromatic Hydrocarbons	< 0.1	

*ACGIH (1983) TLV. 50 ppm for n-hexane or 500 ppm for its isomers (excluding n-hexane).

SECTION III. PHYSICAL DATA

	2,2-Dimethyl Butane	2,3-Dimethyl Butane	2-Methyl Pentane	3-Methyl Pentane
Boiling point, 1 atm, deg C --------	49.7	57.9	60	63.3
Vapor pressure, mm Hg/Temp ---------	400/31 C	400/39 C	400/41.6 C	400/10.5 C
Specific gravity at 20 C (H_2O=1) ---	0.649	0.662	0.654	0.664
Flash point, deg F ----------	-54	-20	-10	<-29
Autoignition temperature, deg F ----	797	788	583	--
Flammability limits, LEL/UEL -------	1.2/7.0	1.2/7.7	1.2/7.0	1.2/7.0

These compounds and their mixtures are clear, colorless liquids which are insoluble in water. Hydrocarbon odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air Volume % (estimate) Lower	Upper
Depends on components (See Sect. III)	Depends on components (See Sect. III)	1.2	

Extinguishing Media: Use carbon dioxide, dry chemical or foam. Water may be ineffective in putting out fire and water stream will spread flames; but a water spray should be used to cool fire-exposed containers to prevent pressure rupture.
This flammable liquid is a dangerous fire hazard; it may be an explosion hazard when heated.
Firefighters should use self-contained breathing equipment with proper eye and skin protection.

SECTION V. REACTIVITY DATA

This is a stable liquid in a closed container at room temperature. It does not polymerize.
This highly flammable liquid (OSHA Class 1B) must be kept away from heat, and sources of ignition. It is incompatible with oxidizing agents.
Thermal-oxidative decomposition products in air can include carbon monoxide.

Copyright © 1984 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

NO. 397A

SECTION VI. HEALTH HAZARD INFORMATION

TLV 500 ppm (See Sect II)

Excessive exposure to vapors of this material can be irritating to the respiratory tract and can produce dizziness, intoxication and unconsciousness, depending on exposure level and time. Liquid contact with the eyes is irritating; skin contact can be irritating, defatting, and lead to dermatitis when repeated or prolonged. Ingestion is upsetting and irritating to the GI tract. Aspiration is a hazard if vomiting occurs.

FIRST AID:

Eye Contact: Flush eyes well with running water for 15 minutes. Get medical help if irritation persists.

Skin Contact: Wash contact area with soap and water. Remove contaminated clothing promptly. Replace skin oils with lotions or creams.

Inhalation: Remove to fresh air. Restore breathing if required. Get medical help.

Ingestion: Get medical help immediately. Give several ounces of edible oil to drink. (Aspiration hazard! Do not induce vomiting. If spontaneous vomiting occurs, lower head to knee level.)

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Establish plans and provide training prior to any emergency situation. When spills occur exclude workers from area except those assigned to clean-up who must have proper protection against inhalation of vapors or contact with liquid (See Sect. VIII). Provide maximum explosion-proof ventilation. Eliminate ignition sources. Flush away from sensitive areas with a cold water spray. (Flush to ground not to the sewer!) Small amounts of liquid (or absorbed liquid) can be allowed to evaporate with good ventilation or in a hood or open area; large spills should be picked up in a safe and appropriate manner for disposal.

DISPOSAL: Scrap material can be burned with skill and caution in an approved incinerator in accordance with Federal, State and local regulations.

Aquatic toxicity: TLm96: > 1000 ppm

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and local exhaust ventilation which is explostion proof and adequate to meet the action level or TLV requirements. For emergency or nonroutine exposures above the TLV an approved organic vapor cartridge respirator can be used for a limited time below 1000 ppm. Use an approved air-supplied or self-contained respirator with full-facepiece protection for higher or unknown exposure levels.

Prevent skin contact by use of impermeable gloves, aprons, boots, suits, etc as needed by the circumstances of use. Prevent eye contact by use of safety glasses, goggles, or face shield with goggles or glasses as the workplace circumstances may require.

Eyewash stations and safety showers should be readily available to areas of handling and use.

Preemployment and periodic medical exams should emphasize the skin and the nervous system.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a clean, cool, well-ventilated place, away from oxidizing agents and sources of heat and ignition. Protect containers from physical damage. Ground and bond containers for transfers to prevent static sparks. Use metal safety cans for handling small amounts. Storage and handling conditions must follow OSHA regulations for OSHA Class 1B flammable liquid. No smoking in areas of storage or use.

Avoid breathing vapors! Prevent contact with skin or eyes! Do not ingest!

Exposure monitoring and recordkeeping requirements which have been proposed by NIOSH for alkanes should be instituted.

DATA SOURCE(S) CODE: 2-12, 14, 19, 23, 25, 37, 38, 47

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY 7-18-83

MEDICAL REVIEW: 1 August 1983

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

From Genium's MSDS Collection, to be used as a reference.

MSDS # G 398

ISOBUTYL ALCOHOL
Revision A

Issued: October, 1978
Revised: August, 1985

SECTION 1. MATERIAL IDENTIFICATION

17

MATERIAL NAME: ISOBUTYL ALCOHOL

OTHER DESIGNATIONS: IBA, Isobutanol, 1-Hydroxymethyl propane, Isopropyl Carbinol, 2-Methyl Propanol, 2-Methyl-1-Propanol, 2-Methylpropan-1-ol, 2-Methylpropyl Alcohol, $(CH_2)_2CHCH_2OH$, GE Material D5B4B, CAS #000 078 831

MANUFACTURER/SUPPLIER: Available from several suppliers, including;
Celenese Chemical Co. Dallas, TX 75240
1250 W Mockingbird Lane (214) 689-4000

3 / 1 / 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
ISOBUTYL ALCOHOL * Current ACGIH TLV/STEL. The OSHA PEL is 100 ppm, 300 mg/m^3. $(CH_3)_2CHCH_2OH$	ca 100	8 Hr. TWA: 50 ppm, 150 mg/m^3 STEL: 75 ppm, 225 mg/m^3* Rat Testing Oral: LD50: 2460 mg/kg Inhalation LClo: 8000 ppm for 4 hours Subcutaneous (intermittent) TDLo: 29g/kg (carcinogenic) Rabbit, Skin: LD50: 4240 mg/kg

SECTION 3. PHYSICAL DATA

Boiling point, 1 atm	226.2°F (107.9°C)	Specific gravity (20/20°C)	0.803
Vapor pressure, 20°C, mmHg	8.8	Volatiles, %	ca 100
Vapor density (Air=1)	2.55	Evaporation rate (BuAc=1)	0.82
Solubility in water, 20°C, wt. %	8.5	Freezing point	-162.4°F (-108°C)
		Molecular weight	74.12

APPEARANCE & ODOR: Clear, colorless liquid with a mild, alcohol-like, non-residual odor. The odor recognition threshold (100% of test panel, unfatigued) is 2.05 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
86°F (30°C) T.C.C.	824°F (440°C)	Vol. %	1.2	10.9

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, or alcohol type foam. Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool fire-exposed tanks/containers. This flammable liquid (OSHA Class IC) is a moderate fire hazard when exposed to heat, flame or oxidizers. Its vapors are heavier than air and may travel considerable distance to a source of ignition and flashback.

Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving Isobutyl Alcohol.

SECTION 5. REACTIVITY DATA

Isobutyl Alcohol is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This flammable material should be kept away from strong oxidizing agents, heat, sparks, and open flame. It is incompatible with inorganic acids, aldehydes, and isocyanates. Isobutyl alcohol may attack metallic aluminum at high temperatures.

Thermal decomposition or burning will produce carbon monoxide, carbon dioxide, or isobutylene.

Copyright © on issue date, Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

TLV 50 ppm, 150 mg/m^3 (See Section 2)

Vapors of isobutyl alcohol are irritating to the eyes, mucous membranes, and respiratory tract. In high concentration, vapors may cause headache, nausea, dizziness, drowsiness, narcosis, and unconsciousness depending on the level and time of exposure. The liquid is irritating to the skin and may cause eczematoid dermatitis, especially if contact is repeated or prolonged. It is slightly toxic through skin absorption. Contact with the eyes causes extreme irritation and may cause severe, irreversible damage. Ingestion of isobutyl alcohol causes irritation of the gastrointestional tract and may cause nausea, dizziness, headache, stupor, and CNS depression. Chronic effects of exposure to isobutyl alcohol are not well understood. The TLV is based on analogy with n-Butyl alcohol.

FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with plenty of running water for 15 minutes; get medical attention (Inplant, paramedic, community). SKIN CONTACT: Flush exposed skin area with plenty of water at once. Promptly remove contaminated clothing. Wash with soap and water.

INHALATION: Remove to fresh air. Restore and/or support breathing if required. Get medical help if irritation persists or if symptoms of serious overexposure have occurred. INGESTION: Give victim milk or water as quickly as possible. Don't induce vomiting unless directed to do so. Contact a physician or Poison Control Center. Never give anything by mouth to a person who is unconscious or is having convulsions.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate all personnel from the area, except for those involved in clean-up. Remove leaking container to safe place if feasible. Clean-up personnel should wear suitable protective clothing and equipment (see Section 8). Absorb small quantities on paper towels or vermiculite and place in closed containers for disposal. Dike large spills and collect for reclamation or disposal. Prevent liquid from entering sewer, watersheds, or waterways.

DISPOSAL: Place in suitable container for disposal by licensed contractor or burn in an approved incinerator. Landfill diking material. Follow all Federal, State and Local regulations.

Isobutyl alcohol has been designated as a hazardous waste by the EPA (RCRA40CFR261.33). The EPA Hazardous Waste Number is U140.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion-proof) to meet TLV requirements. For emergency or non-routine exposures where the TLV may be exceeded, wear an appropriate NIOSH approved respirator with full face covering. All electrical service in use and storage areas should have an explosion-proof design.

To prevent contact with skin and eyes, wear impervious gloves, apron, boots, protective clothing and chemical splash goggles or face shield as necessary. Remove contaminated clothing promptly and do not reuse until it has been properly laundered.

Eyewash stations and safety showers should be available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from strong oxidizing agents, heat, sparks and open flame. Protect containers from physical damage. When transferring or pouring isobutyl alcohol, ground and bond containers and equipment to prevent static sparks. Use metal safety cans to handle small amounts of liquid. Do not smoke in use or handling areas. Holding vessels and chemical processing equipment used in the storage and handling of isobutyl alcohol should be composed of carbon steel, 304 ss, or lined carbon steel. Brass or lead alloys may cause color or contamination problems. Aluminum may be corroded. Use only with adequate ventilation. Do not breathe vapors. Prevent contact with eyes, skin and clothing. Follow good personal hygiene practices since chronic exposure effects are not well understood. Chronic tests have indicated possible carcinogenic properties for excessive repeated exposures in rats (see Section 2). DOT CLASSIFICATION: Flammable liquid, UN1120; DOT LABEL: Red Diamond

DATA SOURCE(S) CODE (See Glossary) 1-8, 12, 21, 47, 59, 71.R.

Judgements as to the suitablity of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitablity of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS JO Accrocco 11/85

INDUST. HYGIENE/SAFETY DJW 11-85

MEDICAL REVIEW: [signature] Dec 85

Copyright © August 1, 1985

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 402
BENZOIC ACID
(Revision A)

Issued: November 1978
Revised: February 1987

SECTION 1. MATERIAL IDENTIFICATION

22

MATERIAL NAME: BENZOIC ACID

DESCRIPTION/USES: Used in plasticizers, food preservatives, tobacco seasoning, flavors, perfumes, dentifrices, and as an antifungal agent.

OTHER DESIGNATIONS: Benzenecarboxylic Acid, Phenyl Carboxylic Acid, Phenylformic Acid, C_6H_5COOH, CAS #0065-85-0

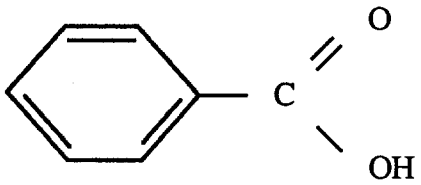
MANUFACTURER/SUPPLIER: Available from many suppliers, including: Velsicol Chemical Corp., 341 E. Ohio St., Chicago, IL 60611; Telephone (312) 670-4500

HMIS
H 1
F 1
R 0
PPE*
*See Sect. 8

R 1
I --
S 1
K 1

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Benzoic Acid, CAS #0065-85-0	100%	No TLV Established. Human, Skin, 22 mg/3 days, Intermittent: Moderate Irritation Man, Oral, LDLo: 500 mg/kg Rat, Oral, LD_{50}: 2530 mg/kg Rabbit, Eye, 100 mg: Severe Irritation



SECTION 3. PHYSICAL DATA

Boiling Point at 1 atm ...480.6°F (249.2°C)
(Sublimes at 100°C and readily steam distills)
Vapor Pressure at 96°C, mm Hg ... 1.0
Vapor Density (Air=1) ... 4.2
Water Solubility at 25°C, g/liter ... 2.9

Specific Gravity (H_2O)=1) ... 1.3
Molecular Weight ... 122.1
Melting Point ... ca 251.6°F (122°C)
Percent Volatile by Volume ... Negligible

Appearance and odor: Colorless-to-white solid: crystals, powder, platelets, scale (technical-grade flake can also be tan colored); benzoin- or benzaldehydelike odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
249.8°F (121°C), CC	1065.2°F (574°C)	Not Found	--	--

EXTINGUISHING MEDIA: Use dry chemical, carbon dioxide, foam, water spray, or fog to extinguish a benzoic acid fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: High concentrations of benzoic acid dust particles in the air may form an explosive mixture. Vapors from hot or molten benzoic acid may form explosive mixtures with air.

SPECIAL FIRE-FIGHTING PROCEDURES: This combustible material is a slight fire hazard when exposed to heat or flames. Fire fighters should wear protective clothing and use self-contained breathing apparatus when fighting fires involving it.

SECTION 5. REACTIVITY DATA

Benzoic acid is stable. Hazardous polymerization cannot occur.

As a carboxylic acid, this material reacts exothermically with strong bases and can generate hydrogen gas when a water solution made from it reacts with metals.

Avoid combining benzoic acid with strong oxidizing agents.

Hazardous products of decomposition can include phenol, benzene, carbon monoxide, and carbon dioxide.

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Benzoic acid is not listed as a carcinogen by the NTP, IARC, or OSHA.
Inhalation of this material's dust or vapors may cause irritation of the upper respiratory tract. Prolonged or repeated contact may result in irritation. Contact with eyes can cause serious eye irritation and possible injury. Ingestion of excessive amounts may cause nausea, gastrointestinal disorders, and/or allergic response.
TARGET ORGANS: Eyes. PRIMARY ENTRY: Inhalation. ACUTE EFFECTS: Extremely irritating and corrosive to eyes. CHRONIC EFFECTS: Unknown.

FIRST AID: EYE CONTACT: Flush eyes thoroughly, including under eyelids, with running water for 15 minutes. Get medical help.* SKIN CONTACT: Remove contaminated clothing. Flush affected area with water; wash with soap and water. Get medical help.* INHALATION: Remove victim to fresh air. Restore and/or support his breathing as required. Get medical help.* INGESTION: Rinse victim's mouth with water. Give him 2 to 3 glasses of water to drink to dilute the material. Induce vomiting. Do not induce vomiting or give anything by mouth to someone who is unconscious or convulsing. Get medical help.*

* GET MEDICAL ASSISTANCE = In plant, community, paramedic. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of benzoic acid spills or leaks. Cleanup personnel should use appropriate personal protection equipment (see sect. 8). Sweep up solid material and place it in drums for disposal. Avoid raising benzoic acid dust.

DISPOSAL: Bury waste in an approved landfill or incinerate it under controlled conditions. Follow Federal, state, and local regulations.

EPA, Clean Water Act, Reportable Spill Quantity: 5,000 lbs (40 CFR 117.3)

SECTION 8. SPECIAL PROTECTION INFORMATION

Supplier recommends a C-241 respirator with a C-241-1 filter for protection from dust.

Provide general dilution and local exhaust ventilation in sufficient volume and pattern to keep concentration of hazardous ingredients listed in section 2 below the minimal exposure at which irritation may occur.

Wear appropriate protective clothing such as chemical safety goggles and/or a full face shield to prevent skin or eye contact when working around hot or molten benzoic acid.

