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WARZYN

Report
13114

Work Plan
Hagen Farm Site
Stoughton, Wisconsin
Volume 2 Of 4

Prepared For:

Waste Management
Of Wisconsin, Inc.
Milwaukee, Wisconsin

Prepared By:

Warzyn Engineering Inc.
Madison, Wisconsin

June 1988

Waste Management of North America, Inc.
Northern Region Office
W124 N8925 Boundary Road · Menomonee Falls, Wisconsin 53051
414/251-4000

April 7, 1988

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Gentlemen:

Enclosed for your review are copies of the revised RI/FS Work Plan for the Hagen Farm Site in Dane County, Wisconsin. These plans have been prepared for Waste Management by Warzyn Engineering, Inc., Madison, Wisconsin. The revised Work Plan incorporates the comments that were received on January 18, 1988 and which were discussed in the meeting on February 10, 1988. As you are aware, numerous meetings and discussions have occurred since the February 10, 1988 meeting to resolve the detailed technical issues.

If you have any questions, please contact me at 414/251-4000.

Sincerely,

Jack Dowden
Remedial Project Coordinator
Environmental Management

JD/ems
Enclosure
cc: Ann Straw, WMNA-Legal
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Work Plan
Hagen Farm Site
Stoughton, Wisconsin
Volume 2 Of 3

April 1988

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DRAFT WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HAGEN FARM SITE,
DANE COUNTY, WISCONSIN

INTRODUCTION

This Work Plan presents the proposed activities for performing a Remedial Investigation (RI) and Feasibility Study (FS) at the Hagen Farm site near Stoughton, Wisconsin. This Work Plan is a result of the Administrative Order of Consent (AOC) and Statement of Work (SOW) that was signed by the U.S. Environmental Protection Agency (U.S. EPA), Waste Management of Wisconsin, Incorporated (WMWI) and Uniroyal Plastics Company, Incorporated, (Uniroyal) which became effective September 14, 1987. The Wisconsin Department of Natural Resources (WDNR) will also provide input into RI/FS documents and activities.

This Work Plan has been prepared following the phased iterative approach presented in the Hagen Farm SOW. Accordingly, the RI/FS tasks, subtasks and activities are presented in the sequence in which they are to be performed and have been renumbered. This format differs from that presented in the SOW. Table 1 shows the numbering sequence used in this Work Plan and the corresponding SOW task numbers. The sequence in which the RI/Fs tasks will be performed is illustrated in Figure 1. A description of the phased iterative approach is presented below.

The purpose of the RI is to determine the nature and extent of contamination at the Hagen Farm site in order to support the activities of the FS. The purpose of the FS is to develop and evaluate appropriate remedial action alternatives based on the RI data and report. Personnel, materials, and services required to perform the RI/FS will be provided by the PRPs identified in the AOC.

TABLE 1

WORK PLAN TASK NUMBERS AND CORRESPONDING AOC/SOW TASK NUMBERS

	Plans & Management	Remedial Investigation	Feasibility Study	AOC/SOW
Phase I		Task 1 - Site Evaluation Report		Task 1
Phase II	Task 2 - Work Plan Preparation			Task 0
		Task 3 - Site Investigation		Task 2
		Task 4 - Site Investigation Analysis		Task 3
		Task 5 - Draft RI Report		Task 5
			Task 6 - Remedial Alternative Screening	Task 7
			Task 7 - Alternatives Array Document	Task 9
Phase III	Task 8 - Supplemental Work Plan Preparation			Task 0
		Task 9 - Supplemental Site Investigation & Bench/Pilot Testing		Task 2
		Task 10 - Supplemental Site Investigation Analysis		Task 3
		Task 11 - Final RI Report		Task 5
			Task 12 - Remedial Alternatives Evaluation	Task 8
			Task 13 - Final FS Report	Task 9
	Task 14 - Community Relations			Task 6
	Task 15 - Monthly Operating Reports			Task 5

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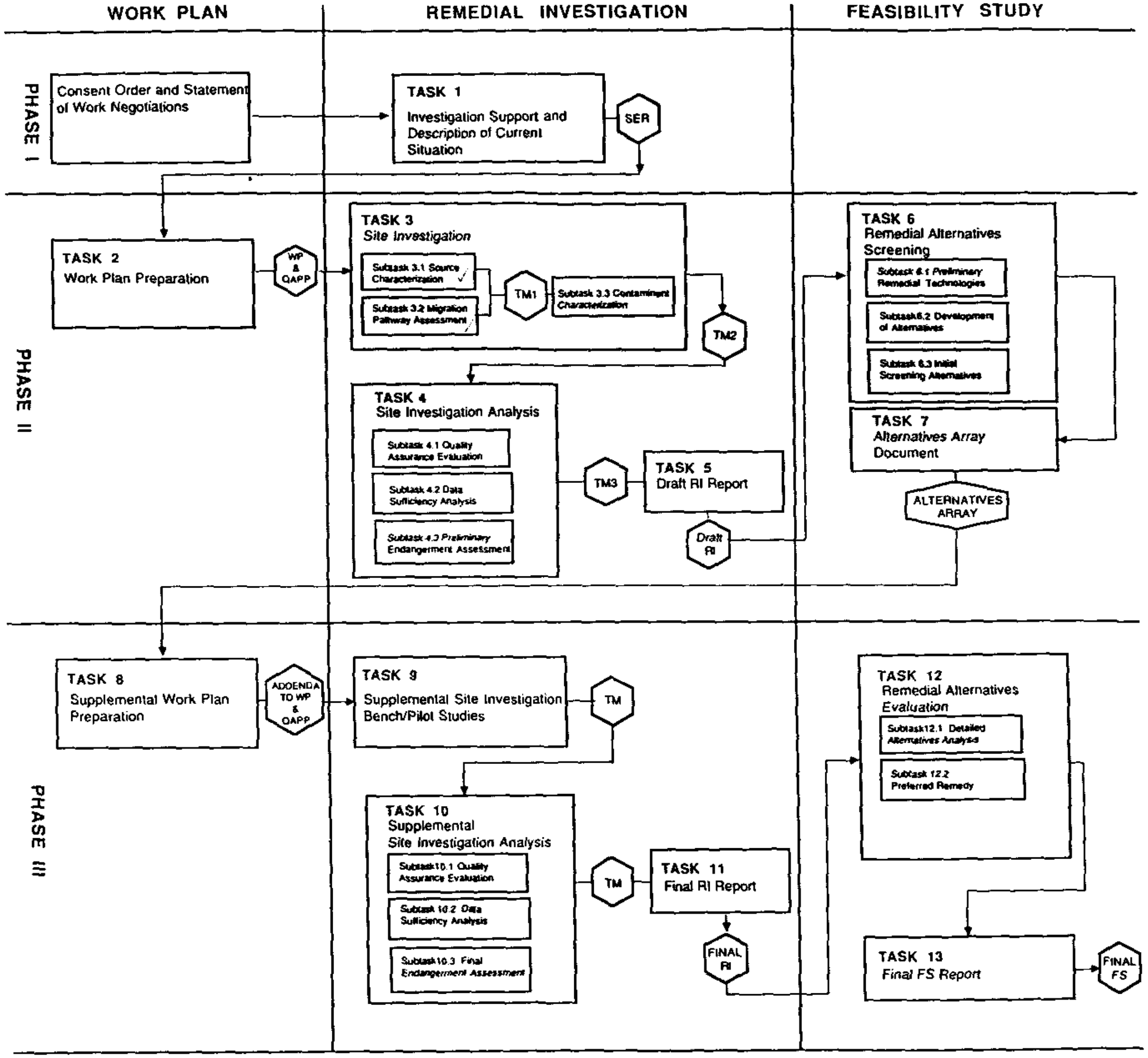
[jpl-402-71]

WMI'S PROPOSED REMEDIAL SELECTION PROCESS IN ACCORDANCE WITH SARA



WP = Work Plan   QAPP = Quality Assurance Project Plan   RI = Remedial Investigation Report   FS = Feasibility Study Report   TM = Technical Memorandum   SER = Site Evaluation Report

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FIGURE 1

The objectives of this RI/FS project, as required under the Superfund Amendments and Reauthorization Act (SARA), will be achieved using a phased iterative approach. As illustrated in Figure 1, RI activities will focus on meeting the site specific data requirements of the FS remedial alternative selection process. Provisions can be made at several points in the process to collect additional data, if needed to fulfill FS requirements. For example, if additional data are needed for the completion of the Source Characterization (Subtask 3.1) and the Migration Pathway Assessment (Subtask 3.2), then provisions can be made to collect these data during the Supplemental Site Investigation (Task 9). Thus, the Remedial Alternative Screening (Task 6) can present meaningful information toward the selection of a final remedial alternative(s) for the Hagen Farm site. Although this approach differs somewhat from traditional approaches to RI/FS projects, it will achieve the goals presented in SARA while minimizing the need to conduct post-FS or supplemental RI/FS investigations.

The planning documents for this project are presented in three volumes complementary to each other. They include:

Volume 1 - Site Evaluation Report
Volume 2 - Work Plan
Volume 3 - Quality Assurance Project Plan

The Site Evaluation Report prepared for this site describes the site setting and history, including studies performed to date, and identifies data needs (see Phase I of Figure 1).

The specific tasks described in this Work Plan (Volume 2) have been grouped into the following three categories:

- Plans and Management;
- Remedial Investigation (RI); and
- Feasibility Study (FS).

PHASE II PLANS AND MANAGEMENT

Task 2 - Work Plan Preparation

This RI/FS Work Plan has been prepared for the Hagen Farm site to detail the technical approach and schedule for the tasks described below. The schedule (Appendix A) illustrates the implementation of tasks and submission of deliverables to U.S. EPA and WDNR and activities following advance approval of these deliverables. As an initial activity of Phase III, a Supplemental Work Plan may be prepared to describe additional activities required for performance of Phase III activities to gather to support the Final FS Report. This Work Plan contains the following plans:

Health and Safety Plan

The Health and Safety Plan (Appendix B) has been prepared to address hazards that the investigation activities may present to the investigation team and to the surrounding community. The plan conforms to applicable regulatory requirements and guidance, including U.S. EPA Standard Operating Safety Guides, and details personnel responsibilities, protective equipment, procedures and protocols, decontamination, training and medical surveillance. The plan identifies problems or hazards that may be encountered and their solutions. Procedures for protecting third parties, such as visitors or the surrounding community, are also provided.

Endangerment Assessment Plan

An Endangerment Assessment Plan (Appendix C) has been developed for quantitatively evaluating the risks posed by the Hagen Farm site under a no-action alternative. The methodology presented in this plan conforms to the Superfund Public Health Evaluation Manual (ICF, 1986).

Data Management Plan

A Data Management Plan (Appendix D) has been developed to document and track investigation data and results. The plan identifies and establishes laboratory and data documentation materials and procedures, project file requirements, and project-related progress reporting procedures and documents.

Volume 3 includes the following described plans which are part of the planning documents for the Hagen Farm site RI/FS.

Sampling Plan

A Sampling Plan (Volume 3, Appendix A) that addresses data acquisition activities for this Work Plan has been prepared. The Sampling Plan contains a statement of sampling objectives, specification of equipment, analyses and sample types, locations and frequency. The plan assesses specific hydrologic, hydrogeologic, and air migration pathways using methods such as geologic mapping, geophysics, field screening, drilling and well installation, determination of groundwater flow and velocity estimates, and sampling. The application of these methods is described for the initial subtasks of the Site Investigation: Source Characterization and Migration Pathway Assessment (see Figure 1). The activities proposed for Contaminant Characterization will be described in Technical Memorandum No. 1, along with the summary results of initial investigation activities. If needed, additional Source Characterization and/or Migration Pathway Assessment Activities to be performed as part of the Phase III RI will also be identified and described.

Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) has been prepared in accordance with current U.S. EPA guidance, and contains the Sampling Plan in Appendix A. The QAPP specifies the analytical methodologies and protocols to be used for the Phase II activities in the site investigation. The U.S. EPA Contract Laboratory Program protocols will be followed for waste and contaminant characterization analyses; however, unforeseeable circumstances may necessitate the use of special analytical methods.

PHASE II SITE INVESTIGATION

Objectives and Scope

The Site Investigation (SI) will be implemented in two phases as shown on Figure 1. the objectives of the Phase I SI are to:

- Define and quantify the migration pathways;
- Determine the nature of the source;

- Define the nature, extent and magnitude of the contamination.
- Preliminary assessment of risk.

The second phase of the SI will focus on:

- Contamination activities regarding quantification of migration pathways, nature of source and extent and magnitude of contamination.
- Specific data requirements of the applicable remedial technologies (in pilot/bench testing)
- Specific data requirements of the EA

Descriptions of each for tasks are presented in the following sections. As shown in Figure 1, the tasks will be performed in the phased, iterative approach to allow initial RI tasks to fully support FS tasks.

Task 3.0 - Site Investigation

Investigations characterizing the site and its actual or potential hazard to public health and the environment will be conducted. The investigations will provide adequate technical data to support the development and evaluation of remedial alternatives during the FS. Investigation activities will focus on problem definition and data to support the screening of remedial technologies, alternative development and screening, and detailed evaluation of alternatives. Table 2, Site Investigation Activity Summary, presents the anticipated field activities and the specific utilization of their results as the RI/FS progresses.

The site investigation activities will follow the plans set forth under Task 1. Protective measures for site personnel for each activity are described in the Site Health and Safety Plan (Appendix B). Sample analyses will be conducted at laboratories following EPA protocols. Chain-of-custody procedures, as described in the Data Management Plan (Appendix D) and the QAPP (Volume 3), will be followed. Sampling locations will be placed on the site map established under Tasks 1 and 2.

TABLE 2

SITE INVESTIGATION ACTIVITY SUMMARY

Activity	Subtask No.	Type*	Description	Results	Utilization Of Data	Anticipated No. of Investigative Samples
Geophysical Investigation	3.1	IM	Electromagnetic and magnetometer surveys of the disposal area and two potential disposal areas, performed on a grid with 10 ft. centers. EM will measure electromagnetic field; magnetometer will record total and vertical magnetic gradient readings.	Site diagrams with anomalous areas marked	1. Investigate potential boundaries between natural soils and waste materials. 2. Assess potential ferromagnetic anomalies.	0
Soil-Gas Survey	3.1	FA	A soil-gas survey will utilize grids on the disposal and potential disposal areas. Soil gases will be collected from shallow probes and analyzed on site for volatile organic compounds (VOC) with a field gas chromatograph.	Site diagram with soil VOC readings marked.	1. Investigate potential for concentrated sources of VOCs. 2. Examine potential retention of VOCs in the unsaturated zone.	0
Refuse Borings	3.1	IM, LA	Eight refuse borings will be performed in the disposal area and the 2 potential disposal areas with hollow stem augers and continuous split spoon sampling from the surface, through fill, and 3 ft. into base soil. Split spoon samples will be classified in the field. Selected soil samples will be laboratory analyzed for particle size, % volatile residue, and vertical permeability.	Soil boring logs, laboratory results for % volatile residue, particle size distribution, and vertical permeability.	1. Characterize the thickness and the type of fill cover and base materials. 2. Visually describe the profile of waste materials, including vertical extent of fill. 3. Describe source materials for use in Contaminant Characterization Subtask.	16 LA
Leachate ead Wells	3.1	IM, LA	Up to eight leachate head wells will be instrumented in the refuse borings or, if no leachate or liquid is encountered, borings adjacent to the fill area will be made and instrumented as water table wells. Hydraulic head measurements will be measured in the wells, and vapor and liquid samples will be collected for chemical analysis (TCL and major anions; vapor samples for VOCs only).	Well construction logs, liquid level measurements, lab results for TCL and major anion concentrations, lab results for vapor VOC concentrations.	1. Evaluate head distribution within or next to the fill area to delineate migration pathways. 2. Screen for VOCs to assess source potential for air release as a migration pathway. 3. Evaluate source contamination for refinement of Contaminant Characterization analytical parameters.	8 LA (vapor) 8 LA (liquid)
Soils haracterization	3.2	IM, LA	Thirteen borings at 11 locations will be drilled with hollow stem augers. Split spoon soil samples will be collected at ten of these locations according to SPT methods. Samples will be visually classified in the field. Selected samples will be analyzed in the laboratory for particle size distribution and % volatile residue.	Soil boring logs, lab analyses for particle size distribution and % volatile residue.	1. Characterize site soils for migration pathway evaluation, to determine potential contaminant characterization routes.	15 LA (soil)

TABLE 2

SITE INVESTIGATION ACTIVITY SUMMARY

Activity	Subtask No.	Type*	Description	Results	Utilization of Data	Anticipated No. of Investigative Samples
Hydrogeologic Investigation	3.2	IM, FA	Nine water table wells and four piezometers will be instrumented at the soil boring locations. Screened augers will be used during drilling and water samples will be analyzed on site for pH, conductivity, and VOCs. Groundwater level measurements will be made at new and existing wells. Single well hydraulic conductivity tests will be performed at new wells.	Well construction logs, field vertical profiles for pH, conductivity, and VOCs, groundwater elevations, hydraulic values.	1. Locate geological strata of potential contaminant migration. 2. Estimate groundwater flow direction and rate for contaminant characterization. 3. Estimate vertical extent of subsurface contamination.	13 LA (liquid) 78 FA
Surface Water/ Sediments Investigation	3.2	IM	Evidence of potential surface water movement will be investigated by observation. Staff gauges will be installed and read at four locations	Surface water level elevations.	1. Estimate potential for contaminant migration from the site by surface water/sediment route.	4 IM
Meteorlogical Investigation	3.2	IM	Meteorological information will be collected by on site weather instrumentation.	Ambient air temperature, humidity, barometric pressure, wind speed and direction readings, air VOC concentrations.	1. Estimate potential of air for contaminant characterization.	4 IM
Evaluation of Soil ontamination	3.3, 9.0	LA	Potentially investigate leachate potential or aeration potential of fill area soils.	Soil porosity,	1. Evaluate remedial alternatives for the Feasibility Study (FS). determined	to be determined
Groundwater Quality ssessment	3.3	IM, LA	Collect groundwater level measurements and groundwater samples from selected wells; analyze samples for parameters determined by Source Characterization Subtask.	Groundwater elevations, groundwater concentrations of selected chemical parameters.	1. Evaluate extent of problem for Remedial Investigation (RI) report. 2. Supply data for the Endangerment Assessment (EA). 3. Provide a basis for remedial alternative screening for the FS.	to be determined
ir uality Evaluation	3.3	LA	Air sampling for VOC analysis will be performed over a single 24 hour period.	VOC concentrations in ambient air at upwind and downwind locations.	1. Supply dispersion data to drive the EA. 2. Provide a basis for consideration of air stripping as a remedial alternative in the FS.	to be determined

*IM = In situ measurement
FA = Field Analysis
LA = Laboratory Analysis

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A description of the investigations is presented below. These investigation activities are specifically cross referenced in the following sections of the QAPP (Volume 3).

- Section 3.4.1 - Project Objectives and Use of Data
- Table 2 - Sample Types and Estimated Sample Numbers
- Table 4 - Summary of Data Gathering Activities and Associated Data Quality Objectives
- Appendix A (Sampling Plan) - Section 3, Sampling Locations and Numbers
- Appendix A (Sampling Plan) - Section 5, Sampling Equipment and Procedures

Subtask 3.1 - Source Characterization

A sampling and analysis program that characterizes the site's waste material leachate will be conducted. Media analyzed will include liquids (leachate) present within the landfill and associated vapors.

The leachate and vapor samples collected under this subtask will be screened for the U.S. EPA Target Compound List (TCL) compounds using high detection level techniques specified in the QAPP. Additional compounds that will be analyzed will include tetrahydrofuran (THF) in the volatile organic screening and the following indicator parameters for leachate treatability:

pH (field)
conductivity (field)
Alkalinity
Selected anions
Chloride
Sulfate

These analytical data will provide information on mobile waste constituents and will serve as the data base for selecting the parameter list to be used in Contaminant Characterization (Subtask 3.3). Specific source characterization activities are described below.

Prior to initiating source characterization activities, an on-site meterological station will be established as part of Migration Pathway Assessment (Subtask 3.2). Although this activity (3.2.1) is described under Subtask 3.2, meterological data must be gathered. Source characterization activities begin so that air quality sampling stations for contaminant characterization (Subtask 3.3) can monitor ambient air quality under assumed worst case conditions. It is assumed that penetrating the refuse area (Refuse Borings, Activity 3.1.3) will correspond to the worst case condition for ambient air quality.

Activity 3.1.1 Geophysical Investigation

Electromagnetic and magnetometer surveys of the disposal area (5.5 acres) and the two areas identified as potential disposal areas (1.5 acres each) will be performed.

Objectives:

- Locate anomalies suggestive of potential boundaries between natural soils and waste materials.
- Assess the potential disposal of ferromagnetic materials (e.g. roofing tin) for the avoidance of these anomalies in the selection of boring locations.

Description:

The survey will be laid out on a grid basis with 10 foot centers over the three study areas. The survey grid will be tied into a sitewide topographic survey. Instrumentation will include a Geonics EM 31-D and an EGA recording magnetometer. Total electromagnetic field will be recorded by the magnetometer. Anomalies will be flagged and will be recorded on a copy of the site map. Sample collection or intrusive testing (e.g., refuse borings) will not be performed as a part of this activity.

Detailed descriptions of the investigative methods are given in Section 5.1 of the Sampling Plan (Appendix A of the QAPP). Equipment is described in Appendices C-7 and C-8 and associated quality assurance/quality control measurements are presented in Section 5.1.c of the QAPP.

Date Use:

Results of the geophysical investigation will be used to select locations for refuse borings as a part of Source Characterization. The grids established as a part of this activity will be the basis for selection of measurement points for the soil-gas survey, which will be used for Source Characterization.

End Product:

Results of this activity will be plotted on site drawings to show areas of **elevated EM readings** and **geomagnetic anomalies**. The site drawings and their interpretation will be included in the description of Source Characterization in Technical Memorandum No. 1. The geophysical data and interpretation will aid in locating the refuse borings. The U.S. EPA and the WDNR will be given the opportunity for on-site input in selecting refuse boring locations. The U.S. EPA and the WDNR will also review the geophysical data and interpretation when it is submitted in Technical Memorandum No. 1. The agencies comments on Technical Memorandum No. 1 will be addressed before these results are included in the Draft RI Report (Task 5).

Activity 3.1.2 Soil-Gas Survey

A soil-gas survey will be performed in the known fill and in the two suspected fill areas.

Objectives:

- Screen the areas for potential concentrated sources of volatile organic compounds (VOCs).
- Examine the potential retention of VOCs in the unsaturated zone.

Description:

Initial soil-gas sampling points will be located on the grid network laid out as a part of the geophysical survey and will reflect the results of that investigation. Additional soil-gas sampling locations will be selected based on results from initial points. This activity will be a field survey of an indicative nature only; gas samples will not be collected for off-site laboratory analysis.

The method to be used will involve driving a solid stainless steel pipe into the ground [redacted] Upon removal of the pipe, a collection probe will be inserted in the hole, capped and vapors will be allowed to collect in the hole. The vapors will be collected in a gas sampling vial and tested in the field using a portable gas chromatograph. Additional locations may be selected based on positive results from the initial soil gas survey sampling points.

Sections 5.2 of the Sampling Plan (Appendix A of the QAPP) presents information regarding the sampling and equipment methodology. Target compounds and QA objectives for the analyses are given with the ~~method description~~ in Appendix D of the QAPP (Volume 3).

Data Use:

Results of the soil-gas survey will be used to assist in the siting of refuse borings based on elevated concentrations of subsurface organic vapors. Soil-gas readings will be compared with results of the geophysical investigation to further characterize the waste depositional area. The results will also be considered in the Remedial Alternatives Screening (Task FS) for the evaluation of in-situ treatment processes.

End Product:

Results of the soil-gas survey will be plotted on a site diagram showing elevated readings for total organic vapors higher than background. Where numerical values may be presented, their interpretation will be qualitative and will be used only for comparative purposes. The site diagram and interpretation will be presented as a part of Source Characterization in Technical Memorandum No. 1. The soil-gas survey results will be used to help select refuse boring locations. The U.S. EPA and the WDNR will be given the opportunity for on-site input in selecting the refuse boring locations. The U.S. EPA and the WDNR will also review the soil-gas survey results and interpretation of those results when Technical Memorandum No. 1 is submitted. The agencies' comments on Technical Memorandum No. 1 will be addressed before it is incorporated into the Draft RI Report (Task 5).

Activity 3.1.3: [redacted]e [redacted]

Up to [redacted] will be performed within the disposal area and the potential disposal areas.

Objectives:

- Characterize the thickness and **type of the fill cover** and to profile waste materials, including the vertical extent of fill.
- Characterize the fill area base soils, including vertical permeability and grain size.

Description:

Location of refuse borings will depend on results of geophysical and soil-gas surveys. As noted under Activities 3.1.1 and 3.1.2, the U.S. EPA and the WDNR will have the opportunity to review proposed refuse boring locations on-site. If soil gas measurements indicate regions of higher vapor concentration within the fill area, these will be selected as sites for borings. Drilling will not be attempted in areas having ferromagnetic anomalies as indicated by the EM and magnetometer surveys. If results of geophysical and soil-gas surveys indicate the fill is essentially uniform, locations will be selected to provide uniform coverage of the fill areas. Boring locations will be designated using the same grid as that used in the geophysical and soil-gas surveys.

Refuse borings will be performed with 4 1/4-inch I.D. x 8 1/2-inch O.D. hollow stem augers. Continuous split spoon samples will be collected and visually classified in the field. Boreholes will be completed to a depth of 15 feet or until 3 feet of visually clean base material is encountered, whichever is greater. Split spoon samples will be described by observation in the field to provide a visually based profile of the waste material. Samples of the cover and the underlying soil will be collected for analysis of grain size, permeability and percent volatile organic residue. Dry boreholes will be grouted with a bentonite slurry or granular bentonite to the surface. If fill material proves to be extremely porous and/or unstable, after the initial boring, permanent casing will be advanced on succeeding boreholes. The casing annulus would then be pressure filled with grout from the base upward (Halliburton grouting).

Leachate headwells (see Activity 3.1.4) will be installed in refuse borings where saturated conditions are encountered within the fill materials. Before installing the head well, the portion of the refuse boring that extends into the base soils will be grouted. This procedure will reduce potential for contaminant migration along the borehole annulus and into underlying soils.

Saturated and unsaturated cuttings from the refuse borings will be segregated and placed in separate, lined lugger boxes. Composite samples will be collected from each lugger box and tested for E.P. Toxicity and flamability. These testing data will be used to evaluate disposal options for the cuttings.

Data Use:

Results of the refuse borings will be used to provide a description of the disposal area, including its cover and base soils and the vertical extent of the waste. This information will be used for Source Characterization and to provide a partial basis for consideration of Remedial Alternatives Screening (Task 6).

Results of refuse borings will be presented as tables of chemical and physical analytical results and as refuse boring logs. The information will be presented as a part of Source Characterization in Technical Memorandum No. 1. The U.S. EPA and WDNR will review and comment of Technical Memorandum No. 1 before these results are included in the Draft RI Report.

Activity 3.1.4: Leachate Head Wells

A [redacted] will be constructed in the known and potential disposal areas. Liquid head measurements will be taken, and vapor and liquid samples will be collected and analyzed. tum

Objectives:

- Locate and chemically characterize liquids within the waste.
- Characterize organic vapors associated with the liquid waste, which may have the potential for atmospheric releases.
- Investigate the relationship between leachate and groundwater levels at the site.

Description:

Locations for up to 8 leachate head wells will be determined utilizing the results of the geophysical investigation, the soil-gas survey, and visual observations from refuse borings. Liquid [illegible] waste material will be considered leachate. If leachate is encountered within a refuse boring, a leachate head well will be constructed within the boring. If no leachate is observed, up to 8 groundwater wells will be installed adjacent to the fill area and sampled. The U.S. EPA and the WDNR will have the opportunity to review, on-site, the proposed groundwater well locations. The agencies' comments will be addressed before final locations are selected.

The refuse borings described under Activity 3.1.3 (Refuse Borings) will be used to install leachate headwells at locations where the fill is saturated. Wells will be constructed of 2-inch diameter threaded flush joint Schedule 80 PVC pipe rated NSF-NC by the National Sanitation Foundation with a 10-foot screen with a slot size of 0.01 inch.

The locations and elevations of the leachate headwells will be surveyed by a registered land surveyor. The liquid levels within each of the wells will be determined at least four times during the site investigation and on a monthly basis thereafter.

Leachate samples will be collected from each leachate headwell using a dedica[illegible] bailer. Approximately three to five casing volumes of liquid will be removed from the leachate head well, using the dedicated bailer, before a sample is collected. Purged liquids will be collected and disposed of in the fill area at least 20 feet away from the leachate headwell. The leachate sample will be collected with the dedicated bailer. A more detailed description of sample collection and handling procedures is presented in Section 5.4 of the Sampling Plan (Appendix A of the QAPP).

The leachate samples will be analyzed for the U.S. EPA Target Compound List (TCL) compounds using high detection level techniques specified in the QAPP (Volume 3). Additional compounds will include tetrahydrofuran (THF) and the following indicator parameters for leachate treatability:

pH (field)
conductivity (field)
Alkalinity
Selected anions
Chloride
Sulfate

I need detection limit ? (THF)

Head space vapor samples will be collected from leachate head wells with sampling pumps and vapor collection tubes. Vapor samples will be analyzed for TCL volatile organic compounds and THF for characterizing potential atmospheric releases as addressed in the Endangerment Assessment Plan (Appendix C). Leachate samples will be collected using dedicated bailers for TCL organic and inorganic parameters, and selected indicator parameters.

The sampling and analytical methodologies used in this activity are described in detail in Section 5.4 of the Sampling Plan (Appendix A of the QAPP). The quality assurance/quality control measurements associated with this activity are also presented in the Quality Assurance Plan for analysis of VOCs in air samples in Appendix D of the QAPP.

Data Use:

Data from the leachate head well activity will be used to locate and measure the distribution of liquid heads within the fill area to assist Migration Pathway Assessment. Head space vapor sample results will be evaluated to assess the source potential for air releases as a Migration Pathway. Analytical results will be used to refine analytical parameters for the Contaminant Characterization (Subtask 3.3).

End Product:

Results of leachate head well installation will be documented in refuse/soil boring logs and well construction logs. Analytical results will be presented for chemical analyses of the liquid and vapor fractions sampled from the leachate head wells. Liquid level measurements will be presented on a leachate head or a water table diagram of the fill area. Results will be presented as part of the Source Characterization in Technical Memorandum No. 1. The U.S. EPA and WDNR will review and comment on these results before they are incorporated into the Draft RI Report. Data and data analysis from this activity will be used to further develop the scope of Subtask 3.3 (Contaminant Characterization). The recommendations for additional activities in Subtask 3.3 will be presented in Technical Memorandum No. 1. The agencies comments on these recommendations will be addressed before implementing Subtask 3.3.

Subtask 3.2 - Migration Pathway Assessment

A Migration Pathway Assessment will be conducted to evaluate pathways by which potential contaminants could migrate in the environment. The assessment will investigate the following activities.

Activity 3.2.1: Meteorological Investigation

Collection of meteorological information will be performed on-site.

Objectives:

- Characterize the weather patterns at the site for the evaluation of air as a migration pathway.
- Identify potential worst case conditions for air quality evaluation (Activity 2.3.3).

Description:

A meteorological station will be set up prior to commencing Source Characterization activities to collect periodic data concerning air temperature, humidity, barometric pressure, wind speed, and wind direction.