Eyewash stations and washing facilities should be readily accessible in areas of use and handling.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles may adhere to contact lenses and cause corneal damage.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store benzoic acid in tightly closed containers in a cool, dry, well-ventilated area away from oxidizing agents, strong bases, and sources of heat or ignition.
Molten benzoic acid is very hot (251.6°F [122°C]). Its vapors sublime readily and condense on cold surfaces, and this can block vent openings.
Avoid breathing benzoic acid dust. Prevent contact of this material with your eyes. Minimize its contact with your skin by wearing proper gloves and suitable work clothing. Practice good personal hygiene. Wash thoroughly after handling it. Do not take this material out of your work area or to your home on your clothing or equipment. Do not eat benzoic acid.

Benzoic acid is designated as a hazardous substance by the EPA (40 CFR 116).
DOT Classification: ORM-E DOT ID No. NA9094
Data Source(s) Code: 1, 2, 4-12, 14, 23, 42, 55, 58, 82, 84. CK

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	
Indust. Hygiene/Safety	4/87
Medical Review	May 87

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © February 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 405

PYRIDINE
(Revision A)
Issued: December 1978
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: PYRIDINE

Description (Origin/Uses): Used to denature alcohol; as a solvent in the paint and rubber industries; as an intermediate in the manufacture of pharmaceuticals, dyes, pesticides, polycarbonate resins; and in water-repellent finishes for textiles.

NFPA: 3 / 2 / 0 / -

Other Designations: C_5H_5N; CAS No. 0110-86-1

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

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

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Pyridine, CAS No. 0110-86-1	Ca 100	**OSHA PEL** 8-Hr TWA: 5 ppm, 15 mg/m³ **ACGIH TLVs (Skin*), 1987-88** TLV-TWA: 5 ppm, 15 mg/m³ TLV-STEL: 10 ppm, 30 mg/m³ **Toxicity Data**** Rat, Oral, LD_{50}: 891 mg/kg Rat, Inhalation, LC_{Lo}: 4000 ppm/4 Hrs

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (UR8400000), for additional data with references to mutagenic and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 239°F (115°C)
Specific Gravity (H_2O = 1): 0.9780 at 77°F (25°C)
Vapor Pressure: 18 Torrs at 68°F (20°C)
% Volatile by Volume: 100

Water Solubility (%): Miscible
Molecular Weight: 79 Grams/Mole
Melting Point: -44°F (-42°C)
Vapor Density (Air = 1): 2.7

Appearance and Odor: A flammable, colorless-to-slightly yellow liquid; characteristic disagreeable odor detectable at levels as low as 0.021 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
68°F (20°C)	900°F (482°C)	% by Volume	1.8	12.4

Extinguishing Media: Use dry chemical, "alcohol" foam, or carbon dioxide. Water may be ineffective in extinguishing pyridine fires, but it can be used to cool fire-exposed containers, to dilute spills, and to flush spills away from sources of ignition.

Unusual Fire or Explosion Hazards: Pyridine vapor is heavier than air and can collect in enclosed spaces and flow along a surface to reach a distant source of ignition in a low-lying area and flash back. It is a dangerous fire hazard when exposed to sources of ignition. Its vapor forms an explosive mixture with air over a wide range.

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

SECTION 5. REACTIVITY DATA

Pyridine is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving pyridine and chlorosulfonic acid, chromium trioxide, maleic anhydride, nitric acid, oleum, perchromates, ß-propiolactone, silver perchlorate, and sulfuric acid are reported (Genium ref. 84). As a weak base, pyridine reacts exothermically with acids.

Conditions to Avoid: Avoid exposure to incompatible chemicals and sources of ignition.

Hazardous Products of Decomposition: Extremely toxic gases such as cyanides and nitrogen oxides (NO_x) as well as carbon monoxide and carbon dioxide can be produced during pyridine fires.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

Summary of Risks: Systemic effects of pyridine poisoning include liver and kidney damage. If ingested, pyridine may act as a heart poison or it may stimulate the bone marrow to increase production of blood platelets. The vapor is irritating to the mucous membranes, causing eye and nasal irritation. Excessive inhalation produces irritation of the respiratory tract, asthmatic breathing, headache, dizziness, nausea, and depression of the central nervous system CNS). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** CNS, liver, kidneys, skin, gastrointestinal (GI) tract. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Headache, nervousness, dizziness, nausea, anorexia, eye and skin irritation. **Chronic Effects:** None reported.

FIRST AID

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

Skin: Immediately wash the affected area with soap and water because of the increased health hazard from skin absorption.

Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Medical personnel may administer oxygen if necessary.

Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. If he or she is responsive, give exposed person one or two glasses of milk or water to drink. Induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Preplacement and annual medical exams that emphasize the CNS, skin, liver, and kidneys are recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, eliminate all sources of ignition, provide adequate ventilation, and limit access to the spill area to necessary personnel only. Cleanup personnel require protective clothing to prevent skin contact with pyridine and respirators to prevent inhalation of its vapor (see sect. 8). Vacuum or pump the spilled pyridine into closable containers suitable for disposal using nonsparking tools and equipment; or absorb the waste with sand, earth, or vermiculite and then shovel it into containers suitable for eventual disposal or destruction.

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

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U196

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Resource Conservation and Recovery Act (RCRA), section 3001

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Use a respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and any other personal protective equipment necessary to prevent skin contact. **Ventilation:** Install and operate both general and local exhaust systems offering maximum explosion-proof ventilation systems powerful enough to maintain airborne concentrations of pyridine below the OSHA PEL standard cited in section 2.

Safety Stations: Make emergency eyewash stations and safety/quick-drench showers available in work areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean pyridine from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid skin contact with liquid pyridine; do not inhale its vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

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

Special Handling/Storage: Electrically ground and bond all containers used in shipping, receiving, or transferral operations to prevent static sparks. Preplan for routine use and emergency response.

Engineering Controls: Design all engineering systems to be explosion-proof in order to eliminate possible sources of ignition.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Pyridine	**DOT Label:** Flammable Liquid	**IMO Class:** 3.2
DOT Hazard Class: Flammable Liquid	**DOT ID No.** UN1282	**IMO Label:** Flammable Liquid, Poison

References: 1, 84-94, 100.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 412

DIOXANE
(Revision A)
Issued: December 1978
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION 28

Material: DIOXANE

Description (Origin/Uses): Prepared by distilling ethylene glycol with dilute sulfuric acid or by treating ß-ß-dichloroethyl ether with alkali. Used as a solvent for cellulose acetate, ethyl cellulose, benzyl cellulose, resins, oils, waxes; as a wetting/dispersing agent in textile processing, dye baths, and stain and printing compositions; in scintillation counters; and as a stabilizer in chlorinated solvents.

Other Designations: *p*-Dioxane; 1,4 Dioxacyclohexane; 1,4-Dioxane; Diethylene Dioxide; 1,4-Diethylene Dioxide; Diethylene Ether; Di (Ethylene Oxide); Dioxyethylene Ether; $C_4H_8O_2$; CAS No. 0123-91-1

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

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

SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

DIOXANE, ca 100%*

OSHA PEL (Skin†)	ACGIH TLV, (Skin†) 1988-89	NIOSH REL, 1977‡	Toxicity Data§
8-hr TWA: 25 ppm, 90 mg/m³	TLV-TWA: 25 ppm, 90 mg/m³	30-min Ceiling: 1 ppm, 3.6 mg/m³	Human, Inhalation, TC_{Lo}: 470 ppm Rat, Oral, LD_{50}: 4200 mg/kg

*Consult your supplier to determine if the dioxane product contains an added inhibitor to retard formation of peroxides.
†This material can be absorbed through intact skin, which contributes to overall exposure.
‡The health concerns specified in NIOSH, *Criteria for a Recommended Standard --Occupational Exposure to Dioxane* (Genium ref. 89) mention cancer and liver/kidney effects.
§See NIOSH, *RTECS* (JG8225000), for additional data with references to irritative, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 214.34 °F (101.3 °C) at 76 Torr
Melting Point: 14 °F (-10 °C)
Vapor Density (Air = 1): 3
Vapor Pressure: 29 Torr at 68 °F (20 °C)
Molecular Weight: 88 g/mol
Solubility in Water (%): Miscible
Specific Gravity (H_2O = 1): 1.0329 at 68 °F (20 °C)

Appearance and Odor: A colorless, flammable liquid; faint, pleasant, ethereal odor. The odor recognition threshold is 170 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 65 °F (18.33 °C) OC*	Autoignition Temperature: 356 °F (180 °C)	LEL: 2% v/v	UEL: 22% v/v

Extinguishing Media: Dioxane is an OSHA class IB flammable liquid, which represents dangerous fire and explosion hazards when it or its vapor are exposed to sources of heat and ignition. Use dry chemical, carbon dioxide (CO_2), or "alcohol" foam to put out dioxane fires. Use water spray to cool fire-exposed containers, to subdue a dioxane leak that has not yet ignited, to protect personnel attempting to stop the leak, to disperse dioxane vapor, to dilute spills to nonflammable mixtures, or to flush spills away from incompatible chemicals or sources of ignition. **Unusual Fire or Explosion Hazards:** Dioxane vapor is heavier than air and can flow along surfaces, collect in low-lying areas, reach distant sources of ignition, and flash back to its original source. This volatile liquid has a wide range of explosibility (see LEL and UEL) and a low flash point, so potentially explosive air-vapor mixtures can form quickly in production and storage areas if engineering controls are not functioning correctly. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*Flash Point: 54 °F (12.22 °C) CC

SECTION 5. REACTIVITY DATA

Solubility/Polymerization: Dioxane is stable in closed containers under a nitrogen gas blanket during routine operations at room temperature. Anhydrous (dry) dioxane slowly reacts with atmospheric oxygen to form explosive peroxides. If these peroxides are concentrated by evaporation or distillation of the dioxane, there exists a serious risk of explosion. Before attempting evaporation/distillation procedures, determine the extent of peroxide formation and take appropriate steps to safely decompose any unwanted peroxides. Consult with your supplier for data on these procedures. **Chemical Incompatibilities:** Hazardous reactions between dioxane and silver perchlorate, as well as a mixture of hydrogen and Raney nickel, have been reported (Genium ref. 84). Oxidizing agents can also react violently with dioxane. **Conditions to Avoid:** Dioxane is a volatile, very flammable liquid with a wide range of explosibility. Do not--under any circumstances--expose it or its vapor to any source of heat or ignition. Never use bulk quantities of dioxane in work operations without first testing a small sample of it to determine the amount of potentially explosive peroxides it contains. **Hazardous Products of Decomposition:** Thermal oxidative degradation of dioxane can produce toxic gases such as carbon monoxide (CO).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The NTP lists dioxane as an anticipated human carcinogen (group b), and the IARC classifies it as a probable human carcinogen (group 2B). **Summary of Risks:** Dioxane is highly toxic by both inhalation of its vapor and absorption of the liquid through the skin. If this liquid is accidentally splashed on your skin, rinse it off immediately with running water because it will penetrate your skin and cause systemic poisoning *without significant pain or discomfort*. Dioxane poisoning manifests with epigastic pain, anorexia and vomiting, followed by kidney failure, coma, and death with liver necrosis and edema of the lungs and brain. Once absorbed into the body, *(Cont'd)*

Copyright © 1989 by Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Dioxane can damage the liver, kidneys, and brain. It acts as a depressant on the central nervous system (CNS); necrosis of the liver and kidneys have also been reported. Fatalities have been attributed to repeated inhalation of low concentrations of dioxane vapor. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, liver, or CNS disorders. **Target Organs:** Skin, eyes, liver, kidneys, brain, CNS. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Nausea, vomiting, and irritation of the eyes, nose, and repiratory passages. **Chronic Effects:** Prolonged heavy occupational exposure to dioxane may result in jaundice and renal failure. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water; wash it with soap and water. Prolonged or repeated skin contact with dioxane can cause drying and cracking because of its defatting action. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep him or her warm and at rest until medical help is available. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. If accidental ingestion should occur, have the exposed person drink 1 to 2 glasses of milk or water and induce vomiting immediately. **Get in-plant, paramedic, or community medical help for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Appropriate tests for people occupationally exposed to dioxane include those involving liver and kidney functions, serum creatinine, blood urea nitrogen, and urine sediment. Treatment for shock must maintain the proper fluid and electrolytic balance. Reduced urinary output (oliguria, or even anuria) can occur depending upon the extent of the kidney damage.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Treat any incident involving a release of bulk quantities of dioxane as an emergency. Formulate and rehearse a spill-control and countermeasure plan (SCCP) to deal effectively with accidental releases of dioxane. Notify safety personnel, evacuate unnecessary personnel, extinguish all sources of ignition, and provide maximum explosion-proof ventilation in the event of a large spill. Cleanup personnel must wear a complete set of personal protective equipment (see sect. 8) to prevent any skin contact with this liquid or inhalation of its vapor. Use nonsparking tools and equipment in all cleanup operations. Do not flush spilled dioxane into sewers, waterways, or watersheds. Contain the spilled liquid and absorb it with sawdust or vermiculite, then place the resulting mixture into containers suitable for diposal or recovery. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
Listed as RCRA Hazardous Waste No. U108 (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg), [*per the RCRA, §3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not Listed
Listed as a SARA Toxic Chemical* (40 CFR 372.65) [*EPA Form R may apply to your facility; see 40 CFR 372.85 for instructions]

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of dioxane is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent any skin contact with dioxane. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne concentrations of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** All work practices in production and storage areas must be in accordance with detailed OSHA regulations (29 CFR 1910.106) for dioxane, a class IB flammable liquid.
Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in work areas. Take all necessary precautions, using personal protective equipment and/or engineering controls to limit occupational exposure of the workers to this suspected human carcinogen to the lowest level.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store dioxane in tightly closed, airtight containers (preferably under an inert nitrogen gas blanket) in a cool, dry, well-ventilated area away from sources of heat or ignition and incompatible chemicals (see sect. 5). Protect these containers from physical damage and shield them from direct sunlight. Detached, isolated, or remote storage facilities are suggested for bulk quantities of dioxane. **Special Handling/Storage:** Use a first-in, first-out inventory rotation system to ensure proper rotation of dioxane in stock and prevent storing it longer than the shelf-life recommended by your supplier. Prolonged storage is discouraged in order to reduce the hazards of peroxide formation. Redistillation or evaporation procedures can be especially dangerous if unwanted peroxides have formed; always ascertain the quality of the dioxane. Check with your supplier for specifics on the shelf-life requirements for storing dioxane. **Engineering Controls:** Electrically ground and bond all equipment and containers used in shipping, receiving, or sampling operations in production and storage areas to prevent static sparks. Transfer of liquid dioxane from one container to another must also be performed carefully; it requires electrical neutrality to prevent static sparks that could initiate an air-vapor explosion.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Dioxane
DOT Hazard Class: Flammable Liquid
DOT ID No.: UN1165
DOT Label: Flammable Liquid

IMO Shipping Name: Dioxane
IMO Hazard Class: 3.2
IMO Label: Flammable Liquid
IMDG Packaging Group: II

References: 1, 6, 7, 26, 38, 84-94, 100, 116, 118, 119, 122

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 420

ACETONE SOLVENT BLEND

Date July 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: ACETONE SOLVENT BLEND
OTHER DESIGNATIONS: SOLVATONE A (discontinued name), GE Material D5B23B
MANUFACTURER: Available from several supplier-blenders, including:
Ashland Chemical Company
PO Box 2219
Columbus, OH 43216

Emergency Telephone: (606) 324-1133 (Ashland, KY)

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Acetone (See MSDS #300)	>60	8-hr TWA 750 ppm* or 1800 mg/m^3
Isopropanol (See MSDS #324)	10-30	8-hr TWA 400 ppm or 980 mg/m^3 (skin)

*ACGIH (on the 1979 Intended Changes List) has recommended dropping the 8-hr TWA for acetone to 750 ppm; NIOSH (1978) recommended a 10-hr TWA of 250 ppm. Current OSHA 8-hr TWA is 1000 ppm.

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg C ------ 56-83
Vapor pressure at 25 C, mm Hg ---- ca 225
Vapor density (Air=1) ---------- ca 2
Water solubility ---------- Completely Sol.
Specific gravity (20/20 C) ---- 0.79
% Volatiles ---------- ca 100

Appearance & Odor: A clear, colorless liquid with an acetone odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air Volume % (estimate)	LOWER	UPPER
0-53 F (Closed Cup)	>750 F (estimate)		>2	--

Extinguishing media: Alcohol foam, dry chemical, or carbon dioxide. Use smothering effect to extinguish fire. (Waterspray may be ineffective for extinguishment, but is useful in keeping fire exposed containers cool, in reducing fire intensity, and for diluting and flushing solvent.)
Fire and explosion hazards exist when this material is exposed to heat or ignition sources.
Heavier than air vapors can flow along surfaces, reach distant ignition sources and flash back.
Firefighters should use self-contained breathing apparatus with a full facepiece when fighting fires in which this material is involved.