Date Use:

Air sampling data will be used to evaluate air as a migratory pathway for consideration in Containment Characterization (Subtask 3.3). These data will be used to define site-specific meteorological conditions, so that appropriate locations for air quality sampling may be selected. Meteorological data will also be used in the site Endangerment Assessment (Task 5).

End Product:

Meterological results will be reduced to seasonal averages and presented in tabular form and discussed as a part of Migration Pathway Assessment in Technical Memorandum No. 1. The U.S. EPA and WDNR will be given the opportunity for review and comment on these results prior to their inclusion in the Draft RI Report. Meterological results will be used to establish locations for air quality of ambient air (see Activity 3.3.1) under Contaminant Characterization (Subtask 3.3). **Since this air quality sampling will be performed during the Refuse Borings** (Activity 3.1.3), **the U.S. EPA and the WDNR will be given the opportunity on-site**, to **comment on the proposed air quality sampling station** locat**ions before they are instrumented**. The agencies comments on meterological results and the proposed air quality sampling locations will be addressed before initiating subsequent activities.

Activity 3.2.2: Soil Characterization

Thirteen soil borings will be drilled at eleven locations (Drawing 13114-4), to evaluate site stratigraphy.

Objectives:

- Characterize the site soils to identify soil units through which contaminant migration is most likely to occur
- Measure the soil properties controlling contaminant migration.

Description:

Soil samples will be collected from ten boring locations listed in Table 3. Soil stratigraphy description at one boring location (P-7B) and part of another boring (P-12B) will be based on a prior investigation (Warzyn, 1982). Two borings (MW-14 and MW-17) will not be sampled because they will be nested with proposed deeper borings.

TABLE 3
SUMMARY OF PROPOSED OBSERVATION WELL INSTALLATION PROGRAM
HAGEN FARM SITE

Observation Well Number	Proposed Boring Depth (ft)	Proposed Screened Interval (ft)	Screened Auger Water Samples	Soil Sampling Method	Soil Samples for Analysis	Rationale for Well Installation
P-7B ✓	55	50-55	7	ED 0-55	0	Evaluate vertical flow component along eastern perimeter of main fill area; complement soil boring and well MW-7
P-12B	60	55-60	3	ED 0-45; SPT 45-60	1 ✓	Evaluate vertical flow component along southern perimeter of main fill area; complement soil boring and well MW-12
MW-13 ✓	70	20-30	10	SPT 0-60; RC 60-70	2 ✓	Evaluate horizontal groundwater flow direction in northeastern portion of site
MW-14	30	20-30	2	ED	0	Evaluate horizontal and vertical groundwater flow components in northern portion of site
P-14A	60	55-60	8	SPT	1 ✓	Evaluate horizontal and vertical groundwater flow components in northern portion of the site
7/22 [redacted] loct	✓ 50 49	40-50 38.1	6	SPT	1 ✓	Evaluate horizontal groundwater flow direction between disposal area and homes to the west
8/4 [redacted]	90 ✓	30-40	14	SPT 0-80; RC 80-90	2 ✓	Evaluate horizontal groundwater flow direction between disposal area and homes to the west
✓ MW-17	25	15-25	1	ED	0	Evaluate horizontal and vertical flow components between disposal area and Sundby and K-Way wells
P-17A	60	55-60	8	SPT 0-50; RC 50-60	2 ✓	Evaluate horizontal and vertical flow components between disposal area and Sundby and K-Way wells
MW-18	60	15-25 30	8	SPT 0-50; RC 50-60	2 ✓	Evaluate horizontal groundwater flow direction in eastern portion of site

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TABLE 3 (Continued)

Observation Well Number	Proposed Boring Depth (ft)	Proposed Screened Interval (ft)	Screened Auger Water Samples	Soil Sampling Method	Soil Samples for Analysis	Rationale for Installation
MW-19	60	10-20	8	SPT 0-50; RC 50-60	2	Evaluate horizontal groundwater flow direction in eastern portion of site
MW-20	25	15-25	1	SPT	1	Evaluate horizontal groundwater flow in northern portion (possibly upgradient) of site
MW-21	30	20-30	2	SPT	1	Evaluate horizontal groundwater flow in northern portion (possibly upgradient) of site
1						
		TOTALS	78		15	

SPT - Standard Penetration Test Soil Sampling
ED - Earth Drill, No Soil Sampling
RC - Rock Core

Borings will be continued into bedrock at five locations to evaluate the complete profile of glacial drift. At these five locations, the upper ten ft of rock will be cored and rock core samples collected to evaluate the physical condition of the bedrock.

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In addition, the stratigraphy exposed in the sidewalls of the sand and gravel pits located on the northern portions of the property, the Sundby excavation and other locations will be observed and mapped, if appropriate. Description of the bedding present in reconstructing the depositional history and in evaluating migration pathways, at least for the near surface unsaturated zone. Local gravel pit operators will be interviewed to obtain further information on stratigraphy.

Each boring will be drilled using 4 1/4-inch I.D. x 8 1/2-inch O.D. hollow stem augers. Wash boring methods may be used if difficult drilling conditions are encountered (e.g., stiff clays). When wash boring methods are used, the borehole will be temporarily cased and completed using clear water obtained from the City of Stoughton. A sample of water for drilling will be analyzed for the same CLP target compounds and indicator parameters as groundwater and leachate samples prior to the drilling.

Where nested observation wells are planned, the shallower borings will not be soil sampled. At these boring locations, soil samples will be collected only from the deeper boring at that location. Soil samples will be collected at 2.5 ft intervals from ground surface to a depth of 10 feet, and at 5 feet intervals or major changes in stratigraphy between 10 ft and the bottom of the boring. Rock core samples will be collected with NX rock coring drill tubes continuously for 10 feet into competent rock.

interval of soil sample

Soil samples will be collected with a split spoon sampler using ASTM Method D 1586. Soil samples will be field screened with a photoionization detector (PID) or an organic vapor analyzer (OVA) to assess potential hazard to the field personnel. Soil samples will be ~~visually~~ classified in the field by a geologist or geotechnical engineer. Fourteen soil samples are anticipated for analysis for grain size distribution and percent volatile residue to assist in soil classification. Final soil boring logs will be prepared based on both field observations and on soil testing and sample classification performed in the soils laboratory. Soil samples not tested will be retained until the completion of the RI/FS by Warzyn and then transferred to the custody of WMWI.

?

% volatile

The investigative methods used in this Activity are described in detail in Section 5.5 of the Sampling Plan (Appendix A of the QAPP). Level of QA effort for field sampling is covered in Section 5.1.a of the QAPP. Level of QA effort for individual analyses are given with methods descriptions in Appendix D of the QAPP. The health and safety monitoring procedures are presented in Appendix B of this Volume.

Data Use:

Site soils data will be used to evaluate stratigraphic factors which may affect a subsurface migration pathway for consideration in Contaminant Characterization Subtask 2.3. Results will also be used to evaluate contaminant attenuation properties of the soil for Remedial Alternative Screening, (Task 7).

End Product:

Results of soils investigation will include soil boring logs and analytical results of physical analyses. It is anticipated that geologic cross sections and fence diagrams will be constructed to illustrate site stratigraphy. Results will be summarized as a part of the Migration Pathway Assessment in Technical Memorandum No. 1. The U.S. EPA and WDNR will be given the opportunity for review and comment on this document prior to incorporation of the results into the Draft RI Report.

Activity 3.2.3 Hydrogeologic Investigation

The groundwater investigation will include the installation and use of water level observation wells to supplement existing water level and piezometric head data.

Objectives:

- Delineate geological strata which serve as potential contaminant migration pathways.
- Determine groundwater flow direction and hydraulic conductivity of the unconsolidated materials and bedrock.

Description:

The soil borings performed under Activity ~~3.2.1~~ 3.2 (Soils Characterization) will be instrumented with groundwater observation wells. This includes nine water table observation wells and four deeper piezometers (Table 2). Two new well nests are proposed and two of the 13 proposed wells will supplement existing wells to form two other nests. Existing and proposed monitoring well locations are shown on Drawing 13114-4.

Under this Activity, the monitoring wells will be used solely to collect groundwater elevation data. Based on the review of data collected from Subtask 3.1 (Source Characterization) and from Subtask 3.2 (Migration Pathway Assessment), however, certain monitoring wells installed under this activity may be selected as sampling points for groundwater quality data under Subtask 3.3 (Contaminant Characterization). Recommendations for including these wells as sampling points under Subtask 3.3 will be made in Technical Memorandum No. 1. In reviewing that document, the U.S. EPA and the WDNR will review and comment on these recommended sampling points. Final selection of the monitoring points for Subtask 3.3 will be made in cooperation with both agencies.

Soil borings in the saturated zone will be advanced with screened augers (See Activity 3.2.1). Groundwater samples will be collected at 5-foot intervals between the estimated water table surface and the bottom of each sampled borehole. These water samples will be analyzed on-site for volatile organic compounds using a portable gas chromatograph, and for pH and conductivity. These results will be used to determine depths for piezometer screens.

interval
for
grnd wat
for VOC

Observation wells will be constructed of 2-inch inside diameter threaded flush joint schedule 40 PVC rated NSF-NC by the National Sanitation Foundation. Deeper wells (greater than 100 ft) or wells in bedrock will use Schedule 80 PVC pipe. The well screens will have a slot size of 0.01 in. The water table wells will have 10-ft screens and piezometers will have 5-ft screens. Locking steel protective casings will be installed at the surface and will extend to a depth below the frost line (3-5 feet below grade). Typical water table well construction details demonstrated in Figure 2. The wells will be developed after installation in accordance with NR 141 guidelines. Wells will be developed by first "surging" the installation with a bailer and then removing up to 10 casing volumes using a bailer or pump. Purged water will be discharged on the ground at least 20 feet away from the well installations.

Groundwater level measurements will be obtained at existing and proposed wells at least four times during the Migration Pathway Assessment and on a monthly basis thereafter. Existing wells for which construction details can be developed will be included in the water level surveys. Existing and new wells used for water level measurements will be clearly marked with the appropriate well number on the outer casing. Hydraulic conductivity testing of the new wells and selected existing wells will be performed following observation well installation. In-situ single well hydraulic conductivity tests will be performed to assess hydraulic conductivity and groundwater flow rates.

A detailed description of field measurements and sampling activities associated with this Activity is given in Section 5.6 of the Sampling Plan (Appendix A of the QAPP). Methods descriptions and level of QA effort for field measurement of groundwater pH and specific conductance are given in Appendices C-1 and C-2 of the QAPP. Level of QA effort for samples collected for other analyses are given with appropriate CLP protocol documents for CLP protocol analyses and in Appendix D for screening of VOCs using a field GC.

Data Use:

Results from Activity 3.2.3 will be used to evaluate groundwater as a potential migration pathway. It is anticipated that water level and piezometric data will be presented in a tabular form and used to construct water table and flow path maps. Water levels and calculated estimates of hydraulic conductivity will also be presented on plan view flow nets. Groundwater flow rates will also be calculated and discussed. This information will be presented in Technical Memorandum No. 1 along with recommendations for locations and construction of groundwater quality sampling

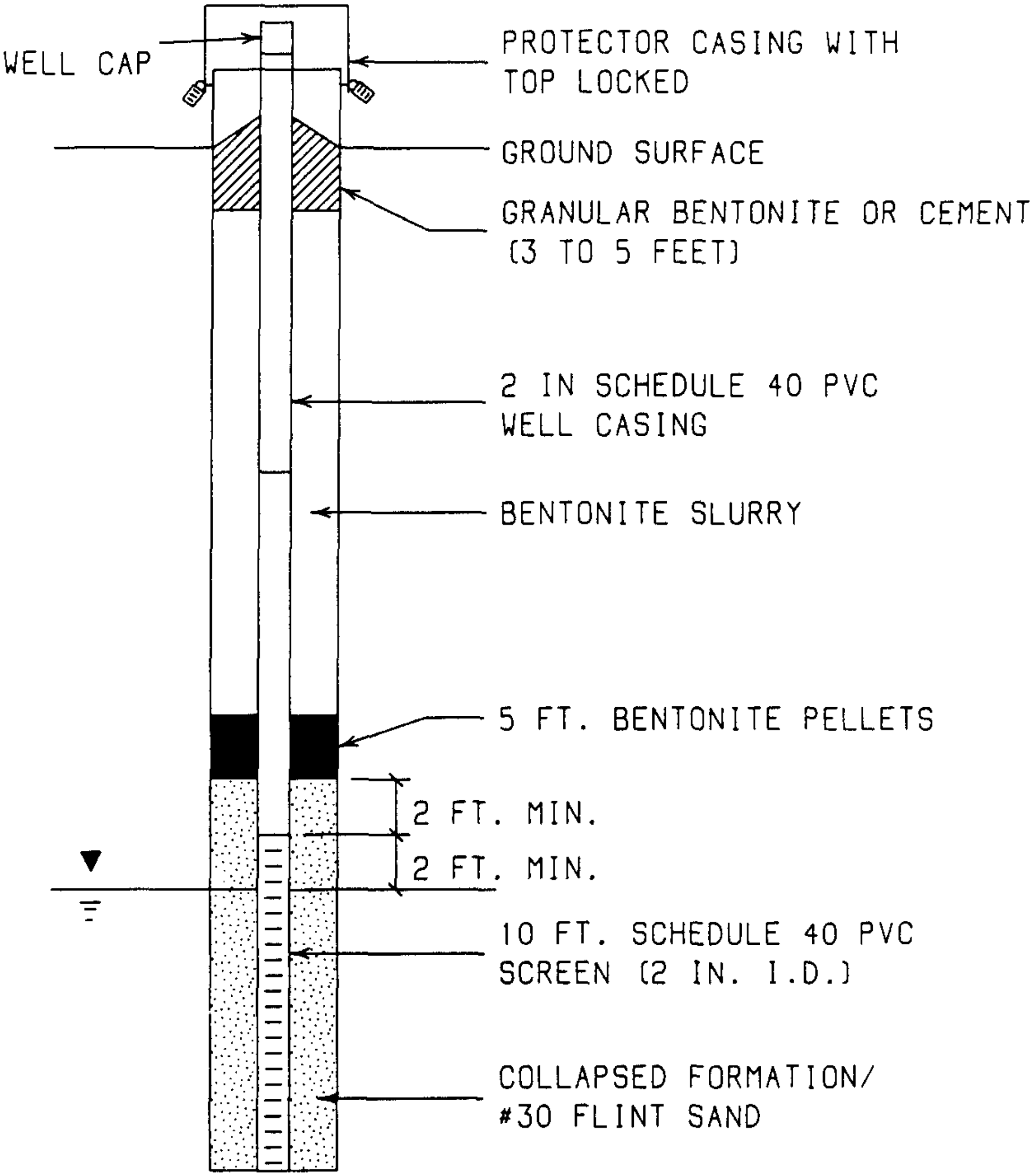

FIGURE 2

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TYPICAL WATER TABLE (SHALLOW) WELL

WORK PLAN

HAGEN FARM SITE

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points. If sufficient data are gathered, a preliminary groundwater flow model may be prepared. Output from the model may be used to locate where water quality sampling points for use in Subtask 3.3 (Contaminant Characterization). The data from Activity 3.2.3 will be used in the screening process for remedial alternatives (Task 6).

End Product:

Results of groundwater investigation activities will generate well construction logs to complement soil boring logs included in the soil investigation. Chemical analyses of groundwater samples analyzed in the field will be presented in tabular form. Groundwater elevations will be presented on a site groundwater table diagram. Results will be included as a part of the Migration Pathway Assessment in Technical Memorandum No. 1. The U.S. EPA and WDNR will be given the opportunity to review and comment on these results before they are incorporated into the Draft RI Report. The data and analysis (e.g., the groundwater flow model) will be used to determine groundwater quality monitoring well locations for use under Subtask 3.3 (Contaminant Characterization). These suggested locations will be presented in Technical Memorandum No. 1. The U.S. EPA and the WDNR will have the opportunity to comment on the suggested water quality monitoring locations and the agencies comments will be addressed before these sampling points are installed.