SECTION V. REACTIVITY DATA

This flammable solvent is stable under normal use and storage conditions. It does not undergo hazardous polymerization.
Strong oxidizing agents can react vigorously with this material. Keep away from sources of heat and ignition; it is an OSHA Class IB liquid.
Oxidation can produce carbon monoxide.
Material is incompatible with strong acids and strong alkalies.

Copyright © 1984 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION VI. HEALTH HAZARD INFORMATION

TLV Variable 1000-1500 mg/m3 (est.)(see Sect. II)

Excessive inhalation of vapors can irritate the mucous membranes and respiratory tract and produce headache, fatigue, dizziness, narcosis and even asphyxiation. Eye contact can cause severe irritation. Skin contact when prolonged or repeated will defat the skin, produce irritation and possible dermatitis. Absorption through skin occurs. Ingestion irritates the GI tract, produces nausea, and can result in severe illness or death; aspiration of vomitus into lungs is a hazard.

FIRST AID:

Eye contact: Flush with large amounts of running water for 15 minutes, including under eyelids. Contact a physician.

Skin contact: Wash exposed area of skin with soap and water. Remove contaminated clothing. Get medical help if irritation persists or when large areas of skin are exposed.

Inhalation: Remove affected individual to fresh air. Restore breathing if necessary. Have trained person administer oxygen if breathing is difficult. Keep warm and at rest. Get medical attention.

Ingestion: Give 2-3 glasses of water to dilute, if person is conscious; then, induce vomiting if physician is not immediately available. Get medical attention as soon as possible.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Provide maximum, explosion-proof ventilation. Eliminate ignition sources. Exclude from area of a large spill those without suitable protective equipment. Contain spill and recover liquid when possible for recycle or disposal. (Liquid can be diluted and flushed with water when necessary to clear area of solvent. Flush to ground for evaporation, not to sewer or surface waters.) Residues and small spills can be picked up with absorbent solid and scooped (with nonsparking tools) into metal containers with covers for disposal.

DISPOSAL: Dispose of waste liquid by incineration or by transfer to a licensed solvent disposal company. Solid-absorbed solvent can be deposited in an approved landfill. All disposal must be in accordance with Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and local exhaust ventilation to meet TLV requirements. Ventilation equipment and electrical services must be explosion-proof. Approved self-contained breathing equipment is advised for nonroutine and emergency use above the TLV. (Other approved respirators can be used within their specific limitations.)

Where splashing is possible, the use of safety goggles is recommended. Prevent skin contact with liquid by use of resistant gloves, apron, boots, etc as conditions indicate.

Eye wash stations and safety shower should be located near workplaces.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a clean, cool, well ventilated area away from sources of heat and ignition and away from oxidizing agents, strong acids and bases. Use metal safety cans to handle small amounts of solvent.

For liquid transfers, bond and ground containers to prevent static sparks; use non-sparking tools to work near this material. No smoking in areas of storage or use. Emptied containers may still be hazardous from residual liquid or vapors. Store and handle as an OSHA Class IB flammable liquid.

DATA SOURCE(S) CODE: 1,2 (Also MSDS #300, #324)

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 422

4-t-BUTYLPHENOL

Date August 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: 4-t-BUTYLPHENOL
OTHER DESIGNATIONS: p-tertiary-Butylphenol, 4-t-Butyl-1-hydroxybenzene, $(CH_3)_3CC_6H_4OH$, CAS # 000 098 544
MANUFACTURER: Available from several suppliers, including:

Dow Chemical U.S.A.
Midland, MI 48640
Telphone: (517) 636-4400

Union Carbide., Chemicals & Plastics
270 Park Ave, New York, NY 10017
Telephone: (212) 551-3763

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
4-t-Butylphenol	>97	No TLV established* Rat, Oral LD_{50} 3250 mg/kg Rabbit, skin LD_{50} 2520 mg/kg

*Supplier has recommended an 8-hr TWA of 2 mg/m^3.

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C (Volatile with steam)	236-240	Specific gravity, liquid (114/4 C)	0.908
		crystals	1.03
Vapor pressure at 70 C, mm Hg	1	Volatiles at 25 C	nil
Vapor density (Air=1)	5.1	Melting point, deg C	97-100
Water solubility at 20 C, %	0.07	Molecular weight	150.21

Appearance & Odor: White or nearly white crystals or flakes with a distinctive odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
235 F (COC)	Unknown	Unknown		

Extinguishing Media: Carbon dioxide, dry chemical, foam, or water fog.
This combustible solid is a slight fire hazard when exposed to heat and flame (note that if dust is dispersed in air it could be explosive). It can produce hazardous fumes and toxic decomposition products in a fire situation.
Firefighters should use full protective clothing, eye protection, and self-contained breathing apparatus.

SECTION V. REACTIVITY DATA

4-t-Butylphenol is stable for normal storage and handling in closed containers at room temperature. It does not undergo hazardous polymerization. It is incompatible with oxidizing agents.
Thermal-oxidative degradation products of this combustible material can include carbon monoxide.

Copyright © 1984 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION VI. HEALTH HAZARD INFORMATION

TLV 2 mg/m^3 recommended (See Sect. II)

Material is corrosive to body tissue - mucous membranes, moist skin and eyes. Inhalation of excessive dust (or vapors if generated) is irritating and damaging to the respiratory tract. Eye contact is painful and can produce corneal burns. Skin contact can be irritating and produce burns, with a possibility of skin absorption, depigmentation and sensitization. It is corrosive and moderately toxic if ingested.

FIRST AID:

Eye Contact: Immediately flush with running water for 15 minutes or more, including under the eyelids. Contact a physician (or an ophthalmologist if possible)!

Skin Contact: Immediately flush exposed area with plenty of water and continue washing for 15 minutes or more. Remove contaminated clothing (under a shower if needed). Get medical help if irritation persists or if large areas of skin were exposed.

Inhalation: Remove to fresh air. Get medical help! Have a qualified person administer oxygen if breathing is difficult.

Ingestion: If conscious, give victim 2-3 glasses of milk or water to drink and immediately induce vomiting. Call a physician!

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel when large spill occurs. Provide ventilation. Exclude from area all except clean-up personnel who have suitable protection against skin or eye contact and inhalation of dust or vapors. If molten, contain spill and allow to solidify; if solution, absorb with inert solid. Scoop solids into a suitable container with lid for disposal or recovery as appropriate.

DISPOSAL: Dispose of scrap material by burning in an approved incinerator. Follow Federal, State, and local regulations. (Material at approximately 0.03 mg/liter in water has produced an adverse taste in the flesh of exposed fish.)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local ventilation to meet the recommended TLV of 2 mg/m^3. Especially consider ventilation where dusting may occur or when material is heated. Respiratory protection (dust mask, for example) may be needed under nonroutine conditions where ventilation is inadequate.

Protect eyes with safety goggles and use gloves and body covering, clean work clothing to prevent skin contact. (Dust can become an increased hazard for skin contact in warm weather where prespiration keeps the skin moist.)

An eyewash station and safety shower must be readily available where this material is handled and used.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a clean, cool, well-ventilated storage area away from oxidizing agents. Prevent dusting conditions in storage or use. Follow good housekeeping practice.

Avoid skin contact and inhalation of vapors or dust! Prevent eye contact! Do not ingest!

Workers using this material should have training and follow good personal hygiene practice.

Those who have become sensitized to this material must avoid exposure, including exposure to materials which include 4-t-butylphenol as an inhibitor at the ppm level.

DATA SOURCE(S) CODE: 1, 4-7, 23

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 425
METHYL n-BUTYL KETONE
(Revision A)

Issued: October 1979
Revised: March 1986

SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: METHYL n-BUTYL KETONE

OTHER DESIGNATIONS: MBK; 2-Hexanone; n-Butyl Methyl Ketone; $CH_3CO(CH_2)_3CH_3$; CAS #0591-78-6

MANUFACTURER/SUPPLIER: Available from several sources, including:
Eastern Chemical Div. of United-Guardian, Inc., PO Box 2500, Smithtown, NY 11787;
Telephone: (516) 273-0900

HMIS
H: 1
F: 3
R: 1
PPE*
*See sect. 8

R 1
I 4
S 3
K 3

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Methyl n-Butyl Ketone * ACGIH (1985-86) TLV. OSHA PEL is 100 ppm or 410 mg/m^3. Significant contribution to overall exposure by skin absorption: G.D. DiVincenzo et al., *Tox. Appl. Pharm.* 36 (1976):511.		8-hr TWA 5 ppm or 20 mg/m^3* ---------- Rat, Oral, LD_{50}: 2590 mg/kg ---------- Rat, Inhalation, LC_{50}: 8000 ppm/4 hrs.

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 262.4°F (128°C)
Vapor Pressure @ 38.8°C, mm Hg ... 10
Vapor Density (Air = 1) ... 3.45
Water Solubility @ 25°C, g/100 g H_2O ... 3.5

Specific Gravity, 20/4°C ... 0.810
Volatiles, % ... ca 100
Melting Point ... -134.6°F (-57°C)
Evaporation Rate (nBuAc = 1) ... 0.87
Molecular Weight ... 100.16

Appearance and odor: Clear, colorless liquid. Characteristic acetonelike odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
77°F (24.9°C) CC	991°F (532.2°C)	Volume %	1.22	8.0

EXTINGUISHING MEDIA: Foam, dry chemical, carbon dioxide. Use water spray to cool metal containers that are exposed to fire.

This material is a moderate fire and explosion hazard when exposed to heat and flame. Its heavier-than-air vapors can flow along surfaces to distant ignition sources and flash back.

Fire fighters should use self-contained breathing equipment when fighting fires in which this material is involved.

SECTION 5. REACTIVITY DATA

Methyl n-butyl ketone is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

MBK is incompatible with oxidizing agents.

It is an OSHA class IC flammable liquid.

Thermal-oxidative degradation in air can produce toxic vapors and gases, including carbon monoxide (CO).

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Methyl n-butyl ketone is not listed as a carcinogen by the NTP, IARC, or OSHA.
MBK can cause nerve damage when excessively inhaled, swallowed, or absorbed through the skin, resulting in a progressive loss of sensitivity from the peripheral nervous system. It is known that MBK is metabolized to 2,5 hexanedione, which appears to act as a neurotoxin that causes nerve fiber (axon) damage (*Neurology* 26 [1976]:919). The condition appears to be reversible when detected early enough. Excessive inhalation of vapor can irritate the respiratory tract and cause impaired judgment and then narcosis by affecting the central nervous system at high concentration. Liquid contact irritates the eyes and defats the skin. Dermatitis can result from prolonged or repeated contact with liquid. MBK readily penetrates the skin to produce systemic effects. MBK is toxic when ingested.
FIRST AID: Get medical help when overexposed to MBK!* EYE CONTACT: Flush with plenty of running water for 15 minutes. Get medical help if irritation persists.* SKIN CONTACT: Immediately wash affected area with soap and water. Remove contaminated clothing. Get medical help for persistent irritation or if large area of skin is affected.
INHALATION: Remove victim to fresh air. Restore or support his breathing if required. Get medical help.*
INGESTION: Get medical help.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Seek medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of spills. Provide optimum explosion-proof ventilation. Remove sources of ignition. Provide cleanup personnel with protection against contact with liquid and inhalation of vapors. Absorb small spills on paper and evaporate in exhaust hood.
Contain large spills and absorb on vermiculite or sand. Pick up with nonsparking scoop and place in a closed metal container for disposal.
Spills can be flushed with water to remove them from hazardous area; flush them to open area or to ground for evaporation. Prevent their discharge into sewers, drains, and waterways.

DISPOSAL: Burn waste material in an approved incinerator. Follow Federal, state, and local regulations.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Respiratory protection is required for emergency and nonroutine conditions above the TLV. A full-facepiece gas mask with organic vapor canister (or self-contained breathing apparatus) can be used from 50 to 250 ppm; for higher or unknown concentrations, an air-supplied respirator (positive pressure) should be used. Gloves of material resistant to MBK and additional protective clothing (apron, boots, coveralls, etc.) that are appropriate to working conditions must be used to prevent skin contact with liquid. Chemical safety goggles and/or full face shield must be used for eye protection where splashing may occur.

Eyewash stations, safety showers, and washing facilities must be readily available in areas of use and handling.

Clothing contaminated with MBK must be removed promptly and the liquid washed off the skin.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in a clean, cool, well-ventilated area away from heat, ignition, and oxidizing agents. Containers should be electrically interconnected and grounded for liquid transfers to prevent static sparks. Storage and use areas should be NO SMOKING areas. Use nonsparking tools. Small amounts should be handled in approved safety cans with proper labeling. Electrical services must meet code requirements.

Avoid skin and eye contact. Avoid breathing vapors. Do not ingest! Wash thoroughly after handling.
Storage must be suitable for an OSHA class IC flammable liquid.
Provide preplacement and periodic medical examinations for workers exposed to MBK with special attention given to the central and peripheral nervous system, the respiratory system, skin, and eyes. Monitor nerve conduction velocity if neuropathy is suspected.
DOT Classification: FLAMMABLE LIQUID.
Data Source(s) Code: 1, 2-4, 6, 7, 10-12, 19, 23, 26, 47, 82, 84. CK

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals JO Acuracco, 11/86.
Indust. Hygiene/Safety [signature] 9-86
Medical Review [signature] Oct 86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © April 1, 1986

Material Safety Data Sheet
from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NITROBENZENE
(Revision A)
Issued: July 1980
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION

Material: NITROBENZENE

Description (Origin/Uses): Prepared by treating benzene with a mixture of nitric acid (HNO_3) and sulfuric acid (H_2SO_4). Used as an intermediate in the manufacture of aniline and benzidine; also used in some shoe and metal polishes.

Other Designations: Nitrobenzol; Essence of Mirbane; Oil of Mirbane; $C_6H_5NO_2$; CAS No. 0098-95-3

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

NFPA

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

*See sect. 8 †Absorption risk is high

SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

Nitrobenzene, ca 100%

OSHA PEL (Skin*)
8-hr TWA: 1 ppm, 5 mg/m^3

ACGIH TLV (Skin*), 1988-89
TLV-TWA: 1 ppm, 5 mg/m^3

Toxicity Data†
Woman, Oral, TD_{Lo}: 200 mg/kg
Rat, Oral, LD_{50}: 640 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
†See NIOSH, *RTECS* (DA6475000), for additional data with references to irritative, reproductive, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 410 °F (210 °C)
Melting Point: 42.8 °F (6 °C)
Vapor Density (Air = 1): 4.25
Vapor Pressure: <1 Torr
Molecular Weight: 123 g/mol
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 1.205 at 59 °F (15 °C)

Appearance and Odor: A colorless to pale yellow oily liquid or bright yellow solid crystals; a distinctive odor of volatile almond oil. Its identification threshold is 4.7 parts per billion (ppb).

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 190 °F (88 °C) CC	Autoignition Temperature: 900 °F (482 °C)	LEL: 1.8% v/v	UEL: Not Found

Extinguishing Media: Use dry chemical, "alcohol" foam, carbon dioxide (CO_2), or a water spray to put out fires involving nitrobenzene. Water spray can be used to disperse vapor, to cool fire-exposed containers, and to flush nonignited spills or vapor away from sensitive exposures such as incompatible chemicals or sources of ignition. **Unusual Fire or Explosion Hazards:** Nitrobenzene vapor is more than 4 times heavier than air (see sect. 3); it can flow along surfaces, collect in low-lying, confined areas, reach a distant source of ignition, and flash back to its source. This vapor can easily form an explosive mixture with air, especially if the nitrobenzene is heated (heating will cause more nitrobenzene vapor to be given off). **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Solubility/Polymerization: Nitrobenzene is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Nitrobenzene is an oxidizing agent that can react dangerously with reducing agents such as nitric acid (HNO_3); phenol (C_6H_5OH) and aluminum chloride ($AlCl_3$); aniline and glycerine; silver perchlorate ($AgClO_4$); dinitrogen tetroxide (N_2O_4); caustics; and reactive metals such as tin or zinc. **Conditions to Avoid:** Prevent exposure to sources of heat and ignition or to incompatible chemicals. **Hazardous Products of Decomposition:** Thermal oxidative degradation of nitrobenzene can produce toxic gases such as carbon monoxide (CO) and oxides of nitrogen (NO_x).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Nitrobenzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Nitrobenzene is a deadly poison that can be rapidly absorbed through intact skin. It reacts with hemoglobin in the blood to form methemoglobin, which seriously depletes the blood's oxygen-carrying capacity. The onset of even potentially fatal methemoglobinemia is insidious; severe symptoms can be delayed for up to 4 hours. The exposed person may feel well and have no complaints; he or she may exhibit signs of cyanosis such as blue lips, nose, and ears, which are noticeable but not uncomfortable; headache is commonly the first symptom of intoxication and may become more intense as the condition progresses. Workers can be exposed to dangerous levels of this poison without immediately discernible health effects. Cyanosis, anemia, and deleterious effects on the central nervous system (CNS) and the cardiovascular system (CVS) can develop following significant occupational exposure to nitrobenzene. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the heart, liver, and blood. **Target Organs:** Skin, eyes, blood, liver, kidneys, testicles, and CVS. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Symptoms of occupational exposure to nitrobenzene include headache, vertigo, vomiting, nausea, dizziness, anemia, atoxia, shortness of breath, rapid pulse, and irritation of the skin and eyes. Coma and death may ensue. **Chronic Effects:** Chronic exposure produces a reversible anemia. *(cont'd.)*

Copyright © 1989 by Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

SECTION 6. HEALTH HAZARD INFORMATION, continued

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Completely remove nitrobenzene from the exposed person's body. Immediately remove all clothing and wash the entire body from head to foot with soap and water. Pay special attention to the ear canals, fingernails, toenails, hair, and scalp because they are sources of continuing absorption of this poison. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen to alleviate the headache and general sense of weakness that characterize nitrobenzene intoxication. Keep exposed person warm and at rest until medical help is available. **Ingestion.** Unlikely. If accidental ingestion should occur, have the exposed person drink 1 to 2 glasses of water, then induce vomiting. **Comments:** Do not allow workers with existing disorders of the heart, liver, or blood to be exposed to nitrobenzene. Screen prospective employees by testing them for hypersensitivity to hemolytic chemicals such as nitrobenzene. Alcohol ingestion and a heated environment may increase susceptibility. Employees working with nitrobenzene should be instructed on the signs and symptoms of methemoglobinemia. **Get in-plant, paramedic, or community medical help for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Determine the methemoglobin concentration in the blood; repeat this test every hour for at least 24 hours until a decline is conclusively noted. Repeat thorough skin cleaning if the methemoglobin level rises after 3 or 4 hours. Usually patients will return to normal within 24 to 48 hours if all sources of continuing absorption are completely eliminated. Administer oxygen, using intermittant positive-pressure breathing (IPPB) if it is available.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat accidental bulk releases of nitrobenzene as emergencies.* Prior planning and designing of emergency response routines are necessary. Notify safety personnel, evacuate nonessential personnel, eliminate sources of heat and ignition, and provide adequate explosion-proof ventilation, particularly at floor level (see sect. 4). Cleanup personnel must wear a complete set of personal protective clothing and equipment (see sect. 8) to protect the skin and eyes against any contact with this liquid poison or inhalation of its vapor. Shovel, scoop, or vacuum the released nitrobenzene and place it into appropriate containers for disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

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

EPA Designations

Listed as RCRA Hazardous Waste No. U169 (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lbs (454 kg) [*per CWA, §311(b)(4) and 307(a); and RCRA, §3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), Threshold Planning Quantity (TPQ): 10000 lb

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

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of nitrobenzene is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent any contact of nitrobenzene with your skin. **Ventilation:** Install and operate general and local maximum-explosion-proof ventilation systems powerful enough to maintain airborne concentrations of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** The health effects of nitrobenzene are so dangerous that persons exposed to it should be periodically instructed in safe-handling procedures and in recognizing the symptoms of developing cyanosis (see sect. 6). Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in work areas. Avoid all skin contact with this liquid and inhalation of its vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store nitrobenzene in closed containers in a cool, dry, well-ventilated, low fire-risk area away from incompatible chemicals (see sect. 5) and sources of heat or ignition. Protect these containers from physical damage; shield them from direct sunlight. **Engineering Controls:** Electrically ground and bond all containers and equipment used in shipping, receiving, or sampling operations in production or storage areas to prevent static sparks.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Nitrobenzene, Liquid
DOT Hazard Class: Poison B
DOT ID No.: UN1662
DOT Label: Poison
DOT Packaging Requirements: 49 CFR 173.346
DOT Packaging Exceptions: 49 CFR 173.345

IMO Shipping Name: Nitrobenzene
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

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

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

Section 1. Material Identification

2-Nitropropane ($CH_3CH(NO_2)CH_3$) Description: Derived by reaction of propane with nitric acid or nitrogen peroxide at elevated temperature and pressure. Used as a rocket propellant, chemical intermediate, gasoline additive, and as a solvent (improves drying times and alters various characteristics such as pigment dispersion) for inks, paints, adhesives, varnishes, and polymers. It is also a solvent in food processing for fractionation of partially saturated vegetable oil.

Other Designations: CAS No. 79-46-9, ß-nitropropane, *sec*-Nitropropane, dimethylnitromethane, isonitropropane, 2-NP, NiPar S-20, NiPar S-30, nitroisopropane.

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

Cautions: 2-Nitropropane is a highly flammable liquid. It is irritating to the eyes, skin, and respiratory tract. Exposure has caused liver damage and it is a suspected human carcinogen.

R 2
I 3
S 2
K 3

NFPA
3
2 1
–

HMIS
H 2
F 3
R 1
PPE*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

2-Nitropropane, ca <100%. Impurities include 1-Nitropropane.

1992 OSHA PELs
Final Rule Limit
8-hr TWA: 10 ppm (35 mg/m^3)
Transitional Limit
8-hr TWA: 25 ppm (90 mg/m^3)

1990 IDLH Level
2300 ppm

1993-94 ACGIH TLV
TWA: 10 ppm (36 mg/m^3)

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
Ca, keep at lowest feasible level.
Limit of Quantitation: 1.4 ppm

1992 Toxicity Data*
Man, inhalation, TC_{Lo}: 20 ppm caused anorexia, diarrhea, and nausea or vomiting.
Rat, oral, LD_{50}: 720 mg/kg; details not reported
Rabbit, oral, LD_{Lo}: 500 mg/kg caused somnolence, respiratory stimulation, and incoordination.
Rat, oral: 44.6 mg/kg caused DNA damage.

* See NIOSH, *RTECS* (TZ5250000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 249 to 269 °F (120 to 132 °C)
Freezing Point: -162 to -135 °F (-108 to -93 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3 or 0.075 lb/ft^3): 1.243 kg/m^3 or 0.078 lb/ft^3
pH: 0.01 M aqueous solution = 6.2
Surface Tension: 30 dyne/cm at 68 °F (20 °C)
Refraction Index: 1.3941 at 68 °F (20 °C)

Molecular Weight: 89.11
Specific Gravity: 0.9821
Bulk Density: 8.3 lb/gal at 68 °F (20 °C)
Water Solubility: 1.7 mL/ 100 mL at 68 °F (20 °C); 0.6 mL water dissolves in 100 mL 2-nitropropane.
Other Solubilities: Soluble in alcohol, ether, aromatic hydrocarbons, ketones, esters, and lower carboxylic acids.
Odor Threshold: 5 ppm

Appearance and Odor: Clear, colorless liquid with a mild, fruity odor.

Section 4. Fire and Explosion Data

Flash Point: 75 °F (24 °C), TOC	Autoignition Temperature: 789 to 802 °F (421 to 428 °C)	LEL: 2.6% v/v	UEL: 11% v/v

Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam. For large fires, use water spray, fog, or alcohol-resistant foam.

Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Container may explode in heat of fire.

Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. For massive fire in cargo area, use monitor nozzles or unmanned hose holder; if impossible, withdraw and let fire burn. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: 2-nitropropane can form explosive mixtures with air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include chlorosulfonic acid, amines, acids, alkalies, oleum (fuming sulfuric acid), metal oxides (may form unstable salts analogous to nitromethane), and oxidizers. May attack some forms of plastics.

Conditions to Avoid: Exposure to heat and incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of 2-nitropropane can produce toxic nitrogen oxides.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list 2-nitropropane as a suspected carcinogen: IARC-2B,[183] NTP-2,[169] DFG MAK-A2,[183] NIOSH-X,[183] ACGIH TLV-A2[183], and EPA-B2[183].

Summary of Risks: A respiratory, skin, and eye irritant. Liver damage with hepatocyte destruction has been seen in exposed workers.

Medical Conditions Aggravated by Long-Term Exposure: Liver, skin, or respiratory disorders.

Target Organs: Eyes, skin, liver, and respiratory and digestive systems.

Continue on next page

Copyright © 1993 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Acute Effects: Inhalation can cause respiratory tract irritation, headache, dizziness, weakness, nausea and vomiting, diarrhea, difficulty breathing, and cyanosis. Vapors are irritating to the eyes at levels above 150 ppm. Skin contact is irritating and if allowed to remain on skin (e.g., contaminated clothing), may cause redness and smarting. Ingestion causes mouth and stomach irritation. Severe, acute hepatitis has been seen in some exposed workers.
Chronic Effects: Have not been adequately determined. Liver cancer is confirmed in animals, but only suspected in humans.
FIRST AID
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
Note to Physicians: Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against inhalation and skin/eye contact. Cover small spills with soda ash, mix and spray with water. Scoop into bucket, leave two hours, neutralize with 6 M HCl and flush to drain with large amounts of water. Large spills should be flushed to containment area for reclamation or disposal. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Ecotoxicity Values: *Pimephales promelas* (fathead minnow), LC_{50} = 4.71 mg/L/96 hr at 78.8 °F (26 °C).
Environmental Degradation: 2-Nitropropane is expected to volatilize rapidly from land but some may leach into the soil. It should be highly mobile based on a Koc of 21. In water, it will volatilize with a half-life of 9.5 hr (typical river). It is not expected to absorb much to sediment or bioconcentrate in fish. Photolysis is possible from surface water, but rate estimates are unavailable. In air, it may degrade by photolysis and reaction with photochemically produced hydroxyl radicals.
Disposal: Subject to controlled incineration (permit-approved facility). Large quantities may require nitrogen oxide removal by catalytic or scrubbing processes. Contact supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U171
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

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

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg) [* per RCRA, Sec. 3001]

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied-air respirator (with an auxiliary SCBA) with a full-facepiece and operated in pressure-demand or other positive-pressure mode. *Do not* use carbon filters; especially those with a carbon and hopcalite catalyst as ignition may occur upon contact with 2-nitropropane vapors. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber or polyvinyl alcohol (breakthrough time > 8 hr) to prevent skin contact.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate work clothes and street clothes and launder before reuse. Remove 2-nitropropane from shoes and clean PPE.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2-nitropropane, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 5). Outside or detached storage is preferred.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Install Class I, Group C Electrical Equipment
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver. Educate workers about the dangers associated with suspected carcinogens.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Nitropropanes
DOT Hazard Class: 3
ID No.: UN2608
DOT Packing Group: III
DOT Label: Flammable Liquid
Special Provisions (172.102): B1, T1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 60 L
b) **Cargo Aircraft Only:** 220 L

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

MSDS Collection **References:** 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 149, 153, 159, 164, 167, 168, 169,183, 186
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

Copyright © 1993 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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

Section 1. Material Identification

Ethyl Chloride (CH_3CH_2Cl) Description: Derived by passing hydrogen chloride into a solution of zinc chloride and ethanol or by action of chlorine on ethylene in presence of chlorides of copper, iron, antimony, and calcium. Used in organic synthesis, refrigeration, manufacture of insecticides, ethyl cellulose, dyes, drugs, and perfumes; as an alkylating agent and analytical agent; solvent for fats, oils, waxes, phosphorus, acetylene, and many resins; propellant in aerosols; and formerly as an anesthetic (no longer used because of possible respiratory and circulatory depression).
Other Designations: CAS No. 75-00-3, Aethylis, Anodynon, Chloridium, chloroethane, chloryl anesthetic, hydrochloric ether, Kelene, monochloroethane, muriatic ether, Narcotile.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

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

NFPA
4
2 0
–

HMIS
H 2
F 4
R 1
PPE†
† Sec. 8

Cautions: Ethyl Chloride is a highly flammable and explosive gas. Inhalation of high concentrations can cause central nervous system depression. Skin absorption is possible and the liquid can cause frostbite.

Section 2. Ingredients and Occupational Exposure Limits

Ethyl Chloride, ca 100%

1992 OSHA PELs
Transitional & Final Rule Limits
8-hr TWA: 1000 ppm (2600 mg/m^3)

1993-94 ACGIH TLV*
TWA: 1000 ppm (2640 mg/m^3)

1992 Toxicity Data†
Rat, inhalation, LC_{50}: 160 g/m^3/2 hr; no toxic effects noted

1990 IDLH Level
20,000 ppm

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
None established

* Notice of intended change to 100 ppm (264mg/m^3) and designation as a class A3 carcinogen (animal carcinogen).
†See NIOSH, *RTECS* (KH7525000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 54 °F (12 °C)
Freezing Point: -217.6 °F (-138.7 °C)
Vapor Pressure: 1064 mm Hg at 68 °F (20 °C)
Density (Air = 1): 2.22
Surface Tension: 19.5 dyne/cm at 68 °F (20 °C)
Ionization Potential: 10.97 eV
Relative Evaporation Rate (BuAc =1): > 1
Viscosity: 0.279 cP at 50 °F (10 °C)
Octanol/Water Partition Coefficient: log Kow = 1.43
Molecular Weight: 64.52
Specific Gravity: 0.9214 at 32 °F (0 °C)
Water Solubility: 0.57% at 68 °F (20 °C)
Other Solubilities: Per 100 g water at 77 °F (25 °C): acetone (103 g), benzene (110 g), *n*-heptane (87 g), methanol (37 g); at (21 °C): ethanol (48 g)
Odor Threshold: 4.2 ppm (should be sufficient warning)
Critical Pressure: 52 atm
Critical Temperature: 368.9 °F (187.2 °C)

Appearance and Odor: Colorless gas with an ethereal, slightly pungent odor at room temperature. When compressed, it is a colorless, volatile liquid.

Section 4. Fire and Explosion Data

Flash Point: -58 °F (-50 °C) CC	Autoignition Temperature: 966 °F (519 °C)	LEL: 3.8% v/v	UEL: 15.4% v/v

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Burning rate = 3.8 mm/minute. Container may explode in heat of fire. Ethyl chloride presents a vapor explosion hazard indoors, outdoors, and in sewers. Burns with a smoky, greenish flame.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately in case you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Ethyl chloride is stable up to 752 °F (400 °C) in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include oxidizing materials, water/steam (produces hydrogen chloride), sodium, potassium, calcium, and powdered aluminum, copper, magnesium, and zinc.
Conditions to Avoid: Contact with heat, ignition sources, and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of ethyl chloride can produce phosgene, and hydrogen chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies consider ethyl chloride to be a carcinogen: NIOSH-X[183] and DFG MAK-B.[183] The NTP has positive studies (equivocal tumorigenic agent) but no carcinogen designations have been assigned.
Summary of Risks: Ethyl chloride does not appear to present a serious industrial health hazard because very high concentrations are needed to produce adverse effects. If concentrations are high, central nervous system depression is the most common effect and... *Continue on next page*

Copyright © 1993 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

the resulting "drunkenness" and incoordination may lead to incorrect machinery operation with possible injury. Ethyl chloride can be absorbed through the skin and frostbite is possible from contact with the liquid (compressed gas).

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

Target Organs: Respiratory and cardiovascular system; liver and kidneys (seen in animals and is possible but not likely in humans).

Primary Entry Routes: Inhalation, skin absorption.

Acute Effects: At high concentrations, inhalation can cause central nervous system depression and cardiac arrythmias. Some irritation of the eyes, skin, and respiratory tract is also possible. Allergic eczema is reported in two individuals subjected to an allergy test but it is not expected to occur frequently. Volunteers exposed to 40,000 ppm experienced dizziness, eye irritation, and abdominal cramps; 25,000 ppm caused incoordination; 19,000 produced analgesia after 12 minutes; and 13,000 ppm resulted in slight inebriation. Ethyl chloride is quickly absorbed both via the lungs and through the skin but most is eliminated via the lungs just as quickly.

Chronic Effects: None reported.

FIRST AID Eyes and Skin: The liquid (compressed gas) can cause frostbite. Immerse affected skin (or rinse eyes) with tepid water (104 °F/ 40 °C) until completely rewarmed. *Do not* rub affected area or use dry heat!

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

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

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

Note to Physicians: Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Isolate and ventilate area, deny entry, and stay upwind. Stop gas flow. Shut off all ignition sources. Cleanup personnel should protect against gas inhalation and contact with the liquid. It is a gas above 54 °F (12 °C) so if spilled as a liquid, it would tend to evaporate before cleanup could begin. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Degradation: In water, some ethyl chloride will volatilize with estimated half-life of 1.1 to 5.6 days and some will hydrolyze with an estimated half-life of 38 days at 77 °F (25 °C). In soil, some will volatilize (dry soil) or leach; and some will hydrolyze (moist soil). In air, ethyl chloride will react with photochemically produced hydroxyl radicals with an estimated half-life of 40 days.