Activity 3.2.4 Surface Water/Sediment Investigation

Drainage patterns and runoff characteristics will be evaluated for potential surface water and erosional transport.

Objective:

- Evaluate potential pathways of surficial contaminant migration.

Description:

A site inspection will be performed to determine surface water drainage directions. Staff gauges will be installed in the pond located in the northeast corner of the site and in several off-site locations (Drawing 13114-4). Staff gauge level reading will be obtained during each round of groundwater level measurements.

Date Use:

Field observations and correlation of staff gauge readings with groundwater conditions will be used to evaluate the potential for surface water or sediment transport as a potential migratory pathway and to select appropriate surface water and sediment sampling locations.

End Product:

Surface water elevations will be plotted on the site water table diagram. Results and discussion of the potential for this route as a migratory pathway will be presented in Technical Memorandum No. 1. Recommendations will be made for locations of additional sampling or investigation as necessary. The U.S. EPA and WDNR will be given the opportunity for review and comment on these results and recommendations prior to their inclusion in the Draft RI Report.

Technical Memorandum No. 1

Technical Memorandum No. 1 will be prepared following completion of the Source Characterization and Migration Pathway Assessment (see Figure 1) activities. This Technical Memorandum will contains sufficient data and data analysis to support recommendations for future activities made within the document. This memorandum will summarize the findings of these activities and may recommend chemical parameters, or classes of parameters, appropriate for subsequent contaminant characterization studies. It will also contain recommendations for the location and design of monitoring stations and media to be used during the Contaminant Characterization (Subtask 3.3 - Figure 1). Technical Memorandum No. 1 may also contain additional Source Characterization and/or Migration Pathway Assessment data requirements to be addressed in the Phase III RI.

Technical Memorandum No. 1 will be written in modular form so that it can be readily incorporated into the RI report. Technical Memorandum No. 1 will be distributed as specified in the AOC, Part X. Five copies each will be submitted to the U.S. EPA Remedial Project Manager, the WDNR Project Coordinator, and the Respondent Project Coordinator. U.S. EPA and WDNR comments on the existing data analysis and future activities will be addressed. The included comments and final recommendations in Technical Memorandum No. 1 will be incorporated into the Draft RI Report.

Subtask 3.3 - Contaminant Characterization

Data generated from the Migration Pathway Assessment and Source Characterization will be used to design an environmental sampling and analysis program that will be carried out under Subtask 3.3 (Contaminant Characterization). The scope of the environmental sampling and analysis will be defined in Technical Memorandum No. 1. The objective of this program is to evaluate the extent and magnitude of contaminant migration along the pathways of concern at the Hagen Farm site.

Technical Memorandum No. 1, in addition to presenting the results of the Source Characterization and Migration Pathway Assessments, will present plans and QA/QC requirements for Contaminant Characterization activities. Selection of specific activities will be based on the results of the Source Characterization and Migration Pathway Assessment. Air quality sampling stations (Activity 3.3.1), however, were established prior to initiating the refuse borings (Activity 3.1.3) so that "worst case" ambient air conditions would be monitored. Monitoring points will be installed in each medium previously identified as a potential migration pathway. As noted earlier, this monitoring network may incorporate several of the water level observation locations and/or staff gauges installed during the Migration Pathway Assessment.

The analytical parameter list used in this subtask will be based on the data collected during the Source Characterization. The selection of parameters or classes of parameters (i.e., volatile organics, metals, PCBs/pesticides, etc.) will be based upon their presence at the source, their estimated concentrations, persistence, and mobility within the most likely migration pathway(s). Provisions will be made for conducting full TCL analyses at those monitoring stations where there is a reasonable anticipation of detecting a complex contaminant profile. However based on existing knowledge of the site contamination, it is anticipated that the first round of sampling will be restricted to volatile organic compounds and inorganic parameters (metals, anions, cations). Samples will be collected, handled and analyzed in accordance with the protocols and procedures described in the site Sampling and Quality Assurance Project Plans.

Potential specific activities of Contaminant Characterization are described below. Numbers of samples and detailed activity descriptions cannot be presented at this time. These activities, and estimated numbers of samples and types of samples are included in summary form in Table 1.

Activity 3.3.1: Air Quality Evaluation

Air sampling for quantifying volatile organic compound concentrations under assumed worst case conditions, projected from meteorological data collected under the Meteorological Investigation (Activity 3.2.1). **It is assumed that the "worst case" conditions will occur when source characterization activities penetrate the fill material.**

Objectives:

- Characterize organic compound concentrations in ambient air under assumed worst case conditions.
- Supply air dispersion data for consideration in the EA.
- Provide a data base for evaluating air stripping techniques in the Remedial Alternatives Screening Task of the EA.

Description:

Ambient air sampling will be performed at the site perimeter at one upwind and three ~~downwind locations.~~ The upwind and central downwind locations will be on an ~~axis of wind~~ flow. The two remaining downwind stations will be located on an axis with the upwind station and will be situated approximately 30 degrees normal to wind flow direction.

Since wind flow direction will be determined under Activity 3.2.1 (Meteorological Investigation), exact site locations will be specified in Technical Memorandum No. 1.

Air sampling for VOC analysis will be performed during a single, 24 hour period. The samples will be collected with personal sampling pumps and Tenax/Tenax-charcoal collection tubes. The 24 hour collection period will be selected so that assumed worst case (e.g., high temperature and low wind) conditions would be monitored.

Data Use:
Air VOC analytical data will be utilized in the EA. These data may also be used to evaluate air stripping technologies in the FS (Task 7 - Figure 1).

End Product:
Results of this activity would be presented in Technical Memorandum No. 2. The U.S. EPA and WDNR would have the opportunity to review and comment on this memorandum prior to its inclusion in the Draft RI Report.

Activity 3.3.2: Evaluation of Soils Contamination

Soils in the vicinity of the disposal area may be sampled and analyzed for selected chemical parameters.

Objective:

- Gather data to assist in screening remedial alternatives for the Feasibility Study.

Description:
Based on the current understanding of the Hagen Farm site characteristics, soils are not anticipated to be a contaminant migration pathway. The fill is below grade and, therefore, there is a lower potential for erosion to move potentially contaminated soils. Also, given the fact that the fill area is relatively flat, precipitation falling on the area will almost exclusively exfilterate through the bottom of the fill. Furthermore, existing information

indicates that the soils at the Hagen Farm site are predominately coarse grained (e.g., sand). Coarse grained soils typically have a lower attenutive capacity. Therefore, it is less than likely the soils at the Hagen Farm site would retain substantial concentrations of contaminants. If fine grained soils are encountered during the Migration Pathway Assessment (Subtask 3.2) and field screening suggests that these soils contain contaminants, then provisions will be made to collect and chemically analyze these soils in the Supplemental Site Investigation (Phase III).

Soils on-site may be collected for analysis at porosity, permeability and grain-size to evaluate the potential/leachate movement and potential for using soil aeration/vacuum extraction as a remedial alternative in the FS.

Data Use:

Results will be used to assist in Remedial Alternatives Screening (Task 6).

End Product:

Results of soil porosity tests will be included in Technical Memorandum No. 2. The U.S. EPA and WDNR will have the opportunity for review and comment on these results. Agencies comments will be addressed before these results are included in the Draft RI Report.

Activity 3.3.3: Groundwater Quality Assessment

Groundwater quality and hydrogeological characteristics may be investigated at selected locations.

Objectives:

- Evaluate the extent and migration of groundwater contamination in the vicinity of the site.

Description:

The probable groundwater migration pathways will be delineated in Technical Memorandum No. 1. These results will be used to determine where groundwater quality monitoring wells should be sampled to provide a characterization of contaminant transport from the site via groundwater. If, as expected, additional well locations are deemed necessary, those monitoring wells will be installed as a part of this activity. A list of analytical parameters will be developed from the results of the Source Characterization (Subtask 3.1), as presented in Technical Memorandum No. 1. Groundwater flow characterization will be performed by continuing the groundwater level measurement surveys initiated under the Migration Pathway Assessment (Subtask 3.2).

Data Use:

Results of this activity will be used to evaluate potential contaminant migration from the site by groundwater. Results will also be considered in Remedial Alternative Screening (Task 6) and the Preliminary Endangerment Assessment (Subtask 3.3).

End Product:

Results of the groundwater investigation will be presented as maps of groundwater elevation and tabular summaries of concentrations of selected parameters. Results will be included in Technical Memorandum No. 2. The U.S. EPA and WDNR will be given the opportunity for review and comment on this document prior to its inclusion into the Draft RI Report.

Technical Memorandum No. 2

Technical Memorandum No. 2 will be prepared at the conclusion of Contaminant Characterization (Subtask 3.3). This short report will address the magnitude and extent of contamination from the site. This memorandum, like Technical Memorandum No. 1, will be written in a modular format so that it can be readily incorporated into the RI report. The U.S. EPA and WDNR will review and comment on Technical Memorandum No. 2 and the recommendations for further study.

If Technical Memorandum No. 2 of the Phase II Site Investigation identifies the need for additional Contaminant Characterization, that activity will be addressed in the Supplemental Work Plan (Task 8) for the Phase III, Supplemental Site Investigation (Task 9). Agency review comments will be incorporated during the preparation of the Supplemental Work Plan.

Task 4.0 - Site Investigation Analysis

A Quality Assurance Evaluation and Data Sufficiency Analysis will be performed under this task to determine if the data collected under Task 3 are sufficient and of the quality necessary to support the performance of an Endangerment Assessment and the FS. The Preliminary Endangerment Assessment will also be performed under this task. A groundwater model will be adopted for the site based on the Task 3 data collection for consideration of groundwater treatment as a remedial alternative of the FS.

Subtask 4.1 - Quality Assurance Evaluation

The objective of this subtask is to determine whether RI Site Investigation data are of sufficient quantity and quality to support the Endangerment Assessment and the Phase II Draft FS (see Figure 1). The QA/QC evaluation will determine if the data have met the requirements of the QAPP and will include an analysis such as exemplified for organics by U.S. EPA's Laboratory Data Validation Functional Guidelines (R-582-5-5-01). Once the data validation step has been completed, the sufficiency review will evaluate whether the data will meet the RI objectives.

These evaluations will be discussed and summarized in Technical Memorandum No. 3. This technical memorandum will be submitted with the appropriate number of copies to the Project Coordinators listed in Section X of the AOC. Agency review comments on the technical memorandum will be considered in the design of supplemental site investigation activities (Task 8) and the preparation of the Draft RI Report (Task 5).

Subtask 4.2 - Data Sufficiency Analysis

An analysis and summary of site investigations and their results will be prepared. The results and data from site investigations will be organized and presented so that the relationships between the site investigations for each medium are apparent. A summary will be prepared that describes the quantities, concentrations, and environmental distribution of specific chemicals at the site and ambient levels around the site. The number, locations and types of nearby receptors will be identified. Activities and pathways that may result in actual or potential threats to public health, welfare or the environment presented by the no-action alternative will be described.

Subtask 4.3 - Preliminary Endangerment Assessment

An Endangerment Assessment will be performed with the objective of providing insight into the probability and magnitude of potential harm to public health and the environment, by release of hazardous materials from the site. In general, this objective will be addressed by assessing the following key components:

- Contaminant Identification
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

The evaluation will be performed according to the procedures presented in the Superfund Public Health Evaluation Handbook (ICF, 1986).

Data and information from the Preliminary Endangerment Assessment will be reflected in the remedial response objectives and will be used to aid in screening various alternatives. The Endangerment Assessment will be submitted as part of the Preliminary RI Report (Task 5). Recommendations for further study, as required, to complete the EA for the Draft RI Report will be presented in Technical Memorandum No. 3.

Technical Memorandum No. 3

Technical Memorandum No. 3 will be prepared at the conclusion of Task 4 (Site Investigation Analysis). This short report will summarize the findings of Subtask 4.1 (Quality Assurance Evaluation) and Subtask 4.2 (Data Sufficiency Analysis). If the data do not meet the QAPP's Data Quality Objectives, then recommendations for meeting those objectives will be made.

Technical Memorandum No. 3 will also contain a Preliminary Endangerment Assessment (EA). The Preliminary EA will identify migration pathways (Subtask 3.2) and assess their completeness. The Preliminary EA will also qualitatively identify the population at risk, list contaminants identified at the site and summarize the available toxicity information on the identified contaminants. Recommendations for further analysis will be made, if necessary.

Technical Memorandum No. 3 will be submitted to and reviewed by the U.S. EPA and the WDNR. Agency review comments will be taken into account when the Phase III Supplemental Site Investigation (Task 8) is prepared.

This task will begin following the issuance of the Alternatives Array Document (Task 7). The Work Plan and QAPP documents prepared under Phase II (see Figure 1) will be amended and supplemented to meet data needs identified in the Draft RI report, which will contain the Preliminary EA and in the Alternatives Array Document to support completion of the FS under Phase III.

Task 5 - Draft Remedial Investigation Report

Following the completion of the Agencies review of Technical Memorandum No. 3, a Draft Remedial Investigation Report will be prepared as specified in Section X of the AOC. The report will characterize the contaminant source(s) (Subtask 3.1), identify probable migration pathways (Subtask 3.2), and evaluate the extent and magnitude of the potential contamination within those pathways (Subtask 3.3). The report will also present the findings of the Preliminary Endangerment Assessment (Subtask 4.3). Results of the Quality Assurance Evaluation (Subtask 4.1) and the Data Sufficiency Analysis (Subtask 4.2) will also be presented.

The Draft Remedial Investigation Report will also recommend future investigation, as necessary, to meet the quality assurance goals and to complete the Endangerment Assessment.

The agencies comments on the draft report will be incorporated into a draft final report, which will be resubmitted to the Project Coordinators.

PHASE II FEASIBILITY STUDY

Objectives and Scope

The Phase II FS will present a screening of remedial alternatives for the site. A supplemental RI investigation and/or bench/pilot studies will be performed as part of the Phase II RI to present data for the remedial alternatives screening (see Table 1 and Figure 1). The purpose of the Phase II FS *for the Hagen Farm site is to develop alternative remedial actions*, based upon the results of the RI, which will mitigate unacceptable impacts to public health and welfare and the environment. The following sections describe preparation of the FS on a task basis.

Performance of the RI/FS will follow the phased, iterative approach, as shown in Figure 1. The FS will address Section 121 of SARA; revisions to the NCP and USEPA FS Guidance.

The initial screening of remedial alternatives will be performed in the Phase II FS, so that data requirements for the Phase III FS can be met according to the phased, iterative approach shown in Figure 1. The Phase III Supplemental Work Plan will present the data requirements and the means of fulfilling them by Phase III RI activities. The intent and purpose of each of the FS tasks is outlined in the following sections. The schedule for each of these tasks is presented in Appendix A.

Task 6 - Remedial Alternatives Screening

This task constitutes the first stage of the FS and is comprised of four interrelated subtasks. The objective of this task is to develop and evaluate remedial alternatives for additional screening and evaluation. The results of the Preliminary Endangerment Assessment will be considered throughout this evaluation process.

Subtask 6.1 - Preliminary Remedial Technologies

A master list of potentially feasible technologies will be developed. The list will include both appropriate on-site and off-site technologies, depending on the magnitude of the problem identified during the Phase II Site Investigation. The technologies will be screened based on:

- Site conditions;
- Waste characteristics;
- Technology limitations; and
- The potential for reduction in toxicity, mobility or volume (Section 121 of SARA).

Emerging technologies that are being evaluated through U.S. EPA's SITE program will also be evaluated, if that information is available prior to initiating this task. The results of this task will be summarized in a preliminary technical memorandum, which will be submitted to the PRP's Project Manager. Based on the PRP's comments, Warzyn will provide within fourteen calendar days, a revised technical memorandum to the PRP's Project Manager. Five copies of the technical memorandum will be submitted in draft form by the PRP's Project Manager to the U.S. EPA Remedial Project Manager and the Wisconsin DNR Project Coordinator.

Subtask 6.2 - Development of Alternatives

Based on the results of the RI and consideration of preliminary remedial technologies (Subtask 6.1), a limited number of alternatives will be developed which meet the objectives established for the response.