Soil Absorption/Mobility: With estimated Koc values of 33 and 143, ethyl chloride is expected to be highly mobile.

Disposal: Thermal destruction is difficult unless a gas feed to an incinerator (permit-approved facility only) can be arranged. Complete combustion is necessary to prevent the formation of phosgene gas. Incinerator should be equipped with an afterburner and scrubber to remove the halo-acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a SARA Toxic Chemical (40 CFR 372.65)

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

Listed as a RCRA Hazardous Waste (40 CFR 261.21): D001, "Characteristic of Ignitability"

Listed "chlorinated ethanes" as a CERCLA Hazardous Substance* (40 CFR 302.4); per CWA, Sec. 307 (a)

OSHA Designations

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

* An RQ is not given for the broad class.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 10,000 ppm, use a supplied-air respirator (SAR) or SCBA. For < 20,000 ppm, use a SAR operated in continuous-flow mode or any SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton, nitrile, or butyl rubber to prevent skin contact.

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

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

Contaminated Equipment: Separate work and street clothes and launder before reuse. Remove ethyl chloride from shoes and clean PPE.

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

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage cabinet.

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

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers. Educate workers on ethyl chloride's explosive potential.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1037
DOT Packing Group: —
DOT Label: Flammable Gas
Special Provisions (172.102): B63, B77

Packaging Authorizations
a) **Exceptions:** None
b) **Non-bulk Packaging:** 173.322
c) **Bulk Packaging:** 173.314, .315

Quantity Limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** 150 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 159, 164, 167, 168, 176, 183, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

Copyright © 1993 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

MSDS # G 560
o-CRESOL

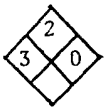
Issued: November 1985
Revised:

From Genium's MSDS Collection, to be used as a reference.

SECTION 1. MATERIAL IDENTIFICATION

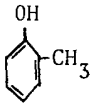
18

MATERIAL NAME: o-CRESOL
OTHER DESIGNATIONS: 2-Methylphenol, o-Cresylic Acid, o-Hydroxytoluene, o-Methylphenol, o-Oxytoluene, C_7H_8O; CAS # 0095 48 7.
MANUFACTURER/SUPPLIER: Available from several sources, including:
Koppers Company, Organic Materials Group
Koppers Building
Pittsburgh, PA 15219 (412) 227-2000



SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
O-CRESOL	99.2	8-Hr. TWA: 5 ppm, 22 mg/m³*
Phenol	0.3	Rat, oral LD50: 121 mg/kg
2,6-Xylenol	0.5	Rat, skin LD50: 1100 mg/kg
		Rabbit, skin: 524 mg/24 hrs. Severely irritating
		Rabbit, eye: 105 mg/kg Severely irritating.



* Current ACGIH TLV and OSHA PEL
o-Cresol is not listed as a carcinogen by NTP, IARC or OSHA.

SECTION 3. PHYSICAL DATA

Boiling point, 1 atm ..... 376°F (191°C)
Vapor pressure @ 25°C, mmHg ... 0.25
Vapor density (Air=1) 3.72
Solubility in water, wt % 2.5
Specific gravity (H_2O=1), 25°C ... 1.048
Volatiles, % by vol. ..... ca. 100
Evaporation rate (BuAc=1) ..... N/A
Melting point ..... 87.6°F (30.9°C)
Molecular weight 108.13

APPEARANCE & ODOR: Colorless, yellowish, or pink liquid or crystal with a characteristic sweet, tar-like odor. The odor can be easily recognized at concentrations as low as 5 ppm in air.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
178°F (81°C) C.C.	1110°F (599°C)	% by vol. at 300°F	1.35	

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, foam. Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool fire-exposed containers.

This combustible liquid is a moderate fire hazard and a slight explosion hazard when exposed to heat, sparks or open flame.

Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving o-Cresol.

SECTION 5. REACTIVITY DATA

This material is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

o-Cresol is incompatible with strong oxidizing agents. When o-Cresol is mixed with chlorosulfonic acid, nitric acid, or oleum in a closed container, an increase in temperature and pressure results.

Thermal decomposition or burning produces toxic vapors and gases, including carbon monoxide.

Copyright © on issue date, Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

TLV 5 ppm or 22 mg/m^3

o-Cresol is a highly toxic compound. Overexposure to o-Cresol via ingestion, skin absorption, or inhalation may cause muscular weakness, headache, dizziness, nausea, vomiting, gastrointestinal disturbances, respiratory distress, confusion, loss of consciousness, and death. It may also cause damage to the kidney, liver, pancreas and spleen. Vapors of o-Cresol are irritating to the eyes, nose, throat and respiratory tract. The liquid is extremely corrosive to the skin and eyes. If eye contact occurs, it may cause loss of vision if not promptly and completely removed. Contact with skin may cause severe irritation or burns, dermatitis, or death if large areas of skin are exposed to o-Cresol and it is not promptly removed. Chronic exposure to low doses of o-Cresol may cause gastrointestinal disturbances, headache, dizziness, mental disturbance, skin rash and damage to the liver and kidneys. The main industrial hazard associated with use of o-Cresol is prolonged and/or extensive skin contact. Under normal conditions, overexposure to vapors of o-Cresol is unlikely because of its low vapor pressure and disagreeable odor. Some individuals may be hypersensitive to this material. Toxic effects of o-Cresol are similar to Phenol, but less severe.

FIRST AID: EYE CONTACT: Promptly flush eyes, including under eyelids, for at least 15 minutes with running water. Get medical attention. SKIN CONTACT: Flush skin with running water while removing contaminated clothing for at least 5 minutes. Get medical attention.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as needed. Get medical help.* INGESTION: Give victim one glass of milk or water. Contact a physician or Poison Control Center. Do not induce vomiting unless instructed to do so. Do not give anything by mouth to a person who is unconscious or is having convulsions. Get medical attention.*

* MEDICAL ATTENTION = Inplant, Paramedic, Community.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the area of all nonessential personnel. Clean-up personnel need full protective clothing and equipment to prevent inhalation and contact with solid or liquid. Absorb small spills on paper, vermiculite or other absorbent material and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Shovel solid into steel container for disposal. Do not allow o-Cresol to enter sewer, watersheds, or waterways.

DISPOSAL: Place in a suitable container for disposal by licensed contractor or burn in an approved incinerator.

o-Cresol is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U052 (40 CFR 261).
EPA (CWA) RQ is 1000 lbs/454 kgs (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion proof) to meet TLV requirements. When o-Cresol is heated, vapor inhalation can be a serious hazard without proper precaution. For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved respirator. Fume hoods should maintain a minimum face velocity of 100 lfm. All electrical service in use or storage areas should have an explosion-proof design. DANGER! Avoid any contact with this material. Full protective equipment, including splash goggles, face shield, impervious gloves, apron, boots, impervious shirts and trousers, hard hat with brim, acid suit, and respirator should be available and worn as necessary. Remove contaminated clothing promptly and do not reuse until it has been properly laundered.

Eye wash stations and safety showers should be readily available in use and handling areas.
Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks and open flame. Protect container from physical damage. Outside or detached storage is preferred.
Use only with adequate ventilation. Avoid contact with skin, eyes, and clothing. Do not breathe vapors. Wash thoroughly after handling. o-Cresol may turn color upon exposure to air or light. Untrained workers should not handle this material.

DOT CLASSIFICATION: Corrosive material, UN2076.

DATA SOURCE(S) CODE (See Glossary) 1,2,6,7,9,12,23,26,31,34,37,47,54,63,69,75,78,79, 59, R.

Judgements as to the suitablity of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitablity of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS J.O. Acrocco 1/86
INDUST. HYGIENE/SAFETY DJW 1-86
MEDICAL REVIEW: 7 Feb 86

 Copyright © November 1, 1985

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 608

PROPIONIC ACID

Issued: March 1987

SECTION 1. MATERIAL IDENTIFICATION 22

MATERIAL NAME: PROPIONIC ACID

DESCRIPTION/USES: Derived from a reaction of ethyl alcohol with carbon monoxide, using a boron trifluoride catalyst; also by the reaction of carbon monoxide with hydrogen and olefins or alcohols. Used as proponiates, mold inhibitors in bread, and general fungicides; grain and wood chip preservatives; emulsifying agents; solutions for electroplating nickel; perfume esters; artificial fruit flavors; pharmaceuticals; and cellulose proponiate plastics.

OTHER DESIGNATIONS: Carboxyethane, Ethanecarboxylic Acid, Ethylformic Acid, Methyl Acetic Acid, Propanoic Acid Grain Preserver, Pseudoacetic Acid, $C_3H_6O_2$, CAS #0079-09-4

MANUFACTURER/SUPPLIER: Celanese Chemical Co., Inc., 1250 W. Mockingbird Ln., Dallas, TX 75247; Telephone: (214) 689-4000

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

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Propionic Acid, CAS #0079-09-4		8-hr. TWA: 10 ppm or 30 mg/m^3*
$CH_3\ CH2\ C(=O)\ O\ H$		Rat, Oral, LD_{50}: 2500 mg/kg
		Rabbit, Skin, LD_{50}: 500 mg/kg
		Rabbit, Eye: 990 µg, Severe
		Rabbit, Skin: 495 mg Open, Severe

* Current (1986-87) ACGIH TLV.

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 286°F (141.1°C)
Vapor Pressure @ 39.7°C, mm Hg ... 10
Water Solubility ... Miscible
Vapor Density (Air = 1) ... 2.56
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 0.9942
Melting Point ... -67°F (-21.5°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 74.08
Refractive Index n^{20}_D ... 1.3862

Appearance and odor: Clear, colorless, oily liquid; pungent, rancid odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
130°F (54.4°C)	955°F (512°C)	% by Volume	3.0	14.9

EXTINGUISHING MEDIA: Use dry chemical, "alcohol" foam, carbon dioxide, or water fog to put out propionic acid fires. Do not use a solid stream of water, because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fires and to disperse vapors. UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class II combustible liquid is a moderate fire hazard when exposed to heat, sparks, or open flame. It can react with oxidizing materials. When involved in a fire, propionic acid emits acrid smoke and fumes. SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should use self-contained breathing apparatus with facepieces and be fully suited with protective clothing when fighting fires involving this material.

SECTION 5. REACTIVITY DATA

This material is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Propionic acid is incompatible with oxidizing agents and bases.

Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

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

SUMMARY OF RISKS: Vapors of this material are irritating to the eyes, nose, throat, and lungs. The liquid is severely irritating to the skin and eyes. Its contact with the skin may cause reddening, swelling, and burns. Contact with the eyes may cause permanent eye damage. Ingestion of propionic acid may cause severe irritation and burns of the gastrointestinal tract. The TLV of 10 ppm, which is based on analogy to acetic acid, is designed to prevent significant irritation of the eyes or respiratory passages. TARGET ORGANS: Eyes, respiratory tract. PRIMARY ENTRY: Inhalation

FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, with large amounts of running water for at least 15 minutes. Cover both eyes with dry, sterile dressing and get medical help.* SKIN CONTACT: Promptly flush exposed area with soap and water. For gross contact, remove contaminated shoes and clothing and get under a safety shower. If skin is burned, cover it with a dry, sterile protective dressing and get medical help.* INHALATION: Remove victim to fresh air. Restore and/or support his breathing as required. Get medical help immediately.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Before using propionic acid, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of large propionic acid spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the spill area and limit access to trained personnel only. Remove leaking containers to a safe place, if feasible. Those involved in cleanup need protection against contact with the liquid and inhalation of the vapor (see sect. 8). Absorb small spills with an absorbant material. Dike large spills with sand or earth and pump the waste into a salvage container. Wash spill area thoroughly with a soda ash solution and flush it with water. Do not flush the spill to a sewer, watershed, or waterway. Water spray may be used to flush spills away from sensitive exposures and to dilute them to nonflammable mixtures. Place waste in a suitable container for disposal by a licensed contractor or dissolve it in a flammable solvent and burn it in an approved incinerator equipped with an afterburner and scrubber. Follow all Federal, state, and local regulations.

Propionic acid is designated as a hazardous waste by the EPA (40 CFR 261). The EPA (RCRA) HW No. is U233. Reportable Discharge Quantity (RQ) is 5000 lbs/2270 kgs.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute). For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved respirator.

When handling propionic acid, wear neoprene or rubber gloves and chemical safety goggles. If splashing can occur, wear an impervious suit, boots, face shield, and other appropriate protective clothing and equipment. Remove contaminated clothing immediately and do not wear it again until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store propionic acid in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, caustics, heat, sparks, and open flame. Storage areas must meet OSHA requirements for class II combustible liquids. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, and clothing. Do not breathe or eat this material. Wash thoroughly with soap and water after handling it. Do not smoke in use or handling areas.

Bond and ground metal containers and equipment when making transfers to avoid static sparks.

Use caution when handling propionic acid. Wear appropriate protective clothing and equipment to prevent exposure. Emptied containers retain product residues; handle them accordingly!

Preplacement and periodic physical examinations emphasizing eyes, skin, and lungs should be provided for persons who handle this material.

Propionic acid is designated as a hazardous substance by the EPA (40 CFR 116).

DOT Classification: Corrosive, Acidic, Combustible. DOT ID No. UN1848

Data Source(s) Code: 1, 2, 4, 5, 7-9, 12, 14, 47, 69, 75, 78, 81-83. CR

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	
Indust. Hygiene/Safety	5/87
Medical Review	May 87

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © March 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 625

p-NITROANILINE

Issued: November 1987

SECTION 1. MATERIAL IDENTIFICATION

24

Material Name: *p*-NITROANILINE

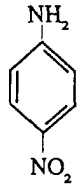
Description (Origin/Uses): This material is used as an intermediate in the manufacture of dyes, antioxidants, pharmaceuticals, and pesticides.

Other Designations: *p*-Aminonitrobenzene; 1-Amino-4-Nitrobenzene; 4-Nitroaniline; 4-Nitrobenzenamine; *p*-Nitrophenylamine; $C_6H_6N_2O_2$; NIOSH *RTECS* No. BY7000000; CAS No. 0100-01-6

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

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

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
p-Nitroaniline, CAS No. 0100-01-6 	100	**ACGIH TLV (Skin*), 1987-88** TLV-TWA: 3 mg/m³ **OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 6 mg/m³ IDLH** Level: 300 mg/m³ **Toxicity Data***** Rat, Oral, LD_{50}: 750 mg/kg Mouse, Oral, LD_{50}: 810 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**Immediately dangerous to life and health
***See NIOSH *RTECS* for additional data with references to mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 637°F (336°C)
Vapor Pressure at 20°C, mmHg: 0.00015
Water Solubility at 18.5, wt. %: 0.08
Vapor Density (Air = 1): 4.77
Specific Gravity (H_2O = 1): 1.44
Melting Point: 293°F (146°C)
% Volatile by Volume: ca 100%
Molecular Weight: 138.14 Grams/Mole

Appearance and Odor: Bright yellow crystals or powder; pungent, faint, ammonialike odor.

Comments: *p*-Nitroaniline is not soluble in water, but it is dissolved by alcohol and ether.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
390°F (199°C)	940°F (504°C)	% by Volume	Not Listed	Not Listed

Extinguishing Media: Use carbon dioxide, dry chemical, foam, or water fog. Water or foam may cause frothing. Use water spray to cool fire-exposed tanks/containers.

Unusual Fire/Explosion Hazards: This OSHA class IIIB combustible liquid is a slight fire hazard when exposed to heat, sparks, or open flame. **Warning:** In the presence of moisture it causes nitration (reacting with the NO_2 molecular group) of organic materials resulting in spontaneous ignition. Like many organic materials in powder form, *p*-nitroaniline is capable of creating a dust explosion (refer to NFPA pamphlet No. 63, "Prevention of Dust Explosions in Industrial Plants"). When involved in a fire, *p*-nitroaniline emits toxic fumes of nitrogen oxides.

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

SECTION 5. REACTIVITY DATA

p-Nitroaniline is stable. Hazardous polymerization cannot occur.

Chemical Incompatibilities: *p*-Nitroaniline is incompatible with strong oxidizing agents and moisture. The liquid will attack some forms of plastics, rubber, and coatings, so care is needed in the selection of safety and handling equipment such as respirators.