Activity 6.2.1
Establishment of Remedial Response Objectives

Site-specific objectives for the response will be established. These objectives will be based on public health and environmental concerns for the Hagen Farm site, the description of the current situation, information gathered during the RI, Section 300.68 of the National Contingency Plan (NCP), U.S. EPA's interim guidance documents, and the requirements of other applicable U.S. EPA, Federal, and Wisconsin environmental standards, guidance and advisories as defined under Section 121 of SARA. Preliminary cleanup objectives will be developed under formal consultation with the PRP's, the U.S. EPA and the WDNR.

Activity 6.2.2 Alternative Remedial Actions

Combinations of identified technologies will be assembled into alternative remedial actions. To the extent it is both feasible and appropriate, alternatives will be assembled into a comprehensive, site-specific remedial action approach. Alternatives that will be developed will include the following:

- Treatment alternatives for source control that eliminate the need for long-term management (including monitoring); and
- Alternatives involving treatment as a principal element to reduce the toxicity, mobility, or volume of waste.

Activity 6.2.3 Additional Alternatives

At least two additional alternatives will be developed, including the following:

- An alternative that involves containment of waste with little or no treatment, but provides protection of human health and the environment primarily by preventing the exposure or reducing the mobility of the waste.
- A no action alternative.

For groundwater response actions, a limited number of remedial alternatives will be developed within a performance range that is defined in terms of a remediation objective. The targeted remediation level will be within the risk range of 10E-04 to 10E-07 for maximum lifetime risk and includes different rates of restoration. If feasible, one alternative that would restore groundwater quality to a 10E-06 risk for maximum lifetime risk objective within five years will be identified.

The remedial action alternatives developed for the Hagen Farm site may involve both source control and groundwater response actions. In these instances, the two elements may be formulated together so that the comprehensive remedial action is effective and the elements are complimentary. However, because each element has different requirements, they will be detailed separately in the development and analysis of alternatives.

Subtask 6.3 - Initial Screening of Alternatives

Activity 6.3.1 Initial Screening

The alternatives developed under Subtask 6.2 will be subjected to an initial screening to narrow the list of potential alternatives for detailed analysis. The rationale for eliminating any alternative will be included. The criteria that will be used in the Initial Screening will include:

- Effectiveness: Alternatives will be evaluated to determine whether they adequately protect human health and the environment; attain Federal and Wisconsin Applicable or Relevant and Appropriate Regulations (ARARs) or other applicable criteria, advisories, or guidance; significantly and permanently reduce the toxicity, mobility, or volume of the hazardous constituents; are technically reliable; or are effective in other respects. The consideration of reliability will include the potential for failure and the need to replace the remedy.

- Implementability: Alternatives will be evaluated based on the technical feasibility and availability of the technologies that each alternative would employ; the technical and institutional ability to monitor, maintain, and replace technologies over time; and the administrative feasibility of implementing the alternative.

- Cost: The cost of construction and long-term costs to operate and maintain the alternative will be evaluated. This evaluation will be based on conceptual costing information and not a detailed cost analysis. At this stage of the FS, cost will be used as a factor when comparing alternatives that provide similar results, but will not be a consideration when comparing treatment and non-treatment alternatives. However, cost will be a factor in the final remedial section process as described in Subtask 12.2, Section 1, paragraphs (c) and (d).

Activity 6.3.2 Preservation of Alternatives

The initial screening of alternatives incorporating treatment will be conducted with the intent of:

- Preserving the most promising alternatives as determined by their likely effectiveness and implementability.
- Preserving for further analysis a range of alternatives as described previously in Activity 6.2.2.

Innovative alternative technologies will be carried through the screening, if there is a reasonable belief they offer either potential for better treatment performance or implementability; fewer or lesser adverse impacts than other available approaches; or lower costs for similar performance than the demonstrated technologies.

The containment and no-action alternatives will be carried through the screening process to the detailed analysis.

Task 7 - Alternatives Array Document

To obtain ARARs from Wisconsin and U.S.EPA, a description of the alternatives and technologies (including the extent of remediation, contaminant levels to be addressed and method of treatment) will be prepared. This document will also include a brief site history and background, a site characterization that indicates the contaminants of concern, migration pathways, receptors, and other pertinent site information. Data requirements that are specific to the relevant and applicable technologies will be identified. These requirements will be focused on providing data needed for detailed evaluation and development of a preferred alternative. Additional data required to provide the detailed evaluation will be obtained during the Phase III Supplemental Site Investigation and bench/pilot studies, if necessary. The data requirements and means of meeting them will be addressed in the Supplemental Work Plan of Phase III. A draft copy of this Alternative Array Document will be submitted to the PRP's Project Manager. Based on the PRP's comments, Warzyn will provide within fourteen calendar days, a revised document to the PRP's Project Manager. The PRP's Project Manager will submit 5 copies each to the U.S. EPA Remedial Project Manager and the WDNR Project Coordinator, along with the request for a notification of the standards.

PHASE III PLANS AND MANAGEMENT

Task 8 - Supplemental Work Plan Preparation

It is anticipated that, at a minimum, the Work Plan and QAPP addenda will specify a second round of water quality sampling. These water quality samples may be analyzed for TCL organics and inorganics, and several non-routine, general water quality parameters useful in screening potential remedial actions (see Section 3.4.1.3-QAPP-Volume 3).

The draft Work Plan and QAPP addenda will be submitted to the U.S. EPA and the WDNR for review and comment. The addenda will be amended to reflect review discussions between the PRP's and the agencies before final submittal.

Task 9 - Supplemental Site Investigation & Bench/Pilot Studies

Sites sampled under Subtask 3.3 (Contaminant Characterization) that show the presence of contaminants will be resampled to further document the nature of the contaminants present. The scope of activities to be performed under this Task will be specified in the Phase III Work Plan addenda (Task 8). However, it is anticipated that approximately one-half of the sites sampled under Subtask 3.3 (Containment Characterization) may require additional data.

Data evaluation and hydrogeologic analyses may indicate sampling of water supply wells is necessary. Water supply wells determined to be within two miles of the site and along the downgradient flow path will be sampled and analyzed. Appropriate protocols will be implemented for these samples.

Data gathered under this Task will be presented and analyzed in Technical Memorandum (see Figure 1). The Memorandum will be reviewed and commented on by the U.S. EPA and the WDNR. The final RI discussion of the data gathered under this Task will reflect the Agencies' comments.

If necessary, bench and piloting scale testing studies will be performed to determine the applicability of selected remedial technologies to site specific conditions. These may include treatability and cover studies, aquifer testing, and/or material compatibility testing. These studies will be conducted in Phase III of the RI, after the initial screening of remedial technologies and actions, in keeping with the phased iterative approach shown in Figure 1.

A testing plan that identifies the type(s) and goal(s) of field and laboratory bench scale testing will be developed, if needed. The plan will identify the level of effort required, data management procedures and data interpretation guidelines. The testing plan will be described in the Addenda to the Work Plan and the QAPP as a part of Supplemental Work Plan Preparation. The U.S. EPA and WDNR will be given the opportunity for review and comment on these addenda before performing Phase III activities.

Task 10 - Supplemental Site Investigation Analysis

A Quality Assurance Evaluate and Data Sufficiency Analysis will be performed following the completion of Task 9. The objective of this task is to determine if the Supplemental Site Investigation data are of sufficient quantity and quality needed to finalize the Endangerment Assessment (Subtask 10.3) and to support the Remedial Alternatives Evaluation (Task 12).

Subtask 10.1 - Quality Assurance Evaluation

This evaluation will determine if the data have met the QA/QC objectives set forth in the QAPP Addendum (Task 8). Once the data validation step has been completed, the sufficiency review (Subtask 10.2) will evaluate whether the data will meet the objectives set forth in the Work Plan Addendum (Task 8).

Subtask 10.2 - Data Sufficiency Analysis

An analysis and summary of the Phase II Site Investigation and the results will be prepared. The quantities, concentrations, and environmental distribution of specific compounds at the site and corresponding ambient levels around the site will be presented.

Subtask 10.3 - Final Endangerment Assessment

The final Endangerment Assessment will be prepared according to the Superfund Public Health Evaluation Manual (U.S. EPA, 1986) and will address the following elements:

- selection of indicator contaminants;
- exposure assessment;
- toxicity evaluation; and
- risk characterization

The final Endangerment Assessment will address the risk posed to the receptor population by the no action alternative. The risks posed by the other alternatives will be addressed in the final Feasibility Study Report (Task 13).

Task 11 Final Remedial Investigation Report

A final Remedial Investigation report will be prepared and submitted according to Section X of the AOC. The final Remedial Investigation Report will include the data analysis contained in the draft Remedial Investigation report (Task 5). In addition, the final report will address the data and information gathered during the Supplemental Site Investigation (Task 9), including the Technical Memoranda. The Agencies comments will be reflected in this Remedial Investigation Report.

Task 12 - Remedial Alternatives Evaluation

Subtask 12.1 - Detailed Analysis of Alternatives

Activity 12.1.1 Evaluation of Alternatives

The action-specific Federal and Wisconsin ARARs and other criteria, advisories, and guidance to be used in the analysis and selection of a remedy will be identified and described. Alternatives will be analyzed in sufficient detail so that the remedies can be selected from a set of defined and discrete hazardous waste management approaches.

The information needed to develop and evaluate each alternative will be developed. The alternatives will be evaluated under the general factors of effectiveness, implementability, and cost using the more specific component measures such as protectiveness, compliance with ARARs, reliability, and technical feasibility. The detailed analysis of each alternative will include both short-term and long-term considerations for effectiveness, implementability, and cost.

Activity 12.1.2 Comparison of Alternatives

The alternatives will be compared to each other using an array of evaluation factors appropriate for the Hagen Farm site. Component measures of effectiveness will include the degree to which the alternative is protective of human health and the environment. Where ARAR health based standards are established and applicable, they will be used to establish the minimum level of protection at the site. Where such levels do not exist, risk assessments will be used to establish site appropriate levels. The reliability of the remedy, including the potential need for the cost of replacement, will be used as another important element in measuring effectiveness. Site specific measures may also include other health risks borne by the affected population, population sensitivities, and the impacts on environmental receptors. If a groundwater response action is appropriate for the site, the potential for the spread of the contaminant plume and the technical limits of aquifer restoration will be used as measures of effectiveness. Another important measure of effectiveness is the degree to which the mobility, toxicity, or volume of the hazardous substance, pollutant, or contaminant is reduced.

Component measures of implementability that will be considered include the technical feasibility of the alternative; the administrative feasibility of implementing this alternative; and the availability of any needed equipment, specialists, or off-site capacity. Specific measures for groundwater remedial actions will include the feasibility of providing an alternate water supply to meet current groundwater needs, the potential need for groundwater, and the effectiveness and reliability of institutional controls.

Component measures of cost that will be used in this comparison will include short-term capital and operational costs and any long-term operation and maintenance costs. Present worth analyses will be used to compare the alternatives.

Subtask 12.2 - Preferred Remedy

The preferred remedy will be described within a chapter of the FS report. The criteria for remedy selection will be:

1. The appropriate remedy will be recommended from among those alternatives that meet the following findings:
   - The alternative shall be protective of human health and the environment. The alternative will meet the ARARs or health based levels that are established through risk assessments when ARARs do not exist or are waived;
   - Except under circumstances listed in the NCP, the alternative shall attain ARARs that have been identified for the site;
   - The alternative shall be cost effective, accomplishing a level of protection that cannot be achieved by less costly methods; and
   - The alternative will utilize treatment technologies and permanent solutions to the maximum extent practicable as determined by technological feasibility, availability, and cost effectiveness.
2. The preferred remedy will reflect the following preferences:
   - Remedies that involve treatment that significantly reduces the toxicity, mobility, or volume of hazardous constituents as a principal element; and
   - Remedies that minimize the requirement for long-term management of residuals.
3. An alternative that is preferred, but does not meet the Federal or Wisconsin public health or environmental ARARs, will be selected only when:
   - The alternative is an interim remedy and will become part of a more comprehensive final remedy that will meet the Federal and Wisconsin ARARs;

- Compliance with the requirements is technically impractical;
- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through the use of another method or approach;
- Wisconsin has not consistently applied, or demonstrated the intention to consistently apply, the requirement at other similar facilities across the state;
- The evaluation of alternatives to select the appropriate remedy will, in addition to meeting the required findings in Section 300.68(h)(1) of the NCP and reflecting the preferences in Section 300.68(h)(2) of the NCP, also consider and weigh the range of factors in Section 300.68(e)(2) of the NCP. The selected alternative will represent the best balance across all evaluation criteria.

Task 13 - Final FS Report

The FS will be documented in a draft report which will be submitted to the Respondents' Project Manager for review and comment. The FS report will present the Remedial Alternative Evaluation, including a discussion of the Preferred Remedy. Deliverables and technical memorandums prepared previously will be summarized and referenced in order to limit the size of the report. However, the report will completely document the FS and the process by which the recommended remedial alternative was selected.

Based on the PRP's comments, Warzyn will provide within fourteen calendar days, a revised FS to the PRP's Project Manager. The Respondents' Project Manager will submit 5 copies each to the U.S. EPA Remedial Project Manager and the WDNR Project Coordinator. Upon receipt of comments, a draft final FS report will be prepared and submitted. The FS report will be considered final when a letter of approval is issued by the U.S. EPA Remedial Project Manager.

PLANS AND MANAGEMENT

Task 14 - Community Relations Program

A community relations program will be implemented conjunctively by the U.S. EPA and the WDNR. The PRPs will cooperate with the U.S. EPA and the WDNR in providing RI/FS information to the public. The PRPs will, at the request of the U.S. EPA or WDNR, participate in the preparation of appropriate information disseminated to the public, and in public meetings which may be held or sponsored by the U.S. EPA or the WDNR to explain activities at, or concerning, the site, including the findings of the RI/FS.

During preparation of the FS, a program for community relations support will be developed. The program will be consistent with the Community Relations Plan and with the conditions set forth in the Administrative Order. The PRPs will provide information to the U.S. EPA and WDNR, as required by the agencies, to explain activities at or concerning the site. Community relations support will be consistent with Superfund community relations policy, stated in the Guidance for Implementing the Superfund Program and Community Relations in Superfund - A Hand Book.