Hazardous Products of Decomposition: Thermal decomposition or burning produces oxides of nitrogen, carbon monoxide, and/or carbon dioxide.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

p-Nitroaniline is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: This material is toxic by ingestion, inhalation, and skin absorption. Overexposure by these routes may cause hypoxia (reduced level of oxygen in the blood) because of methemoglobinemia. Symptoms of exposure may include headache, cyanosis, weakness, dizziness, irritability, drowsiness, and dyspnea (shortness of breath) because of methemoglobinemia. Severe exposure may cause unconsciousness and death. **Warning:** Symptoms may not appear until up to 4 hours after exposure. Contact with eyes causes corneal damage. **Medical Conditions Aggravated by Long-Term Exposure:** Workers with liver or kidney diseases should not be exposed to this material. Administer preplacement and annual medical exams emphasizing these organs' functions. **Target Organs:** Blood, heart, lungs, liver. **Primary Entry:** Inhalation, skin contact and absorption, eye contact.

Acute Effects: Headache, eye and skin irritation, blue coloration of skin and lips (cyanosis), nausea and vomiting, muscular weakness, irritability and convulsions, increased pulse and respiratory rate. Smokers may be at increased risk of cyanosis because of a preexisting exposure to tobacco smoke. **Chronic Effects:** Possible liver damage.

FIRST AID

Eye Contact: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin Contact:** Immediately wash the affected area with soap and water because of the increased exposure hazard from absorption. **Inhalation:** Remove victim to fresh air; restore and/or support his breathing as required. Keep him warm and quiet. **Ingestion:** Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. If victim is responsive, give him an emetic such as two tablespoons of salt in a glass of warm water. Other sources recommend giving the victim several glasses of water to drink.

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

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the spill area and limit access to necessary personnel only. Remove leaking container to a safe place if it is safe to do so. Those involved in cleanup need protection against contact with the solid and inhalation of dust or vapor (see sect. 8). Shovel, scoop, or vacuum spilled material into a closable container for disposal. Use caution to avoid generating dust. After cleanup wash the spill area with soap and water and collect flushings and wastewater for disposal. Keep waste out of sewers, watersheds, and waterways. Preplan for emergency response. **Waste Disposal:** Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U138

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

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. **Gloves:** Always wear impervious gloves.

Respirator: Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. IDLH or unknown concentrations require an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other Equipment:** Make face shields, aprons, boots, and other appropriate protective clothing and equipment available; wear these when necessary to prevent skin contact. **Ventilation:** Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne levels of *p*-nitroaniline below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations and safety showers available in areas of use and handling.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles may cling to contact lenses and cause corneal injury. Do *not* wear contact lenses in any work areas. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep this material off of your clothing and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store *p*-nitroaniline away from moisture and strong oxidizing agents.

Special Handling/Storage: Store this material in a cool, dry, well-ventilated area away from sources of heat and ignition. Avoid exposure to moist air. Protect containers from physical damage.

Engineering Controls in the Workplace: Ground and bond conveying equipment and storage containers when transferring *p*-nitroaniline to prevent the possibility of a dust explosion. Any bulk storage system should have an explosion-relief design. Moisture contamination of storage facilities must be prevented. If applicable, consider storing this material under a nitrogen blanket.

Other Precautions: Practice good industrial hygiene when handling this material. Avoid generating dust. Emptied containers retain product residues; handle them accordingly! Use extreme caution when using this material. Avoid its contact with skin, eyes, or clothing. Do *not* taste or inhale it!

Transportation Data (49 CFR 172.101-2)

DOT Hazard Class: Poison B	**DOT Shipping Name:** Nitroaniline	**DOT ID No.** UN1661
DOT Label: Poison	**IMO Label:** Poison	**IMO Class:** 6.1

References: 1, 2, 4, 5, 7, 8, 9, 12, 25, 34, 37, 38, 54, 63, 69, 73, 75, 81, 82, 87-94. CR/PJI

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

4

Approvals

Indust. Hygiene/Safety

Medical Review

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © November 1, 1987

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 628

HEXACHLOROETHANE

Issued: November 1987

SECTION 1. MATERIAL IDENTIFICATION 24

Material Name: HEXACHLOROETHANE

Description (Origin/Uses): Used as a rubber vulcanizing accelerator, as a camphor substitute in celluloids, and in explosives.

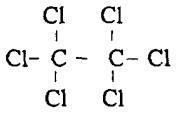
Other Designations: Carbon Hexachloride; Ethane Hexachloride; Ethylene Hexachloride; 1,1,1,2,2,2-Hexachloroethane; Hexachloroethylene; Perchloroethane; C_2Cl_6; NIOSH *RTECS* No. KI4025000; CAS No. 0067-72-1

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

Not Found

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

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

Ingredients and Hazards	%	Exposure Limits
Hexachloroethane, CAS No. 0067-72-1  NCI Carcinogenesis Bioassay Completed; Results Positive: Mouse (NCITR NCI-CG-TR-68, 78) NCI Carcinogenesis Bioassay Completed; Results Negative: Rat (NCITR NCI-CG-TR-68, 78) Carcinogenic Review by IARC 20, 467, 79: Animal Suspect *This material can be absorbed through intact skin, which contributes to overall exposure. **Consult NIOSH, *RTECS*, for additional data on reproductive and tumorigenic effects. ***Immediately dangerous to life and health. The ACGIH has proposed a TLV-TWA of 1 ppm, ≈ 10 mg/m³.	98	**ACGIH TLVs, 1987-88** TLV-TWA: 10 ppm, ≈100 mg/m³ **OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 10 mg/m³ **Toxicity Data**** Rat, Oral, LD_{50}: 6000 mg/kg Mouse, Intraperitoneal, LD_{50}: 4500 mg/kg IDLH*** Level: 300 ppm

SECTION 3. PHYSICAL DATA

Vapor Pressure, 20°C mm Hg: 0.22
Water Solubility: 0.005 g/100 ml water
Vapor Density (Air = 1): >1
Evaporation Rate (BuAc = 1): 0.6
Specific Gravity: 2.09 at 68°F (20°C)

Appearance and Odor: Clear, colorless liquid; mild gasolinelike odor.

Comments: Hexachloroethane sublimes directly without melting at 368.2°F (186.8°C). The saturated air concentration is approximately 670 to 700 ppm at 68°F (20°C). It is soluble in alcohol, toluene, benzene, chloroform, oil, and ether.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
Nonflammable	Nonflammable		Not Applicable	Not Applicable

Extinguishing Media: If it can be done without risk, remove material from fire area. Hexachloroethane does not burn. Use a dry chemical, carbon dioxide, alcohol foam, water spray, or other appropriate extinguishing agent suitable for the surrounding fire. Use a water spray to cool fire-exposed containers, to flush spills away from exposures, and to protect men attempting to remove hexachloroethane from the fire area.

Unusual Fire/Explosion Hazards: Hexachloroethane vapor is denser than air and can flow along surfaces to low-lying areas where it may become concentrated.

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

SECTION 5. REACTIVITY DATA

Hexachloroethane is stable. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material is incompatible with strong oxidizing agents. Avoid reaction with strong alkalies and metals (hot iron, zinc, aluminum) that will produce spontaneously explosive chloroacetylenes from dehalogenation.

Conditions to Avoid include elevated temperatures above 328°F (186°C) and direct physical contact with the previously listed chemically incompatible materials.

Hazardous Products of Decomposition can include oxides of carbon, hydrogen chloride gas, and phosgene. Hydrogen chloride and phosgene gases are very toxic, corrosive, and dangerous.

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

In the *Current Intelligence Bulletin* of August 1978 (Genium ref. 31), NIOSH recommended that exposures to hexachloroethane be reduced to the lowest feasible level because of its potential as a carcinogen. Hexachloroethane is considered to be carcinogenic by *RTECS* criteria, and it is reported to have caused liver tumors in mice (see NCITR NCI-CG-TR-68, 78).

Summary of Risks: The acute inhalation hazard is expected to be low because of hexachloroethane's low vapor pressure. Exposure to high concentrations has shown narcosis in animals as well as central nervous system depression characterized by weakness, staggering gait, and muscle twitching. This material is irritating to skin and mucous membranes. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Eyes. **Primary Entry:** Inhalation, eye and skin contact.
Acute Effects: Eye irritation. **Chronic Effects:** Cancer.

FIRST AID: Eye Contact. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin Contact.** Immediately wash the affected area with soap and water because of the increased exposure hazard from absorption. **Inhalation.** Remove victim to fresh air; restore and/or support his breathing as needed. **Ingestion.** Call a poison control center. Give victim 2 to 3 glasses of water to drink to dilute the material. Never give anything by mouth to someone who is unconscious or convulsing.

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

Comments: "NIOSH recommends that [hexachloroethane] be treated as a carcinogen" (*Am. Ind. Hyg. Assoc. J.* 40 [March 1979]: A-46). Consider using an alternative chemical; if it is irreplaceable, minimize all possible contact with this material.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel of a hexachloroethane spill or leak and implement containment procedures. Cleanup personnel should use protection against inhalation of vapor. When necessary, contain spills using an absorbent material such as dry sand or vermiculite (avoid raising dust). Mix well and place waste in an appropriate container for disposal. Flush trace residue with a lot of water. Do not flush waste to sewers or open waterways. Preplan for emergency response.

Waste Disposal: Waste may be burned in an approved incinerator equipped with an afterburner and scrubber. Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U131
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full faceshield as a supplementary protective measure. **Gloves:** Wear impervious rubber gloves. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. At any detectable concentration of hexachloroethane NIOSH recommends an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. Follow the respirator guidelines in 29 CFR 1910.134. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Ventilation: Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne levels of hexachloroethane below the legislated OSHA PEL cited in section 2. Local exhaust fume hoods should have a minimum face velocity of 100 lfm (linear feet per minute). A local exhaust ventilation system should be the primary removal system as dispersion of the contaminant into the general work area is eliminated. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Comments:** Practice good personal hygiene. Keep this material off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store hexachloroethane in tightly closed containers in a cool, dry, well-ventilated area away from oxidizing agents and sources of heat and ignition. Protect containers from physical damage.

Engineering Controls in the Workplace: Maintain engineering systems and standard operating procedures that minimize contact with this material to the greatest possible extent.

Comments: Do not take hexachloroethane home or out of your work area on your clothes or equipment. Avoid breathing vapors or contact with skin, eyes, or clothing. Wash thoroughly after handling and before eating, drinking, smoking, or using the toilet.

Transportation Data (49 CFR 172.101-2)
DOT Hazard Class: ORM-A **DOT Shipping Name:** Hexachloroethane **DOT ID No.** NA9037

References: 2, 4, 5, 6, 10, 12, 14, 30, 31, 47, 73, 87-94. CK/PJI

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.C. Acciaccio 5/88
Indust. Hygiene/Safety 5/88
Medical Review

Copyright © 1987 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © November 1, 1987

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 677

1,1,2,2-TETRACHLOROETHANE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION 27

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

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

Other Designations: Acetylene Tetrachloride; *sym*-Tetrachloroethane; $CHCl_2CHCl_2$; CAS No. 0079-34-5

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

Genium

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

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
1,1,2,2-Tetrachloroethane, CAS No. 0079-34-5	Ca 100	**OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 7 mg/m³ **ACGIH TLV (Skin*), 1988-89** TLV-TWA: 1 ppm, 7 mg/m³ **Toxicity Data**** Human, Oral, TD_{Lo}: 30 mg/kg Human, Inhalation, TC_{Lo}: 1000 mg/m³ (30 Mins) Rat, Oral, LD_{50}: 800 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (KI8575000), for additional data with references to reproductive, tumorigenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 295°F (146°C)
Melting Point: -47°F (-44°C)
% Volatile by Volume: Ca 100
Vapor Pressure: 6 Torrs at 77°F (25°C)*
Molecular Weight: 168 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.58658 at 77°F (25°C)

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

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

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature*	LEL*	UEL*

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

SECTION 5. REACTIVITY DATA

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

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: NIOSH lists 1,1,2,2-tetrachloroethane as a carcinogen.
Summary of Risks: 1,1,2,2-Tetrachloroethane is absorbed through intact skin in significant amounts; one human fatality has been attributed to this route of exposure. This liquid is considered to be one of the most toxic of the common chlorinated hydrocarbons, particularly with respect to the liver. Severely acute exposure causes depression of the central nervous system (CNS), which can cause death within 12 hours. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, gastrointestinal system, liver, and kidneys. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** The initial symptoms of exposure are lacrimation, salivation, and irritation of the nose and throat; continued exposure can lead to nausea, vomiting, and narcosis. Also, low blood pressure and cardiac rhythm abnormalities; respiratory depression; nausea, vomiting, burns of the esophagus, and diarrhea; and anesthesia with dizziness leading to loss of consciousness and coma; plus possible transient liver and kidney changes. **Chronic Effects:** The two sets of manifestations are (1) malaise, drowsiness, decreased appetite, then nausea and retching, a bad taste in the throat, constipation, headache, pale stools, jaundice, and dark urine, as well as mental confusion, stupor, and coma; and (2) hand

Copyright © 1988 by Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

SECTION 6. HEALTH HAZARD INFORMATION, cont.

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

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

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

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Waste, No. U209
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a); and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

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

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

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

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetrachloroethane
DOT Hazard Class: ORM-A
ID No. UN1702
DOT Packaging Requirements: 49 CFR 173.620
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: 1,1,2,2-Tetrachloroethane
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

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

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by: PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

Copyright © 1988 by Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 688
Abietic Acid

Issued: 11/89

Section 1. Material Identification 30

Abietic Acid Description: An organic acid prepared by isomerization of rosin; may also be derived from pine resin and tall oil. Used in manufacturing ester gums for use in lacquers and varnishes; on coatings for drugs; in certain hair preparations, soaps, plastics, "metal resinates," and paper sizes. Aids growth of butyric and lactic acid bacteria. Found in waste water from paper mills and solders used in the microelectronics industry.
Other Designations: 13-Isopropylpodocarpa-7,13-dien-15-oic acid; 1-phenanthrenecarboxylic acid (1,2,3,4,4a,4b,5,6,10,10a-decahydro-1,4a-dimethyl-7'-(1-methlethyl)); silvic acid; abietinic acid; $C_{20}H_{30}O_2$; CAS No. 0514-10-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I -
S 2
K 1

Genium

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

Section 2. Ingredients and Occupational Exposure Limits

Abietic acid, ca 100%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data*
None established	None established	None established	Mouse, intravenous, LD_{50}: 180 mg/kg

* Monitor NIOSH, *RTECS* (TP8580000), for future data with references to toxicity effects.

Section 3. Physical Data

Melting Point: 342 to 347 °F (172 to 175 °C)
Molecular Weight: 302.50 g/mol
Water Solubility: Insoluble

Appearance and Odor: Yellow resinous powder.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam.
Unusual Fire or Explosion Hazards: Abietic acid is combustible. Keep away from all heat and ignition sources. As a dust, abietic acid is a slight explosion hazard.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: Abietic acid is stable at room temperature in closed containers. Hazardous polymerization cannot occur.
Chemical Incompatibilities: None reported.
Hazardous Products of Decomposition: Thermal oxidative decomposition of abietic acid emits acrid smoke and irritating fumes.

Copyright © 1989 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists abietic acid as a carcinogen.
Summary of Risks: There is very little toxicity information on abietic acid. Animal studies have reported central nervous paralysis in frogs and intravenous poisoning in mice. Found in tree, particularly coniferous, resins, abietic acid may cause short-term irritation of the eyes, nose, throat, mucous membranes, skin, and possibly the sinuses. Studies note no long-term consequences.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, mucous membranes.
Primary Entry: Skin contact, ingestion, inhalation.
Acute Effects: Possible central nervous system (CNS) disturbances and skin and mucous membrane irritation.
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill or leak and remove all heat and ignition sources. Cleanup personnel should wear protective gear against liquid contact with skin and dust inhalation. Sweep up or vacuum without creating dusty conditions. Absorb the liquid with vermiculite, sawdust, or paper towels and place in a suitable removal and disposal container.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in drums, kegs, or multiwall paper bags away from all heat and ignition sources.
Engineering Controls: Avoid generation of dust as abietic acid is a slight explosion hazard in this form. Practice good personal hygiene procedures.

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

MSDS Collection References: 1, 7, 90, 124, 126, 127
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD M6

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

31

Pyrene Description: A condensed ring, polyaromatic hydrocarbon compound derived from coal tar. Also synthesized from o,o'-ditolyl. Used in biochemical research and as starting material for synthesizing benzo(a)pyrene. An ingredient of smoked and broiled meat, tobacco smoke, and air pollution.
Other Designations: CAS No. 0129-00-0; $C_{16}H_{10}$; beta-pyrene; benzo(d,e,f)phenanthrene; benzo(d,e,f)phenathrene.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K -
* Skin absorption

Genium

HMIS
H 2
F 1
R 0
PPG†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Pyrene, ca 100%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data*
8-hr TWA: 0.2 mg/m³	None established	None established	Rat, oral, LD_{50}: 2700 mg/kg ingested produces conjunctiva irritation, excitement, and muscle contraction Rat, inhalation, LC_{50}: 170 mg/m³ inhaled produces conjunctiva irritation, excitement, and muscle contraction Gene mutation in mammalian cells; human cell types: 12 µmol/l

* See NIOSH, *RTECS* (UR2450000), for additional mutative, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 759 °F/404 °C
Melting Point: 313 °F/156 °C
Vapor Pressure: 6.85 x 10^{-7} torr at 68 °F/20 °C
Molecular Weight: 202.26 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.271 at 73 °F/23 °C
Water Solubility: Insoluble (0.135 mg/l)

Appearance and Odor: Colorless solid or a slight blue florescent solution. Tetracene impurities give pyrene a yellow color.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Use foam, dry chemical, and CO_2 to extinguish fire.
Unusual Fire or Explosion Hazards: Pyrene is a flammable and combustible material that heat and ignition sources may ignite. It burns rapidly with a flare-like effect.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Avoid skin contact. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Pyrene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Hazardous Products of Decomposition: Thermal oxidative decomposition of pyrene can emit irritating fumes and acrid smoke.

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists pyrene as a carcinogen.
Summary of Risks: Pyrene is irritating to exposed skin and eyes, moderately toxic by ingestion and intraperitoneal routes, and a poison by inhalation. Experimental studies show pyrene is a tumorigen in animals and a mutagen in humans. Workers exposed to concentrations between 3 and 5 mg/m^3 showed some unspecified teratogenic effects. In general, human exposure occurs mainly through inhalation of tobacco smoke and polluted air. Although ingesting smoked and broiled meats may expose humans to pyrene, there is little indication of serious health effects.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, respiratory tract.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Vapor inhalation may irritate the nose mucosa and respiratory tract. Vapors may also cause conjunctival irritation. Pyrene is absorbed through intact skin and causes dermal irritation. Ingestion may irritate and burn the esophagus and gastrointestinal tract.
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of milk or water. Do not induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Observe patients with dermal exposure for systemic poisoning since pyrene is absorbed through intact skin.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, and remove all heat and ignition sources. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Scoop spilled material into appropriate disposal containers. Absorb liquid with inert, noncombustible material and place waste in appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 307(a)]
Listed as SARA Extremely Hazardous Substance (40 CFR 355), Reportable Quantity: 5000 lb, Threshold Planning Quantity (TPQ): 1000/10,000 lb
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, well-ventilated area. Protect containers from physical damage.
Engineering Controls: Avoid vapor inhalation and skin contact. Practice good personal hygiene and housekeeping procedures. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Provide preplacement and periodic medical examinations, including comprehensive medical histories with emphasis on the oral cavity, respiratory tract, bladder, and kidneys. Examine the skin for premalignant and malignant lesions.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 7, 73, 87, 103, 123, 124, 126, 127, 136
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

32

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

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

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

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

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

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

Section 2. Ingredients and Occupational Exposure Limits

Nickel, ca 100%

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

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

Section 3. Physical Data

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

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

Section 4. Fire and Explosion Data

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

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

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

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

Section 5. Reactivity Data

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

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

Conditions to Avoid: Avoid incompatibilities.

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

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

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

Section 7. Spill, Leak, and Disposal Procedures

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

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

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

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

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

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

32

1,1,1,2-Tetrachloroethane ($C_2H_2Cl_4$) Description: Prepared by chlorination of 1,1-dichloroethylene. Used in manufacturing insecticides, herbicides, soil fumigants, bleaches, paints, and varnishes; as a chemical intermediate for chlorocarbon solvents, a solvent, and a laboratory reagent.
Other Designations: CAS No. 0630-20-6; ethane, 1,1,1,2-tetrachloro-.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	-
S	2
K	0

Genium

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

Cautions: 1,1,1,2-tetrachloroethane is a skin and *severe* eye irritant.

Section 2. Ingredients and Occupational Exposure Limits

1,1,1,2-Tetrachloroethane, ca 100%

1989 OSHA PEL	1989-90 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data*
None established	None established	None established	Rabbit, eye: 100 mg produces severe irritation Mouse, oral, TD_{Lo}: 129 gm/kg administered intermittently over 2 yr in a number of separate, discrete doses

* See NIOSH, *RTECS* (KI8450000), for additional irritative and tumorigenic data.

Section 3. Physical Data

Boiling Point: 266.9 °F (130.5 °C) at 760 mm Hg
Melting Point: -94.4 °F (-70.2 °C)
Vapor Pressure: 14 torr at 77 °F (25 °C)
Viscosity: 1.501 cp at 20 °C
Molecular Weight: 167.84
Specific Gravity (20 °C/4 °C): 1.54064
Water Solubility: Soluble

Appearance and Odor: A yellowish red liquid.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fires, use dry chemcial, carbon dioxide, halon, water spray, or standard foam. For large fires, use water spray, fog, or standard foam.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Structural fire-fighter's protective clothing is ineffective. If feasible, remove fire-exposed containers; otherwise, use water spray to cool fire-exposed containers. Ventilate closed spaces before entering. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: 1,1,1,2-Tetrachloroethane is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This material is incompatible with potassium, potassium hydroxide, sodium potassium alloy, nitrogen tetroxide, sodium, dinitrogen tetraoxide, and 2,4-dinitrophenyl disulfide.
Conditions to Avoid: Avoid incompatibilities, flame, red hot metal surfaces, or incandescent material.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,1,1,2-tetrachloroethane can produce very toxic oxides of chlorine (Cl^-), carbon dioxide (CO_2), and carbon monoxide (CO).

Copyright © 1990 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: The IARC does not classify 1,1,1,2-tetrachloroethane as a human carcinogen (Group 3) since human evidence is inadequate and animal evidence limited.
Summary of Risks: 1,1,1,2-tetrachloroethane is a skin and severe eye irritant.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes.
Primary Entry Routes: Inhalation.
Acute Effects: Symptoms of inhalation include vertigo, headache, nervousness, numbness, and tremors. Direct contact with skin and eyes causes irritation. Eye contact may result in chemosis (swelling of conjunctival tissue around the cornea) and hyperemia (blood congestion).
Chronic Effects: Chronic effects include appetite loss, nausea, tired feeling, and headache. Prolonged skin contact may lead to blistering.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For ingestion, consider administering charcoal slurry, aqueous or mixed with saline cathartic or sorbitol. The usual charcoal dose for adults is 30 to 100 g.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills with some inert, noncombustible absorbent material. Use a clean shovel to place spilled material into appropriate containers for disposal. For large spills, dike far ahead of spill. Do not release to sewers or waterways [bluegill, LC_{50}: 20 mg/liter/24 hr (with a 95% confidence limit of 16 to 24 mg/liter)]. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U208
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials (Sec. 5). Protect containers from physical damage.
Engineering Controls: Avoid inhalation of vapors and skin or eye contact. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. By analogy to the carcinogenic chloroethanes, minimize all possible exposures to potential carcinogens. Educate workers about 1,1,1,2-tetrachloroethane's hazards and potential dangers.

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

MSDS Collection **References:** 73, 103, 124, 126, 127, 136, 138, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD; **Edited by:** JR Stuart, MS

Copyright © 1990 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 758
Iron

Issued: 7/91

Section 1. Material Identification

Iron (Fe) Description: Occurs naturally as the second most abundant metal (~5%) in the earth's crust. Its commercial form usually contains some carbon, phosphorus, silica, sulfur, and manganese. It has four naturally occurring isotopes: 54, 56, 57 and 58, and six artificial ones: 52, 53, 55, 59, 60, and 61. Iron is purified by smelting ore with limestone and coke in blast furnaces (purity 91 to 92 %), or by continuous direct reduction of iron ore with limestone heated to 1699 °F (926 °C), melted at 3499 °F (1926 °C), and then reduced to iron at 2998 °F (1648 °C) with powdered coal (purity 99%). The powder form is obtained by treating ore or scrap metal with hydrochloric acid to give ferrous chloride solution, then filtrating, vacuum crystallizing, dehydrating, and reducing it at 1472 °F (800 °C) to metallic iron (briquettes or powder); or by thermal decomposition of iron carbonyl. Solid iron is used to alloy with carbon, manganese, chromium, nickel, and other elements to form steel. Its radioisotopes (^{55}Fe and ^{59}Fe) are used in biological tracer studies. The powder form is used in metallurgy products, magnets, high-frequency cores, and auto parts; and as a catalyst in ammonia synthesis.
Other Designations: CAS No. 7439-89-6, Ancor En 80/150,® Armco iron,® carbonyl iron, Loha,® Suy B-2.®
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Genium

Powder Solid

R	1	HMIS	
I	2	H	2
S	1	F	2
K	1	R	1
		PPG*	

*Sec. 8

Cautions: Iron is moderately toxic by ingestion and inhalation of iron dusts and powder. The powder form is pyrophoric (ignites spontaneously upon exposure to air and other substances).

Section 2. Ingredients and Occupational Exposure Limits

Iron, ca 91 to 99%

1990 OSHA PEL	1990-91 ACGIH TLV	1990 NIOSH REL	1985-86 Toxicity Data†
8-hr TWA: 10 mg/m³*	TWA: 5 mg/m³*	5 mg/m³*	Rabbit, intraperitoneal, LD_{Lo}: 20 mg/kg; no toxic effect noted

*As iron oxide fumes.
† See NIOSH, *RTECS* (NO4565500), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 4982 °F (2750 °C)
Melting Point: 2795 °F (1535 °C)
Vapor Pressure: 1 mm Hg at 3248 °F (1787 °C)
Electrical Resistivity: 9.71 μΩ/cm at 68 °F (20 °C)
Molecular Weight: 55.847
Density/Specific Gravity: 7.86 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Pure, solid iron is a silvery-white or gray, soft, ductile, malleable (can be rolled, hammered, or bent), slightly magnetic (becoming more so as it is alloyed; for example, steel) metal. It is available as ingots, wire, sheets, or powder. The powder form is black-gray.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fire, use water spray, carbon dioxide (CO_2), or regular foam. For large fires, use water spray or regular foam. Apply cooling water spray to fires-exposed container sides until fire is well out. If possible with no risk, remove containers from area.
Unusual Fire or Explosion Hazards: Since finely divided iron powder is pyrophoric and ignites upon exposure to air at normal temperatures, fires and dust explosions can occur in ducts or separators used to remove the dust during grinding and polishing operations.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Fight fire from as far a distance as possible. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

*Although no flash point or autoignition temperature is reported, remember that the powder form is pyrophoric and can ignite spontaneously in air at room temperatures.

Section 5. Reactivity Data

Stability/Polymerization: Iron is stable in dry air, but readily oxidizes in moist air to form rust. Highly divided powder forms are very unstable and can ignite spontaneously in air.
Chemical Incompatibilities: Solid or powdered iron ignites or explodes on contact with acetaldehyde, ammonium peroxodisulfate, chloroformamidinium, chloric acid, ammonium nitrate, halogens, dinitrogen tetraoxide, nitryl fluoride, polystyrene, sodium acetylide, potassium dichromate, peroxyformic acid, and nitryl fluoride. Hot iron wire burns in chlorine gas and iron with water forms rust.
Conditions to Avoid: Avoid generation of iron dusts and contact with the materials listed above.
Hazardous Products of Decomposition: Thermal oxidative decomposition of iron can produce toxic iron oxide fumes.

Copyright © 1991 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list iron as a carcinogen although the mining of one particular ore, hematite, may be associated with an increased risk of lung cancer in miners. No other iron ores are identified specifically as a carcinogen.
Summary of Risks: Occupational exposures usually result from dust or fume inhalation during mining, ore preparation, production, and refining of the metal and its alloys. Acute and chronic toxicity can occur. Although rare, occupational toxicity by ingestion has occurred. Its effects are the same as those by ingestion of large amounts of iron tablets.
Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory diseases.
Target Organs: Eyes, respiratory tract, liver, and pancreas.
Primary Entry Routes: Eyes, inhalation, and ingestion.
Acute Effects: Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), and deposition of iron particles can leave a "rust ring" or brownish stain on the cornea. Iron's acute toxicity results primarily from accidental or suicidal ingestions (e.g., overdose of iron-containing vitamin pills). Initially, the patient may have vomiting, abdominal pain, bloody diarrhea, hematemesis (vomiting blood), lethargy, and shock. After several hours, the patient may improve, but should be observed carefully, as toxicity may progress to development of profound shock, severe acidosis (increased acidity in blood), cyanosis (bluish skin discoloration), and fever. Two to four days after exposure, liver damage may occur. Within several weeks after exposure, in several rare cases, gastrointestinal fibrosis (scarring) has occurred with obstruction of the digestive tract. Iron overdose may be fatal.
Chronic Effects: Chronic inhalation can produce mottling (spotting) of lungs (siderosis). This condition is often without symptoms and has been referred to as "benign radiopaque pneumoconiosis." Ingestion of greater than 50 to 100 mg of iron per day may result in pathological iron deposition in body tissues. Symptoms include fibrosis (scarring) of the pancreas, diabetes mellitus, and liver cirrhosis. Repeated iron ingestion can produce cardiac toxicity.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Consult poison control center.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Management of iron poisoning by ingestion is complex and beyond this MSDS's scope. Consult a medical toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind. Shut off all ignition sources–no flares, smoking, or flames in hazard area. Avoid dust generation by cleaning small spills with a damp mop. Since finely divided iron powder is explosive, take special care during cleanup. For large spills, flush material with a stream of water and dike for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed (as iron oxide fumes) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent any skin contact.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area away from flammable gases or liquids, oxidizing materials, or organic peroxides (Sec. 5).
Engineering Controls: Avoid dust inhalation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Regularly service the ducting at grinding and polishing machines and finishing belts to maintain efficiency of exhaust ventilation and prevent explosion. Remote control operations of machinery is advisable when at all possible.

Transportation Data (49 CFR 172.101)
DOT Shipping Name: Iron mass *or* sponge, *not properly oxidized*
DOT Hazard Class: Flammable solid
ID No.: NA1383
DOT Label: Flammable solid
DOT Packaging Exceptions: None
DOT Packaging Requirements: 173.174

MSDS Collection References: 26, 73, 103, 124, 126, 127, 132, 136, 138, 139, 143, 146, 148, 149, 159
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

Copyright © 1991 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

37

Hexachlorobutadiene ($Cl_2C:CClCCl:CCl_2$) Description: Derived as a by-product of chlorination of various hydrocarbons such as tetrachloroethylene, trichloroethylene, and carbontetrachloride. Used as a solvent for elastomers, a heat transfer liquid, a transformer and hydraulic fluid, a wash liquor for removing C_4 and higher hydrocarbons, a chemical intermediate for fluorinated lubricants and rubber compounds, and a fluid for gyroscopes; and in pesticides.
Other Designations: CAS No. 87-68-3, Dolen-Pur, HCBD, hexachloro-1,3-butadiene, perchlorobutadiene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

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

NFPA
1 2 1

HMIS
H 2
F 1
R 1
PPG†
† Sec. 8

Cautions: Hexachlorobutadiene is toxic by inhalation, ingestion, and skin absorption, and is an experimental carcinogen and mutagen. This liquid is slightly combustible.

Section 2. Ingredients and Occupational Exposure Limits

Hexachlorobutadiene, ca 98%

1990 OSHA PEL
8-hr TWA: 0.02 ppm (0.24 mg/m³)

1991-92 ACGIH TLV
TWA: 0.02 ppm (0.21 mg/m³)

1990 DFG (Germany) MAK
Suspected Carcinogen

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Rat, oral, LD_{50}: 90 mg/kg; toxic effects not yet reviewed
Mouse, inhalation, LC_{Lo}: 235 ppm/4 hr; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 15 g/kg given continuously over a 2-year period produced kidney tumors and other effects on ureter and bladder
Rabbit, skin: 810 mg applied for 24 hr produced moderate irritation

* See NIOSH, *RTECS* (EJ0700000), for additional irritation, mutation, reproductivity, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point Range: 410 to 428 °F (210 to 220 °C)
Freezing Point Range: -2.2 to -7.6 °F (-19 to -22 °C)
Vapor Pressure: 22 mm Hg at 212 °F (100 °C), 500 mm Hg at 392 °F (200 °C)
Vapor Density (air = 1): 8.99
Refraction Index: 1.5542 at 68 °F (20 °C)
Molecular Weight: 260.74
Density: 1.675 at 59.9 °F (15.5 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in alcohol and ether and miscible with many resins.
% in Saturated Air: 0.037 at 77 °F (25 °C)
Viscosity: 2.447 cP at 99.86 °F (37.7 °C), 1.131 cP at 210.02 °F (98.9 °C)

Appearance and Odor: Clear, colorless, heavy liquid with a mild turpentine odor. Half the people questioned could detect 1 ppm. *Caution!* Detection of 1 ppm is inadequate for preventing overexposure.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: 1130 °F (610 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Hexachlorobutadiene is slightly combustible. For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. *Do not scatter fire* with more water than necessary to put out fire.
Unusual Fire or Explosion Hazards: Container may explode in heat of fire.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. If possible without risk, remove container from fire. Fight fire from maximum distance. Stay away from ends of tanks. Structural firefighters' protective clothing is ineffective for fires involving hexachlorobutadiene. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Heavy vapors from a fire may accumulate in low areas (pits, etc.) and remain hazardous after the fire is extinguished.