Task 15 - Monthly Reports

Monthly progress reports will be prepared to describe the technical progress of the RI/FS. These reports shall be submitted to the U.S. EPA and WDNR by the tenth business day of each month, following the commencement of the work detailed in the RI/FS Work Plan. The monthly progress reports shall include the following information:

- Sampling and testing results that have been validated (QA/QC) and other raw data (e.g., field measurements) produced during the month pursuant to the implementation of the Consent Order.
- A description of activities completed during the past month pursuant to the Consent Order, as well as such actions and plans which are scheduled for the next month.
- A projection of anticipated sampling events, including dates, types, quantities, parameters, laboratories and shipping considerations.
- A description of difficulties encountered during the reporting period and the actions taken to rectify the problems;

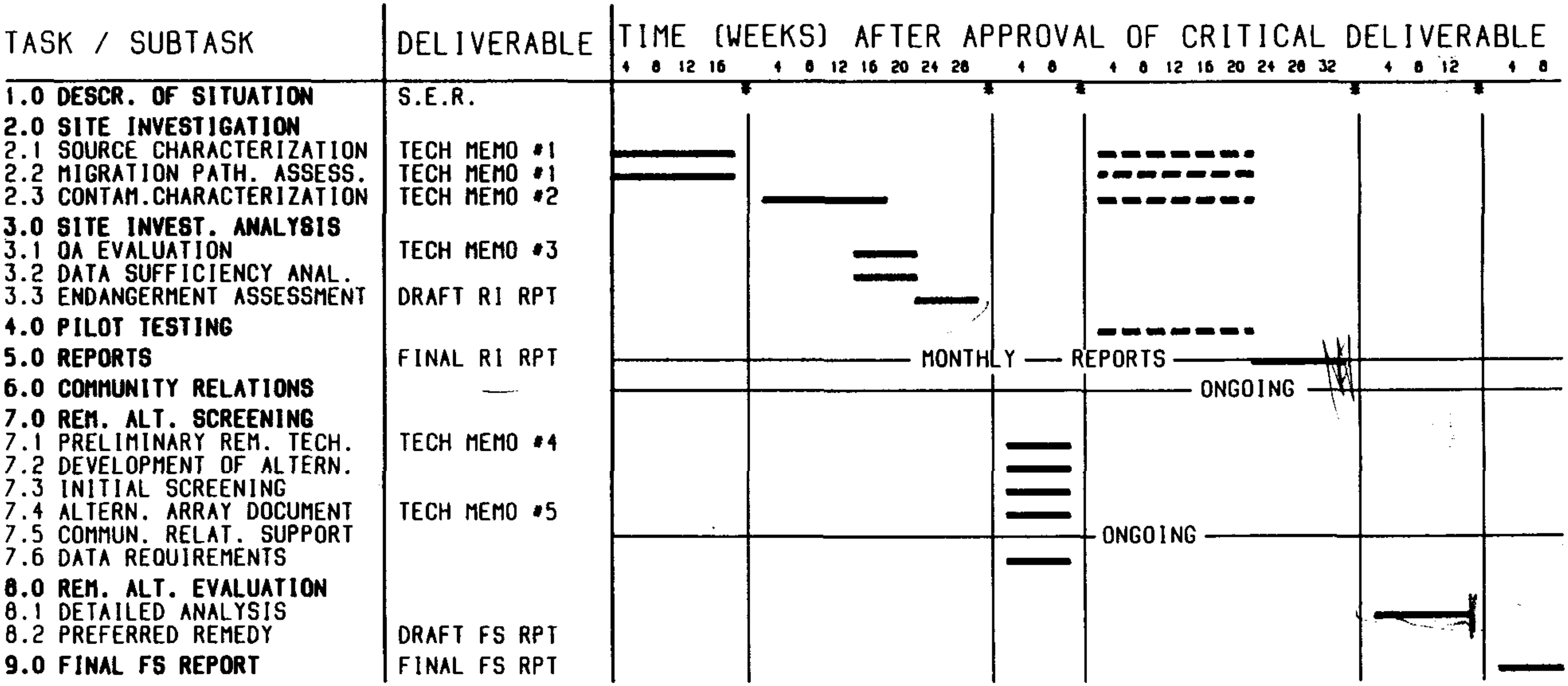
- Target and actual completion dates for each element of activity, including the project completion, and an explanation of any deviation from the schedules provided in the RI/FS Work Plan;
- Changes in key personnel; and
- A Quality Assurance Report to Management section will be prepared and included as described in Section 10 of the QAPP.

[jpl-600-14]

APPENDIX A

SCHEDULE FOR RI/FS IMPLEMENTATION

APPENDIX A
SCHEDULE FOR RI/FS IMPLEMENTATION-HAGEN FARM SITE



TASK / SUBTASK	DELIVERABLE
1.0 DESCR. OF SITUATION	S.E.R.
2.0 SITE INVESTIGATION	
2.1 SOURCE CHARACTERIZATION	TECH MEMO #1
2.2 MIGRATION PATH. ASSESS.	TECH MEMO #1
2.3 CONTAM.CHARACTERIZATION	TECH MEMO #2
3.0 SITE INVEST. ANALYSIS	
3.1 QA EVALUATION	TECH MEMO #3
3.2 DATA SUFFICIENCY ANAL.	
3.3 ENDANGERMENT ASSESSMENT	DRAFT RI RPT
4.0 PILOT TESTING	
5.0 REPORTS	FINAL RI RPT
6.0 COMMUNITY RELATIONS	—
7.0 REM. ALT. SCREENING	
7.1 PRELIMINARY REM. TECH.	TECH MEMO #4
7.2 DEVELOPMENT OF ALTERN.	
7.3 INITIAL SCREENING	
7.4 ALTERN. ARRAY DOCUMENT	TECH MEMO #5
7.5 COMMUN. RELAT. SUPPORT	
7.6 DATA REQUIREMENTS	
8.0 REM. ALT. EVALUATION	
8.1 DETAILED ANALYSIS	
8.2 PREFERRED REMEDY	DRAFT FS RPT
9.0 FINAL FS REPORT	FINAL FS RPT

━━ ACTIVITY
━ ━ ━ IF NECESSARY
* AGENCY REVIEW PERIOD

APPENDIX B

HEALTH AND SAFETY PLAN

HAGEN FARM SITE
HEALTH AND SAFETY PLAN

SECTION 1
SITE CHARACTERISTICS AND HAZARDS

General Project Description

The field work for this project involves the Remedial Investigation of the Hagen Farm site. Field tasks include:

- Geophysical Investigation
- Soil-Gas Survey
- Refuse Borings and Soil Sampling
- Leachate Head Well Installation and Sampling
- Soil Borings
- Installation of Groundwater Observation Wells
- Groundwater Level Monitoring and Aquifer Testing
- Ambient Air Sampling

Site Description

The site is located at 2318 County Highway A, approximately 1 mile east of the City of Stoughton, Dane County, Wisconsin occupying the southwest quarter of Section 10, Township 5 North, Range 11 East, Town of Dunkirk. Land surrounding the site is generally rural and dominated by agriculture and small parcels of trees. An active sand and gravel quarry is located northwest of the site.

The site consists of approximately 9-10 acres with three potential former disposal areas have been identified at the Hagen Farm site; A larger area (5.5-acres) in the southwestern portion of the site, and two smaller areas each are (1.5-acres each) in the northcentral portion of the property. Eight private wells are located within 1200 feet of the approximate disposal area boundaries. The northwestern corner of the site has been used for an open rubble fill area as shown on Drawing A-4. Location of the site is shown on Drawing 13114-A4.

Site History

The Hagen Farm site was operated as a sand and gravel pit prior to the late 1950s. The gravel pit was then used for disposal of waste material from the late 1950's to mid-1960's, based on available records and interviews with former Uniroyal personnel. The site consists of one main disposal area and two smaller potential disposal areas. These area(s) have been covered with soil and the area is now vegetated with grasses and 10 to 15 ft tall trees. Documentation of waste quantities is unavailable. Wastes disposed may include solvents and other organic materials (acetone, butyl acetone, 1,2-dichloroethene, vinyl chloride, and tetrahydrofuran) and scrap vinyl.

Based on information provided by former Uniroyal employees, wastes were hauled from the Uniroyal plant in Stoughton by Uniroyal for approximately two to three years during the late 1950's and/or early 1960's. Documentation of the type or quantity of waste hauled to the site by Uniroyal is unavailable.

City Disposal contracted with Uniroyal to haul waste to the site beginning in late 1962. Information provided by City Disposal and Waste Management of Wisconsin, Inc. (WMWI) suggests City Disposal, now part of WMWI, stopped hauling waste to the site during 1966. Documentation of waste quantities hauled to the site during this period and operational practices are unavailable.

At the time waste disposal was occurring, the property was owned by Henry and Nora Sundby, since deceased. The property was purchased from the Sundbys by Orrin Hagen in approximately 1970 and is now owned by Waste Management Inc. (WMI).

In response to complaints received from local people, groundwater sampling at nearby private water supply wells was conducted by the Wisconsin Department of Natural Resources (WDNR) beginning in November 1980. Sampling of private water supply wells was also later conducted by Warzyn Engineering Inc. (Warzyn) on behalf of Uniroyal. On-site hydrogeologic studies were conducted by Warzyn (for Uniroyal) and by the USGS. Sampling of on-site monitoring wells during the period 1980-1986 indicated certain organic compounds were present in groundwater at the site (including benzene, ethylbenzene, tetrahydrofuran, xylenes and toluene).

The site was proposed for inclusion on the National Priorities List (NPL) on September 18, 1985. Subsequently, WMI and Uniroyal entered into an Administrative Consent Agreement (U.S. EPA Docket No. VW 87-C-016, dated September 14, 1987) with the U.S. EPA to conduct a Remedial Investigation/ Feasibility Study (RI/FS) at the Hagen Farm Site.

Principal Disposal Method

The principal disposal method employed at the site appears to have been the pouring out of liquid wastes from drums into the gravel pit, allowing liquids to percolate into the soil. Some containers, such as drums and cans, may have been dumped intact in the pit and in other locations on site, based on Wisconsin Department of Natural Resources records.

Site Features

Topography:	The site contains excavated and fill areas that present irregular slopes. Naturally, the terrain is sloping or rolling. The east half of the Hagen Farm site is generally flat (field).
Buildings:	Several abandoned farm buildings exist at the south end of the site. The buildings will be demolished.
Waterways:	A wetland exists approximately 1200 ft south of the site. There is a small pond in the north part of the property.
Utilities:	An overhead power line runs through the center of the Hagen Farm site.
Area Population:	Sparse

Principal Chemical Exposure Hazards

The principal chemical exposure hazards at the Hagen Farm Site are the following volatile organic compounds:

Chemical	Maximum Concentrations (ug/L)	
	Monitoring Well	Private Well
chlorobenzene	28	
ethylbenzene	6,000	
xylene	32,000	13
toluene	230	18
acetone	430	102.9
vinyl chloride	94	102
1,2-trans-dichloroethene	240	11
trichloroethylene	1.7	4.8
carbon disulfide		46
tetrachloroethylene	0.2	0.4
n-butyl acetate		100
chlorofluoromethane	11	
1,1-dichloroethylene	240	
methylene chloride		660
benzene	16	
chlorodifluoromethane		7.8
2-hexanone	80	
tetrahydrofuran	58,000	8,400

Safety Hazards

Safety hazards of field investigation include spinning and overhead/hanging drilling equipment and the use of manually operated drilling equipment. On-site hazards include overhead powerlines, excavation wall faces and loose rubble fill. Hazards vary with specific tasks and are addressed under Section 3: Task Evaluation.

Heat Stress

The time of year this investigation begins will determine if heat stress poses a problem. The Site Safety Officer will address concerns as they arise in the daily safety briefing. Field activity will be discontinued when the temperature-humidity index does above 120*. The content of heat stress review is contained in Appendix A.

Cold Exposure

The possibility of cold exposure will be addressed by the Site Safety Officer in the daily safety briefings as it becomes applicable. Field work will be

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*See Appendix A, Table 1

discontinued when the wind chill is below -15°F. A review of exposure to cold conditions is included in Appendix A.

Electrical Hazards

Electrical hazards may occur from underground utilities and overhead lines during drilling operations. Drill sites will be cleared by the local utilities prior to beginning of activities. The drillers discretion will be used for the avoidance of overhead lines.

Site Control Procedures

Access to the site is channeled through driveways with secured gates. Site access will be limited to authorized personnel. Personnel entry and exit logs will be maintained at the site headquarters. Field personnel will request observers to stay at safe distances from operations or will halt activity. Individual work areas will be separated from each other (exclusion zones) and from the office facility.

Personnel entering an exclusion zone must be wearing the appropriate level of protection (see Task Evaluation - Section 3). The Site Safety Officer will be responsible for ensuring the proper level of protection is worn and for decontamination of personnel exiting the site. A personnel decontamination area (contamination reduction area) will be set up near the site headquarters.

Medical Monitoring Requirements

As required by 29 CFR 1910.120[f] (OSHA), on-site personnel who have a potential for exposure to hazardous material, or will be required to wear a respirator, must receive a physical examination that will determine their fitness for these tasks. This determination will be made by a qualified physician and its documentation will be received by the Site Safety Officer before field work will begin.

Personnel Training

Pursuant to 29 CFR 1910.120[e] (OSHA), personnel engaged in field investigation shall have received a minimum of 40 hours of off-site classroom training. This training shall include, but not be limited to, those topics addressed in the cited regulation. Warzyn's in-house Basic Hazardous Waste Site Health and Safety Training meets these requirements. The Site Safety Officer will maintain verification of certification (Appendix C) for site personnel. On-site Supervisors/Managers will have received an additional 8 hours of training on managing site operations.

SECTION 2
CHEMICAL HAZARD INFORMATION

TABLE 1
CHEMICAL PROPERTIES

Name	Molecular Weight	Specific Gravity	Flash Point	Flam. Limits	Vapor Press.	Vapor Density	Ionization Potential	Solubility
chlorobenzene	113	1.11	84°F	1.3-7.7%	8.8 mm	NA	9.07 eV	0.1%
ethylbenzene	106	0.863	<-4°F	6.7-11.3%	375 mm	NA	10.29 eV	0.9%
xylene	106	0.088	81-90°F	1-7%	9 mm	NA	8.56 eV	0.00003%
toluene	92	0.867	40°F	1.3-7.1%	22 mm	NA	8.82 eV	0.05%
acetone	58	0.791	1.4°F	2.6-12.8%	266 mm	2.0	9.69 eV	miscible
vinyl chloride	62.5	0.969	-108°F	3.6-33%	2580 mm	2.2	9.99 eV	0.6%
tetrahydrofuran	72	0.888	6°F	2-11.8%	145 mm	NA	9.54 eV	miscible
1,2-trans-dichloroethene	99	1.253	55°F	6.2-16%	62 mm	3.4	11.12 eV	0.8%
trichloroethylene	131	1.46	None	11-41%	58 mm	4.5	9.47 eV	0.1%
carbon disulfide	76	1.26	-22°F	1.3-50%	300 mm	2.6	10.06 eV	0.2%
tetrachloroethylene	166	1.62	None	----	14 mm	NA	9.32 eV	0.015%
n-butyl acetate	116	0.875	72°F	1.7-7.6%	10 mm	NA	9.56 eV	0.68%
1,1-dichloroethylene	97	1.21	0°F	7.3-16%	665 mm	3.3	NA	0.5%
methylene chloride	85	1.322	None	12%-19%	350 mm	2.9	11.35 eV	1.3%
benzene	78	0.879	12°F	1.3-7.1%	75 mm	2.7	9.25 eV	0.8%
chlorodifluoromethane	86.5	1.41	None	None	NA	3.0	12.45 eV	0.3%
2-hexanone	100	0.830	77°F	1.2-8%	3 mm	3.5	9.34 eV	1.4%

SECTION 2
CHEMICAL HAZARD INFORMATION

TABLE 2
HEALTH PROPERTIES

Name	Odor Characteristic	Odor Threshold (ppm)	TLV (PPM)	IDLH (ppm)	Dermal Toxicity
chlorobenzene	sweet almond odor	0.21-60	75	2,400	moderate
ethylbenzene	pungent, aromatic	0.25-200	100	2,000	moderate
xylene	hydrocarbon	0.05-200	100	10,000	NA
toluene	benzene-like	0.17-40	100	2,000	slight
acetone	mint-like	100	750	20,000	moderate
vinyl chloride	faintly sweet	260	5	NA	NA
tetrahydrofuran	faint, fruity	20-50	200	20,000	extreme
1,2-trans-dichloroethene	chlorinated hydrocarbons	6.2-100	10	1,000	NA
trichloroethylene	sweet	*21.4-400*	*50*	*1,000*	moderate
carbon disulfide	rotten egg to sweet	0.0011-7.7	10	500	extreme
tetrachloroethylene	sweet	4.68-50	50	500	NA
n-butyl acetate	fruity	0.037-20	150	10,000	slight
1,1-dichloroethylene	sweet	0.085-500	5	4,000	NA
methylene chloride	sweet	25-320	100	5,000	moderate
benzene	hydrocarbon like	4.68	10	2,000	extreme
chlorodifluoromethane	odorless	NA	1,000	NA	NA
2-hexanone	hexane like	NA	5	NA	NA

NOTE: organic vapor cartridges are approved for use with all solvents except methylene chloride, vinyl chloride, and chlorodifluoromethane.