Section 5. Reactivity Data

Stability/Polymerization: Hexachlorobutadiene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: None reported.
Conditions to Avoid: Generation of vapors and exposure to excessive heat.
Hazardous Products of Decomposition: Thermal oxidative decomposition of hexachlorobutadiene can produce carbon dioxide (CO_2) and toxic chloride fumes (Cl^-).

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, these groups classify hexachlorobutadiene: IARC (Group 3), NIOSH (Suspected Carcinogen), and ACGIH (A2, Suspected Human Carcinogen).
Summary of Risks: Hexachlorobutadiene is a NIOSH-suspected carcinogen, potentially causing kidney and lung cancer. Most available toxicity data are based on animal studies. According to these studies, a 0.13-ppm air concentration has no effect on humans, and 1.3 ppm produces reversible changes. In the one human toxicity report found, 205 vineyard workers exposed seasonally to hexachlorobutadiene at 0.8 to 30 mg/m³

Continue on next page

Copyright © 1992 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

and polychlorobutane-80 at 0.12 to 6.7 mg/m³ showed a number of toxic effects that led to hypotension, cardiac disease, nervous function disturbances, chronic bronchitis, and hepatitis.

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

Target Organs: Kidney and liver (in animals).

Primary Entry Routes: Inhalation, ingestion, and skin absorption.

Acute Effects: Based on animal data and the one human study, exposure to hexachlorobutadiene could cause irritation of eyes, nose, throat, and respiratory tract, and kidney and nervous system damage.

Chronic Effects: Exposure to hexachlorobutadiene could possibly lead to cardiac disease, chronic bronchitis, and hepatitis.

FIRST AID

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

Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

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

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

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

Note to Physicians: Consider monitoring acutely and chronically exposed patient for renal damage. Since at least some toxicity is presumed reversible, use supportive care.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Prepare a spill control plan. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources—no flames, flares, or smoking in hazard area. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spills for later disposal. Cleanup personnel should wear fully encapsulating, vapor-protective clothing to prevent inhalation and skin exposure. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transportation: When released into the atmosphere, hexachlorobutadiene reacts with hydroxyl radicals and ozone and has a half-life of 3.24 hr. HCDB should biodegrade in natural waters since 100% degradation occurred in 7 days in an aerobic bath culture. Its estimated half-life in river water is 3 to 30 days, and 30 to 300 days in lake and groundwater.

Environmental Degradation: Ecotoxicity values: fathead minnow, LC_{50}, 0.09 mg/L/96 hr; *Poecilia reticula* (guppy), LC_{50}, 0.4 ppm/14 days.

Soil Absorption/Mobility: Hexachlorobutadiene absorbs strongly to soil and does not rapidly migrate, but moves more rapidly in sandy soils.

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

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U128

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1 lb (0.454 kg) [* per RCRA, Sec. 3001 and Clean Water Act, Sec. 307(a)]

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

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact.

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

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

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. Disposable outer garments may be a preferable alternative to prevent employee exposure.

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

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in cool, dry, well-ventilated area away from strong heat sources.

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

Administrative Controls: Consider preplacement and periodic medical examinations of exposed workers. Include urinary excretion of coproporphyrins in medical exams. Training for hazardous communication is very important and workers should be educated about safe handling of a suspected carcinogen.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Hexachlorobutadiene

ID No.: UN2279

IMO Hazard Class: 6.1

IMO Label: St. Andrews

IMDG Packaging Group: III

MSDS Collection References: 73, 89, 103, 127, 132, 136, 142, 153, 159, 161-164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Section 1. Material Identification

37

2,4-Dinitrotoluene [$C_6H_3CH_3(NO_2)_2$] Description: The most important isomer of dinitrotoluene derived by nitration of toluene with nitric acid in the presence of concentrated sulfuric acid to yield about 80% 2,4- and 20% 2,6-isomers from which the 2,4-isomer is not usually separated. Used in manufacturing explosives and dyes, in inorganic synthesis, as a chemical intermediate, a plasticizer, and a modifier for smokeless powders in the munitions industry.
Other Designations: CAS No. 121-14-2, (2,4-dinitrotoluene); CAS No. 25321-14-6 (all isomers), DNT, dinitrotoluol, methyldinitrobenzene, NCI-CO1865.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 3
I 3
S 3*
K 2
* Skin absorption

NFPA

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

Cautions: 2,4-Dinitrotoluene is combustible and explosive. This material is highly toxic by skin absorption, inhalation, and ingestion.

Section 2. Ingredients and Occupational Exposure Limits

2,4-Dinitrotoluene, ca 80% 2,4- and 20% 2,6-, with <5% other isomers

1990 OSHA PEL (Skin)
8-hr TWA: 1.5 mg/m³

1990 IDLH Level
200 mg/m³, *all isomers. Treat as a potential human carcinogen.*

1990 NIOSH REL (Skin)
TWA: 1.5 mg/m³, *all isomers**

1991-92 ACGIH TLV (Skin)†
TWA: 1.5 mg/m³, *all isomers*

1990 DFG (Germany) MAK
Danger of cutaneous absorption
MAK-A2

1985-86 Toxicity Data‡
Rat, oral, LD_{50}: 268 mg/kg; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 2620 mg/kg administered for 78 continuous weeks caused skin and appendage tumors
Rat, oral, TD_{Lo}: 3094 mg/kg administered to a 13-week-old male produced effects on fertility (pre-implantation mortality)

* NIOSH recommends controlling potential carcinogens at the lowest possible level.
† Notice of intended change to 0.15 mg/m³
‡ See NIOSH, *RTECS* (XT1575000), for additional irritation, mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 482 °F (250 °C)
Melting Point: 158 °F (70 °C); decomposes spontaneously at 536 °F (280 °C)
Vapor Pressure: 1 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 6.27
Refraction Index: 1.442
Molecular Weight: 182.14
Specific Gravity: 1.3 *liquid*, 1.5 *solid* at 68 °F (20 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in alcohol, acetone, benzene, carbon disulfide, ether, and pyridine

Appearance and Odor: Orange to yellow crystalline solid or liquid with a slight odor.

Section 4. Fire and Explosion Data

Flash Point: 404 °F (207 °C), CC	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: 2,4-Dinitrotoluene is combustible and can become highly explosive when exposed to heat, friction, or contamination. 2,4-Dinitrotoluene's explosive energy is approximately 85% of TNT (a well-known, powerful explosive). Closed containers may rupture violently when heated. DNT decomposes spontaneously at 482 °F (250 °C, anaerobic) and 536 °F (280 °C, self-sustaining) and causes an explosion if confined. Contamination of DNT with organic materials lowers the decomposition temperature and increases the risk of explosion.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *ineffective* for fires involving DNT. Use extreme caution and fight fire from as far away as possible. Apply cooling water to container sides until long after fire is extinguished. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: 2,4-Dinitrotoluene is explosive when exposed to heat, friction, or contamination. It can be detonated but only by a very strong initiator. DNT is slightly sensitive to impact shock, with the liquid form less so than the solid form.
Chemical Incompatibilities: 2,4-Dinitrotoluene is incompatible with organic materials; strong reducing agents such as sodium sulphide, zinc powder, sodium hyposulphite, and metallic hydrides; strong oxidizing agents such as bichromates, peroxides, and chlorates (especially during transit); caustics; and metals such as tin and zinc. DNT corrodes some forms of plastics, rubber, and coatings.
Conditions to Avoid: Exposure to heat, friction, and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 2,4-dinitrotoluene can produce carbon dioxide (CO_2) and toxic nitrogen oxides (NO_x).

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, NIOSH recommends treating dinitrotoluene as a potential human carcinogen. The ACGIH and Germany (DFG) list it as Class A2 (probably carcinogenic to humans) and MAK-A2 (unmistakably carcinogenic in animals only), respectively. However, neither NIOSH, ACGIH, or MAK specify *which* or *how many* isomers are involved.
Summary of Risks: Highly toxic 2,4-dinitrotoluene is dangerous through all routes of human exposure. Skin absorption is more prevalent than inhalation (due to low vapor pressure) and ingestion. Cyanosis and anemia are the usual manifestations of exposure.
Medical Conditions Aggravated by Long-Term Exposure: Persons with blood disorders may be at increased risk.
Target Organs: Blood, liver, central nervous (CNS) and cardiovascular (CVS) systems.
Primary Entry Routes: Skin absorption, inhalation, ingestion.
Acute Effects: Skin absorption and inhalation cause many of the same effects. The major effect of exposure to DNT is cyanosis (a purplish discoloration of skin and mucous membranes due to lack of oxygenated blood) which occurs when methemoglobin (brownish blood pigment of the blood that cannot

Continue on next page

Copyright © 1992 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *continued*

combine reversibly to molecular oxygen) concentration in the blood reaches 15% or more. Other possible symptoms include headache, irritability, dizziness, weakness, nausea, vomiting, dyspnea (difficulty in breathing), drowsiness, and unconsciousness. If treatment is not prompt, death may occur usually by cardiovascular collapse. Ingestion can cause irritation of mouth and stomach, stomach cramps, and diarrhea. In addition to absorption symptoms, skin contact can cause irritation, small blisters, redness, swelling, ulceration, and necrosis (death of living tissue). Contact with eyes may produce irritation, redness and swelling of eyelids, pain on exposure to light, and severe eye damage. If molten, 2,4-dinitrotoluene can cause thermal burns.
Ingestion of alcohol at time of exposure can increase an individual's susceptibility to toxicity.
Chronic Effects: Repeated or prolonged exposure to DNT may cause anemia (a deficiency in red blood cells, hemoglobin, or both). 2,4-Dinitrotoluene affects the liver's drug-metabolizing enzymes and is a liver mutagen and carcinogen in rodents.
FIRST AID: *Emergency personnel should protect against contamination.*
Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub or keep eyes tightly shut. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash entire body from head to foot with soap and water. Pay special attention to the hair, scalp, finger and toenails, nostrils, and ear canals. Repeat skin cleansing if the methemoglobin concentration appears to rise after 3 to 4 hr. Carefully dispose of contaminated clothing.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Consult a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Determine the methemoglobin concentration in the blood every 3 to 6 hr. Urine excretion of dinitrotoluene in excess of 25 mg/L of urine indicates significant absorption. Consider giving intravenously 10 mL of 1% methylene blue solution at or below a 2 mL/min rate for victims with methemoglobin levels above 20%. Watch patient for 48 hr after apparent recovery to detect relapsing cyanosis and advanced anemia.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources—no flames, flares, or smoking in hazard area. Cleanup personnel should wear fully encapsulating vapor-protective clothing for spills with no fire. Use a water spray to reduce vapors. For small spills, carefully place in suitable, clean, dry containers (steel drums are preferred). Remove containers from area. For large spills, flush area with hot water to remove solid DNT and contain any liquid runoff. Cool and settle solid for disposal in steel drums. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: DNT released into water absorbs slightly to sediments and suspended solids with an estimated half-life of 438 days. When released into the atmosphere, DNT has an estimated half-life of 8 hr.
Soil Absorption/Mobility: DNT is slightly mobile in soil.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U105
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 10 lb (4.54 kg) [* per RCRA, Sec. 3001, Clean Water Act, Sec. 311(b)(4), and Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective face shields (8-in. minimum), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH/MSHA-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, cleaning, and convenient, sanitary storage areas.
Other: Wear chemically protective gloves, boots, aprons, and gauntlets (butyl rubber is the most effective material for protective clothing) to prevent all skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Separate contaminated clothing so that personnel who handle, dispose of, or clean it have no direct contact with it. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in cool, dry, well-ventilated area away from incompatibles. DNT is normally stored as a molten liquid; be sure to keep hot water coils lower than 194 °F (90 °C).
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control the airborne contaminants and to maintain concentrations at the lowest possible level. Totally enclosed equipment systems are preferred. Be aware of mists escaping from hot charges, leaking lines, steaming operations, and hot drainage ditches because they are sources of serious skin exposure and worker environment contamination.
Administrative Controls: Suggested measures of protection include respiratory protection, job rotation, exposure time limitations, and use of protective clothing and whole body protection. Consider preplacement and periodic medical examinations of exposed workers that include blood and urine analysis, and liver function tests.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Dinitrotoluenes, solid; Dinitrotoluenes, molten
IMO Hazard Class: 6.1; 6.1
ID No.: UN1600; UN2038
IMO Label: Poison; Poison
IMDG Packaging Group: II; II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 126, 127, 136, 139, 140, 142, 148, 149, 153, 159, 162, 163, 164
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

SECTION 6. HEALTH HAZARD INFORMATION

TLV 5 ppm or 22 mg/m^3

o-Cresol is a highly toxic compound. Overexposure to o-Cresol via ingestion, skin absorption, or inhalation may cause muscular weakness, headache, dizziness, nausea, vomiting, gastrointestinal disturbances, respiratory distress, confusion, loss of consciousness, and death. It may also cause damage to the kidney, liver, pancreas and spleen. Vapors of o-Cresol are irritating to the eyes, nose, throat and respiratory tract. The liquid is extremely corrosive to the skin and eyes. If eye contact occurs, it may cause loss of vision if not promptly and completely removed. Contact with skin may cause severe irritation or burns, dermatitis, or death if large areas of skin are exposed to o-Cresol and it is not promptly removed. Chronic exposure to low doses of o-Cresol may cause gastrointestinal disturbances, headache, dizziness, mental disturbance, skin rash and damage to the liver and kidneys. The main industrial hazard associated with use of o-Cresol is prolonged and/or extensive skin contact. Under normal conditions, overexposure to vapors of o-Cresol is unlikely because of its low vapor pressure and disagreeable odor. Some individuals may be hypersensitive to this material. Toxic effects of o-Cresol are similar to Phenol, but less severe.

FIRST AID: EYE CONTACT: Promptly flush eyes, including under eyelids, for at least 15 minutes with running water. Get medical attention. SKIN CONTACT: Flush skin with running water while removing contaminated clothing for at least 5 minutes. Get medical attention.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as needed. Get medical help.* INGESTION: Give victim one glass of milk or water. Contact a physician or Poison Control Center. Do not induce vomiting unless instructed to do so. Do not give anything by mouth to a person who is unconscious or is having convulsions. Get medical attention.*

* MEDICAL ATTENTION = Inplant, Paramedic, Community.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the area of all nonessential personnel. Clean-up personnel need full protective clothing and equipment to prevent inhalation and contact with solid or liquid. Absorb small spills on paper, vermiculite or other absorbent material and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Shovel solid into steel container for disposal. Do not allow o-Cresol to enter sewer, watersheds, or waterways.

DISPOSAL: Place in a suitable container for disposal by licensed contractor or burn in an approved incinerator.

o-Cresol is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U052 (40 CFR 261).
EPA (CWA) RQ is 1000 lbs/454 kgs (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion proof) to meet TLV requirements. When o-Cresol is heated, vapor inhalation can be a serious hazard without proper precaution. For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved respirator. Fume hoods should maintain a minimum face velocity of 100 lfm. All electrical service in use or storage areas should have an explosion-proof design. DANGER! Avoid any contact with this material. Full protective equipment, including splash goggles, face shield, impervious gloves, apron, boots, impervious shirts and trousers, hard hat with brim, acid suit, and respirator should be available and worn as necessary. Remove contaminated clothing promptly and do not reuse until it has been properly laundered.

Eye wash stations and safety showers should be readily available in use and handling areas.
Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks and open flame. Protect container from physical damage. Outside or detached storage is preferred.
Use only with adequate ventilation. Avoid contact with skin, eyes, and clothing. Do not breathe vapors. Wash thoroughly after handling. o-Cresol may turn color upon exposure to air or light. Untrained workers should not handle this material.

DOT CLASSIFICATION: Corrosive material, UN2076.

DATA SOURCE(S) CODE (See Glossary) 1,2,6,7,9,12,23,26,31,34,37,47,54,63,69,75,78,79, 59, R.

Judgements as to the suitablity of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitablity of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS J.O. Aarocco 1/86
INDUST. HYGIENE/SAFETY 1-86
MEDICAL REVIEW: 7 Feb 86

 Copyright © November 1, 1985