NA - Not Available

13114.04
TTU/mml/JFK
[mml-600-73b]

SECTION 3
TASK EVALUATION

Instrument Action Levels

Air monitoring instruments to be used on site for personal protection determination include the HNU photoionization detector (PID) with a 10.2 eV probe for organic vapors and a HCN Monotox for cyanide gas. Action levels for these instruments follow. Readings upon which action levels are based are those taken in the worker breathing zone; i.e., within a foot of the head of the worker closest to a source of contamination in his normal activities. Readings to be considered should be persistent rather than instantaneous maximum values. PID readings may be affected by relative humidity. Temperature should not affect PID readings. HCN-Monotox manufacturer's recommended temperature range is 0-50°C with a relative humidity of 10-95%.

PID: Readings at or below background concentration - Level E or Level D
Readings greater than background concentration, but less than or equal to 5 ppm over background - Level C
Readings greater than 5 ppm over background concentration, but less than 500 ppm - Level B
Readings greater than 500 ppm - Depart from the immediate area

HCN Monotox: Readings greater than background concentration, but less than 10 ppm - Continue operations but monitor more frequently
Readings equal to or greater than 10 ppm - Depart from the immediate area

Levels of Protection

The following section describes the levels of protection which may be implemented during the site investigation activities. If upgrading from one level to another is required, authorized site visitors will be advised at that time.

Level E

Level E is to be implemented when work activities take place where there are no anticipated or known environmental health hazards. Level E may include the following:

- Steel toe boots
- Hard hat
- Surgical gloves (when needed)
- Coveralls
- Latex overboots (Modified Level E)
- Participation in medical monitoring program and Health and Safety trained, according to OSHA 29 CFR 1910.120.

Level D

Level D is to be worn during activities which do not suggest any initial respiratory protection, but where dermal protection is warranted. The following list outlines the personal protective equipment to be utilized for Level D:

- Polyethylene (PE) coated Tyvek coveralls
- Steel toe/steel shank leather work boots with latex overboots or steel toe/steel shank neoprene boots;
- Surgical gloves
- Nitrile or neoprene gloves
- Eye protection (safety glasses or face shield)
- Hard hat

Level C

Level C is to be worn when work area organic vapor air contamination is between background and 5 ppm (according to HNU or OVA readings). The following outlines this level of protection:

- PE coated Tyvek coveralls
- Steel toe/steel shank leather work boots with latex overboots or steel toe/steel shank neoprene boots;
- Surgical gloves
- Nitrile or neoprene gloves
- Full face, air purifying respirator with combination organic vapor/dust and mist cartridge
- Hard hat

Level B

Level B protection is worn when work area organic vapor air contamination is greater than 5 ppm. The following outlines this level of protection:

- PE coated Tyvek coveralls
- Steel toe/steel shank leather work boots with latex overboots or steel toe/steel shank neoprene boots;
- Surgical gloves
- Nitrile or neoprene gloves
- Positive pressure self-contained breathing apparatus (SCBA) or airline supplied respirator with 5-minute escape pack, with a full face piece
- Hard hat

Subtask Analysis

The field investigation includes the following subtasks. Specific hazards and levels of protection are described for each subtask.

Subtask A - Geophysical Survey

Preliminary Subtask Evaluation Hazard: Low

Modified Level E Protection

A geophysical survey consisting of walking transects across the fill areas with geophysical monitoring instruments will be a part of field evaluation tasks. The geophysical survey will be conducted to locate the extent of fill and underground anomalies suggestive of buried metal. Modified Level E protection will include latex overboots. Hazards other than those provided under normal field operations are not anticipated. Air monitoring will not be included for this subtask.

Subtask B - Soil Gas Survey

Preliminary Subtask Evaluation Hazard: Low

Level E Protection

The soil gas survey will be performed in the known and suspected waste disposal areas. The survey will entail driving a probe into the soil and measuring soil gas concentrations with a field gas chromatograph. Hazards other than those provided by normal field operations are not anticipated.

Subtask C - Refuse Borings
Preliminary Subtask Evaluation Hazard: Moderate-High
Level D, C and/or B Protection

Refuse borings will be drilled in suspected areas of waste disposal in order to characterize the cover and base materials. Locations selected for borings will be based partially on a negative response to ferromagnetic anomalies determined in the geophysical study. Drilling will be by 4 1/4 in I.D. x 8 1/2 in O.D. hollow stem augers with cover soil samples being collected in continuous profiles. Soil samples will be analyzed for particle size and percent organic matter to describe fill cover material. The drilling rig will be supervised by a Warzyn geologist or technician.

The potential for contact with contaminated soil and leachate poses a chemical hazard. Personnel should also be aware of the hazards involved in the operation of heavy equipment.

Air monitoring to be performed during this subtask includes use of a combustible gas meter, a photoionization detector and a cyanide monitor. Upgrading of a protection level will be determined by air monitoring of the breathing zone for organic vapors. Upgrade to Level C (breathing zone readings above background, but less than 5 ppm) and to Level B (for photoionization readings greater than 5 ppm over background) may be necessary. Elevated readings on the combustible gas meter (>20% LEL) or the cyanide monitor (1/2 TLV) will be cause for borings to be halted until the site safety officer re-evaluates the situation.

Subtask D - Leachate Head Wells
Preliminary Subtask Evaluation Hazard: Moderate-High
Level D, C and/or B Protection

Installing leachate head wells will serve to locate and allow chemical characterization of liquid wastes. This subtask will also be directed at characterizing organic vapors which may have the potential for atmospheric release. Locations, number and depths of leachate head wells will be based on refuse borings. Installation of the leachate head wells will be performed in conjunction with the refuse borings.

Subtask E - Soil Borings/Groundwater Observation Wells
Preliminary Subtask Evaluation Hazard: Moderate
Level D, C and/or B Protection

This subtask involves characterization of the site soils for assessment of contamination migration potential. Soil boring will be performed using a soil boring drill rig advancing 4 1/4 in. I.D. x 8 1/2 in O.D. hollow stem screened augers and sampling soils with a split spoon sampler. Samples will be collected at 2.5 foot intervals to 10 feet and at 5 foot intervals to greater depths. Rotary wash boring will be performed at some locations 10 feet into bedrock. Groundwater samples will be collected through the screened auger at 5 foot intervals in the saturated zone and will be analyzed for pH, conductivity, and VOCs to assist in selecting screened intervals for observation wells.

Working with heavy machinery and transporting potentially contaminated subsurface materials to the surface may pose hazards to investigators. Air monitoring of the breathing zone will determine if upgrading to Level C (breathing zone above background, but less than 5 ppm) and to Level B (for photoionization instrument readings greater than 5 ppm in the breathing zone) are required.

Groundwater observation wells will be installed in the soil borings to determine groundwater flow direction and hydraulic conductivity in the site area. Potential exposure to contaminated groundwater exists as a chemical hazard. Air monitoring will determine the necessity for upgrading protection levels.

Water level measurements and hydraulic conductivity (permeability) testing will be conducted subsequent to groundwater observation well installation.

Level D and/or C protection will be used for these subtasks. Air monitoring will determine the need for upgrading to Level C (breathing zone above background, but less than 5 ppm).

Subtask F - Meteorological Monitoring
Preliminary Subtask Evaluation Hazard: Low
Level E Protection

A meteorological station will be set up to collect periodic data concerning air temperature, humidity, barometric pressure, wind speed and wind direction. Hazards other than those related to normal field activities are not anticipated. Air monitoring for chemical hazards is not anticipated.

Subtask G - Surface Water Elevation Survey
Preliminary Subtask Evaluation Hazard: Low
Modified Level E Protection

On-site surface water bodies will be surveyed for elevations to determine potential pathways of surficial contaminant migration. Hazards other than those associated with field activities are not anticipated, however, latex overboots will be used if direct contact with surface water bodies occurs. Air monitoring is not anticipated for this activity.

Subtask H - Ambient Air Sampling
Preliminary Subtask Evaluation Hazard: Low
Level E Protection

Ambient air will be sampled for volatile organic compounds with personal sampling pumps and Tenax/Tenax-charcoal sampling tubes. Pumps will be placed at 4 locations on the site and operated for an 8-hour period. Hazards other than those related to normal field activities are not anticipated.

Decontamination Procedures

Personnel Decontamination

A decontamination area will be established by the Site Safety Officer. The decontamination area will be set up such that cross contamination will not occur when disposing of contaminated personal protective equipment. Decontamination procedures should be followed, including washing hands and face, upon finishing a field investigative activity.

Drill Rig and Related Equipment Decontamination

Steam cleaning the drill rig between boreholes will be conducted at a central decontamination (decon) area. **Decon water will be collected and drummed.** A secured area for drums containing contaminated drill cuttings will also be provided. Level C personal protection may possibly be required for decontamination of grossly contaminated equipment, based on PID measurements of the equipment.

Sampling Equipment Decontamination

Sampling equipment that is not dedicated to a well or soil sample will be decontaminated between locations with a solution of water and detergent followed by a deionized water rinse. The soil probe used in the soil gas survey will be wiped clean with paper towels and a detergent solution and rinsed with deionized water. Used towels will be disposed in trash bags. All spent decontamination water and wastes will be collected and drummed.

Investigation-Derived Wastes

Boring cuttings, test pit material, monitoring well purge water, borehole wash water (if rotary washbore used), and bagged disposable protective equipment will be collected and drummed. Drums will be labeled and maintained in one location for further consideration by responsible parties.

SECTION 4
SITE EMERGENCY CONTINGENCY PLAN

Chemical Exposure Symptoms

Vapors of chlorinated organic solvents are irritating to the eyes, nose and throat. If inhaled in high concentrations they can cause difficult breathing, nausea or dizziness.

Acetone and several of the methane and benzene derived compounds can cause nausea, vomiting, difficult breathing or loss of consciousness, if inhaled.

Contact with liquids containing the compounds known to occur on-site can cause effects ranging from irritation of the eyes and skin to burns to frostbite (from the freon compounds). If swallowed, they may produce vomiting, nausea, loss of consciousness or death.

First Aid Treatment

For vapor exposure, remove victim to fresh air. If breathing has stopped, begin artificial respiration.

For liquid exposure, remove contaminated clothing and flush affected skin with ample amounts of water.

If in eyes, hold eyelids open and flush with plenty of water. If swallowed and victim is unconscious, do nothing except keep warm and contact emergency medical help.

Hydrogen Cyanide Contingency Plan

Should hydrogen cyanide levels in excess of 10 ppm be encountered, workers will withdraw upwind. If not present at the work location, the Site Safety Officer will be contacted and appraised of the situation. The excavation/drill hole will be allowed to vent and then be rechecked by the

Safety Officer. If levels are below 10 ppm, work will be continued, with close HCN monitoring.

If levels do not fall below 10 ppm within 20 to 30 minutes, the area will be covered as best as possible with available materials. Workers will remain upwind at all times during this closure operation. The Site Safety Officer will be in charge of this operation.

In the event that large quantities of HCN (or other gases) are vented at the work area, and it is not possible to close the point of release, the work crew will immediately leave the area and alert county emergency services.

Resources

Services of Organization	Location	Phone Number
Hospital: Stoughton	900 Ridge Street	608-873-2264
Fire Department	Stoughton	608-873-7217
Poison Control Center	Madison	608-262-3702
Police	Stoughton	608-873-3373
Rescue/Ambulance	Stoughton	608-873-3373
Dane County Emergency Management	Madison	608-266-4330
Warzyn		
H&S Director - Don Woods	Chicago	312-773-8484
	(Home)	312-352-0129
	(Pager)	312-303-8335
Project Manager - Mike Radcliffe	Warzyn	608-273-0440
Project Hydrogeologist - Al Schmidt	Warzyn	608-273-0440
Client Contact: Mr. Bob Vallis	Milwaukee	414-425-3550

Hospital Route

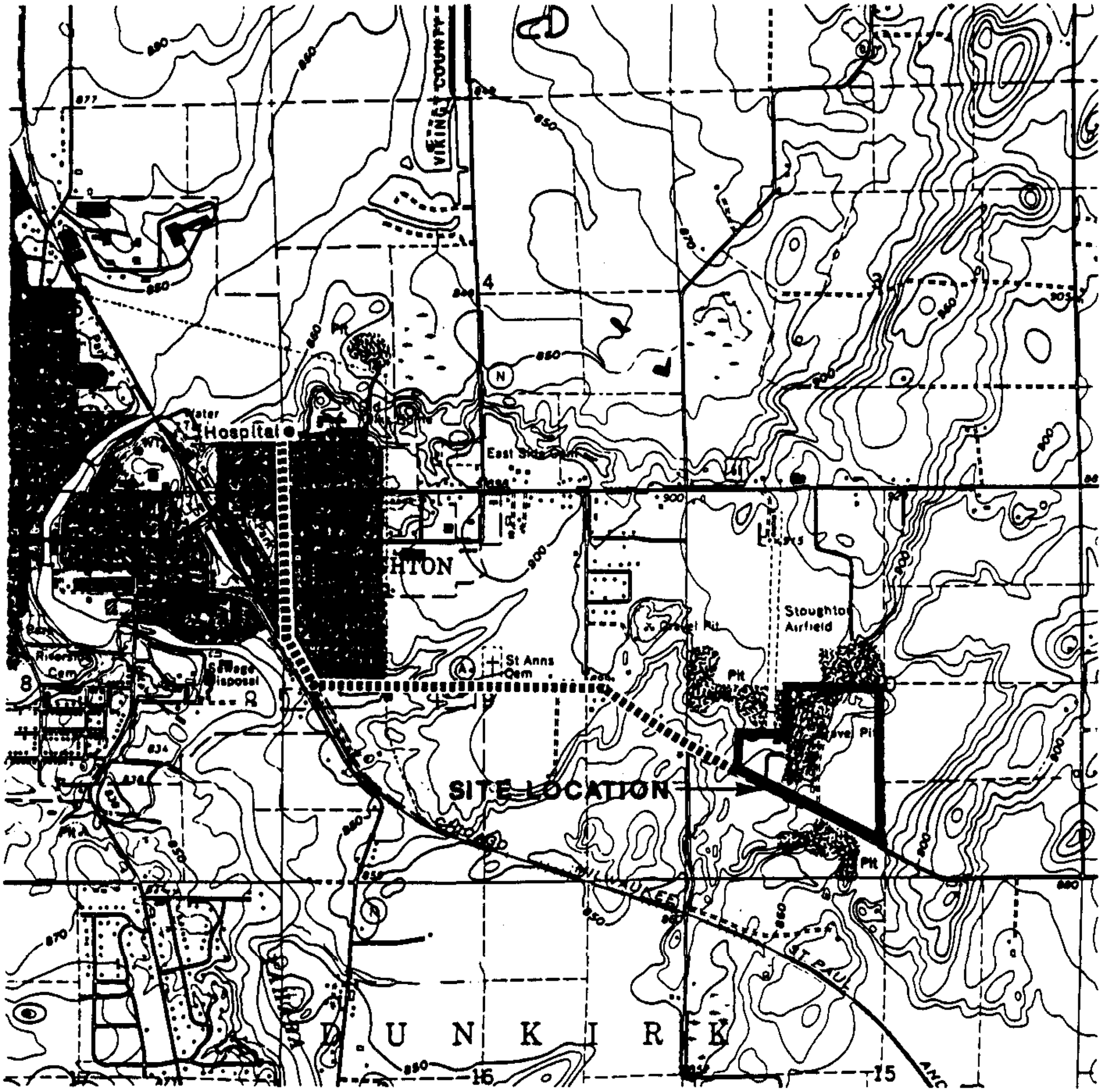
Take Cty Hwy A west to Stoughton (approx. 2 miles), Cty Hwy A becomes Academy Street in Stoughton, go north on Academy to Ridge Street, turn left (west) on Ridge, Stoughton Hospital is on north side of Ridge Street (See Figure 13114-A4).

I have read the Site Health and Safety Plan and understand the health and safety hazards which may result from on-site activities associated with this job. I agree to comply with all of the procedures applicable to me, as outlined in this plan.

Employee Signature

Date

TTU/mml/JFK/DWH
[mml-600-73]



NOTE

1. SITE LOCATION MAP WAS OBTAINED FROM STOUGHTON, WISCONSIN 7 1/2 MINUTE QUADRANGLE MAP DATED 1961, PHOTO REVISED 1982.

FOR
PRELIMINARY
USE ONLY

north

SCALE: 1" = 2000'

WARZYN

HOSPITAL ROUTE MAP

HAGEN FARM SITE
TOWN OF DUNKIRK
DANE COUNTY, WISCONSIN

DWN ALH, LLL	APP'D	DATE	13114-A5

APPENDIX A

APPENDIX A

HOT AND COLD WEATHER CONSIDERATIONS

HOT WEATHER CONDITIONS

Working under hot weather conditions requires special health and safety considerations. Heat is generated in the body as a result of normal oxidation processes. Heat which is produced within the body is brought to the surface by the bloodstream, and escapes to the cooler surroundings through conduction and radiation. If the surrounding air temperature is equal to or above the body temperature, however, body heat can only be lost through the evaporation of moisture from the skin. The effectiveness of this cooling process decreases as the air humidity increases. Therefore, the cooling system of the human body is greatly reduced on hot, humid, still days. It is on such days (or more commonly, a succession of such days) that the threat of heat-related medical emergencies becomes greatest.

When working during hot weather conditions, specific steps should be taken to lessen the occurrence of heat-related emergencies. These include:

- drinking plenty of fluids (particularly "Gatorade" or related drinks)
- taking frequent breaks and cooling off
- working during cooler parts of the day (if possible) such as 5 a.m. to 11 a.m. and 6 p.m. to nightfall.

The wearing of protective clothing significantly impairs the natural cooling system of the body. Therefore, when such clothing is worn, especially Levels A or B, special care must be taken to allow the body to cool at regular intervals. The following tables show suggested guidelines for the maximum wearing time of protective clothing during hot weather.

Table 1

EFFECTS OF HEAT, HUMIDITY

HEAT STRESS. Humidity combines with heat to create a more uncomfortable apparent temperature. The table below, from the National Weather Service, shows the apparent temperatures caused by various combinations of air temperature and humidity. Remember: In heat waves, the apparent temperatures may run 15 to 30 degrees higher in urban areas.

	Air Temperature*										
	70	75	80	85	90	95	100	105	110	115	120
Relative Humidity	Apparent Temperature*										
0%	64	69	73	78	83	87	91	95	99	103	107
10%	65	70	75	80	85	90	95	100	105	111	116
20%	66	72	77	82	87	93	99	105	112	120	130
30%	67	73	78	84	90	96	104	113	123	135	148
40%	68	74	79	86	93	101	110	123	137	151	
50%	69	75	81	88	96	107	120	135	150		
60%	70	76	82	90	100	114	132	149			
70%	70	77	85	93	106	124	144				
80%	71	78	86	97	113	136					
90%	71	79	88	102	122						
100%	72	80	91	108							

*Degrees Fahrenheit.

When apparent temperatures are between 90 and 105 degrees, heat cramps, heat exhaustion and heatstroke are possible after prolonged exposure and physical activity. These become likely when apparent temperatures are between 105 and 130 degrees. Over 130, heatstroke is imminent. Note: Heatstroke can be fatal if medical care is delayed.

TABLE 2

Apparent Temp* (degrees F)	Max. Wearing Time (min) per Excursion
above 90	15
85 - 90	30
80 - 85	60
70 - 80	90
60 - 70	120
50 - 60	180

* From Table 1

To assess effectiveness of the "rest-recovery" regime being used, the heart rate should be monitored using the following system.

1. Count the pulse rate for the last 30 seconds of first minute of a three minute period, the last 30 seconds of the second minute, and the last 30 seconds of the third minute.
2. Double the count.

If the recovery pulse rate during the last 30 seconds of the first minute is at 110 beats/minute or less, and the deceleration between the first, second and third minutes is at least 10 beats/minute, then the work-recovery regime is acceptable. If this is not true, a longer rest period is required, and the intake of fluids should be increased.

Heat-related emergencies fall within three categories: heat cramps, heat exhaustion and heat stroke.

HEAT CRAMPS

Symptoms: painful muscle cramps in legs and abdomen
faintness
profuse perspiration

Cause: Usually affect people who work in hot environments and are heavy perspirers. May result from too great or too quick consumption of cold drinks. Caused by loss of salt from body.

Care: Remove patient to cool place. Provide with sips of Gatorade (or equivalent). Apply manual pressure to cramped muscle.

HEAT EXHAUSTION

Symptoms: weak pulse & generalized weakness
rapid and shallow breathing
pale, clammy skin
profuse perspiration
dizziness/unconsciousness

Cause: To aid in cooling of body, large amount of blood is sent to surface area. In upright position, much blood also in lower extremities. This may lead to inadequate return of blood to heart, causing physical collapse.

Care: Remove patient to cool place and remove clothing as possible. Provide with cool water, "Gatorade" or equivalent. Fan to cool but do not chill. Treat for shock.

HEAT STROKE

Heat stroke is the most severe heat-related medical emergency and represents a profound collapse of the body's heat-regulating mechanism. It is a serious threat to life, with a twenty-percent mortality rate. Alcoholics are extremely susceptible to this condition.

Symptoms:	dry, hot, flushed skin dilated pupils fast pulse early loss of consciousness breathing pattern - initially deep, later shallow or almost absent muscle twitch (eventually convulsions) body temperature of 105 degrees F or greater
Cause:	Direct exposure to sun, poor air circulation, poor physical condition, advanced age (over 40)
Care:	Patients suffering from heat stroke should be regarded as EXTREME MEDICAL EMERGENCY and transported to a medical facility as soon as possible. Remove to cool place and remove clothing as possible. Assure open airway. Douse body with water or wrap in wet sheet or cloths. Apply cold packs under arms, around neck, at ankles. Assist during convulsions to protect from injury.

COLD WEATHER CONDITIONS

Hypothermia is an acute problem resulting from prolonged cold exposure and heat loss. This is almost always the result of improper dress. Compounding the problem is the fact that as an individual becomes fatigued during physical activity, he will be more prone to heat loss, and, as exhaustion approaches, sudden dilation of the blood vessels occurs, with the resultant rapid loss of heat.

In general, proper dress can be worn in the field to protect from the occurrence of hypothermia. The use of protective tyvek coveralls also aids in this, in that they are effective in shielding the body from winds, and maintain an insulating air layer between the coverall and the clothing.

Frostbite is the greatest threat to the field worker during cold weather. Frostbite occurs when there is actual freezing of the tissues. The theoretical freezing point of the skin is about 30 degrees F; however, with increasing wind velocity, heat loss is considerably greater, and the frostbite will occur more rapidly.

Because the face is generally exposed during field work, it is highly susceptible to frostbite. Care should be taken to ensure that the facial skin does not approach freezing temperatures. At the first signs of numbness or stinging, the worker will retire to a warm environment and allow the face to warm-up. When possible, wind-blinds may be constructed to shield workers from prevailing winds.

The hands and feet must also be carefully protected from frostbite. Proper footwear, both insulated and waterproof, should be worn at all times. Inner glove liners, made of cotton or similar material, will aid in keeping the hands warm. Care should be taken to keep the hands and feet from becoming overly cold. At the first signs of numbness or stinging, the worker will find appropriate warm shelter and allow the feet and hands to warm thoroughly before returning to work.

RDL/jap/JFK
[jap-601-89b]

American
Red Cross

WIND CHILL CHART

Madison Location
Dane County Chapter
1202 Ann Street
P.O. Box 603
Madison, Wisconsin 53701

Wind speed in MPH	ACTUAL THERMOMETER READING (F.)									
	50	40	30	20	10	0	−10	−20	−30	−40
	EQUIVALENT TEMPERATURE (F.)									
calm	50	40	30	20	10	0	−10	−20	−30	−40
5	48	37	27	16	6	−5	−15	−26	−36	−47
10	40	28	16	4	−9	−21	−33	−46	−58	−70
15	36	22	9	−5	−18	−36	−45	−58	−72	−85
20	32	18	4	−10	−25	−39	−53	−67	−82	−96
25	30	16	0	−15	−29	−44	−59	−74	−88	−104
30	28	13	−2	−18	−33	−48	−63	−79	−94	−109
35	27	11	−4	−20	−35	−49	−67	−82	−98	−113
40	26	10	−6	−21	−37	−53	−69	−85	−100	−116
Over 40 MPH (little added effect)	LITTLE DANGER (for properly clothed person)				INCREASING DANGER (Danger from freezing of exposed flesh)			GREAT DANGER		

APPENDIX B

h·nu
systems inc.

INSTRUCTION MANUAL
FOR
MODEL PI 101
PHOTOIONIZATION ANALYZER

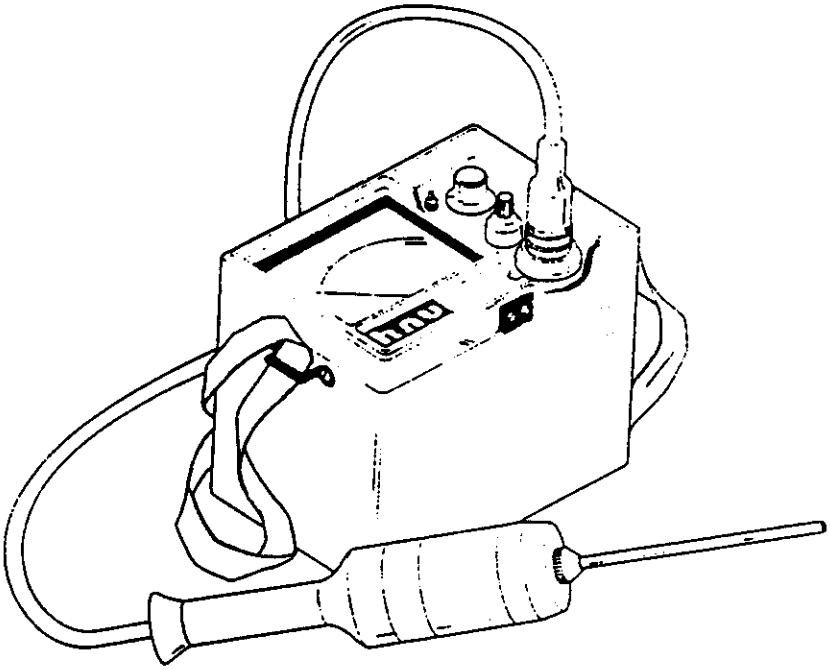


TABLE OF CONTENTS

NOTE

This manual contains operation, service, and maintenance information for HNU Model 101 Photoionization Analyzers equipped with the 10.2 eV lamp and calibrated for direct reading in ppm vol/vol of benzene.

Specific information relative to units equipped with an 11.7 eV or 9.5 eV lamp or calibrated on species other than benzene is contained in the addendum at the back of the manual.

ERRATA

Page		
25	Figure 7	Electrical Block Diagram of Photoionization Analyzer
		Readout Assembly: Point 19 Fan Voltage (DC)
44	Table XVIII	Relative Sensitivities for Various Gases

Species	Photoionization Sensitivity
Ethylene	1.0

52 Power Supply PC Board

Pads	Voltage
18	+19.4V

SECTION 1

INTRODUCTION

The model PI 101 has been designed to measure the concentration of trace gases in many industrial or plant atmospheres. The analyzer employs the principle of photoionization for detection. This process is termed photoionization since the absorption of ultraviolet light (a photon) by a molecule leads to ionization via:

$$RH + h\nu \rightarrow RH^+ + e^-$$

where RH = trace gas

$h\nu$ = a photon with an energy $\geq$ Ionization Potential of RH

The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not ionize the major components of air such as O_2, N_2, CO, CO_2, or H_2O. A chamber adjacent to the ultraviolet source contains a pair of electrodes. When a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the current (proportional to concentration) is measured.

To minimize adsorption of various sample gases, the ion chamber is made of an inert fluorocarbon material, is located at the sampling point, and a rapid flow of sample gas is maintained through the small ion chamber volume.

The analyzer will operate either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger. A solid state amplifier board in the probe and a removable power supply board in the readout module enable rapid servicing of the unit in the field.

The useful range of the instrument is from a fraction of a ppm to about 2,000 ppm. For measurement at levels above 2,000 ppm, dilution of the sample stream with clean air is recommended. Some typical specifications for the model PI 101 Photoionization Analyzer are given in Table 1.

TABLE 1

SPECIFICATIONS FOR MODEL PI 101
PHOTOIONIZATION ANALYZER

performance (benzene referred)

range 0.1 to 2000 ppm
detection limit 0.1 ppm
sensitivity (max) 0-2 ppm FSD over 100 division meter scale
repeatability ± 1% of FSD
linear range 0.1 to 600 ppm
useful range 0.1 to 2000 ppm
response time < 3 sec to 90% of full scale
ambient humidity to 95% RH
operating temperature ambient to 40°C*

physical

size:	probe 6.3 DIA x 28.5L (cm)	(2-1/2 x 11-1/4")
	readout 21W x 13D x 16.5H (cm)	(8-1/4 x 5-3/16 x 6-1/2")
	stowed 21W x 13D x 24H (cm)	(8-1/4 x 5-3/16 x 9-1/2")
	cable 80 cm long (32")	

weight: probe .55 kg (20 ounces)
readout 3.2 kg (7 pounds)
total (shipping) 5.4 kg (12 pounds)

controls and functions

mode switch Off, Battery Check, Standby (zero), 0-2000, 0-200, 0-20 ppm
low battery indicator light
zero (10 turn ± 300% FSD max)
span (10 turn counting dial 1.0 to 10 times nominal sensitivity)
readout 4-1/2" (11.3 cm) meter Taut Band movement graduated 0-5-10-15-20, divisions
signal output for recorder 0-(-5V) FSD
power output for recorder 12 VDC - jack on side of instrument

power requirements of operating times

continuous use, battery > 10 hours
continuous use with HNU recorder reduces instrument battery operating time to 1/2 normal time
recharge time, max < 14 hours, 3 hours to 90% of full charge
recharge current, max .4 Amps @ 15 VDC

TABLE 1 (Continued)

construction

Designed to withstand the shock and abuse to which portable instruments are often subjected. The readout is housed in a two piece aluminum case, and finished with a solvent resistant baked acrylic textured paint.

The probe is fabricated from extruded aluminum sections and machined plastic.

serviceability

The probe and readout are of a modular design allowing rapid servicing and/or replacement of mechanical and electrical components. All module interwiring includes quick disconnects.

maintenance

The instrument contains only one moving part, and consumes no gases or reagents. The only routine maintenance procedure is cleaning the light source window every several weeks.

calibration check

Check instrument calibration at least once per week with HNU calibration standard to ensure that the high sensitivity of the instrument is maintained.

* Instrument is temperature compensated so that a 20°C change in temperature corresponds to a change in reading of $< \pm 2\%$ full scale at maximum sensitivity.

SECTION 2

OPERATION

2.1 Unpacking

Unpack the instrument carefully and remove the housing, the probe and any spare parts from the shipping carton. Place the instrument on a table or bench with the label upright. Remove the top section of the instrument by opening the two fasteners on the cover (see figure 1). The inner panel of the top section can be removed by pulling up on the fasteners. The top section of the instrument contains the battery charger and a waist strap. The waist strap clips on to the strap brackets of the instrument when needed.

Before attaching the probe, check the function switch on the control panel to make sure it is in the off position. The 12 pin interface connector for the probe is located just below the span adjustment on the face of the instrument (see figure 2). Carefully match the Alignment Key in the probe connector to the 12 pin connector on the control panel, and then twist the probe connector until a distinct snap and lock is felt.

Attached to the instrument is a warranty card which should be filled out completely and returned to HNU Systems.

2.2 Operation

Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scaleplate. If the needle is in the lower portion of the battery arc, the instrument should be recharged prior to making any measurements. If red LED comes on, the battery should be recharged.

Next, turn the function switch to the on position. In this position the UV light source should be on. Look into the end of the probe to see the purple glow of the lamp.

A brief description of the instrument controls and functions is shown in Figure 2.

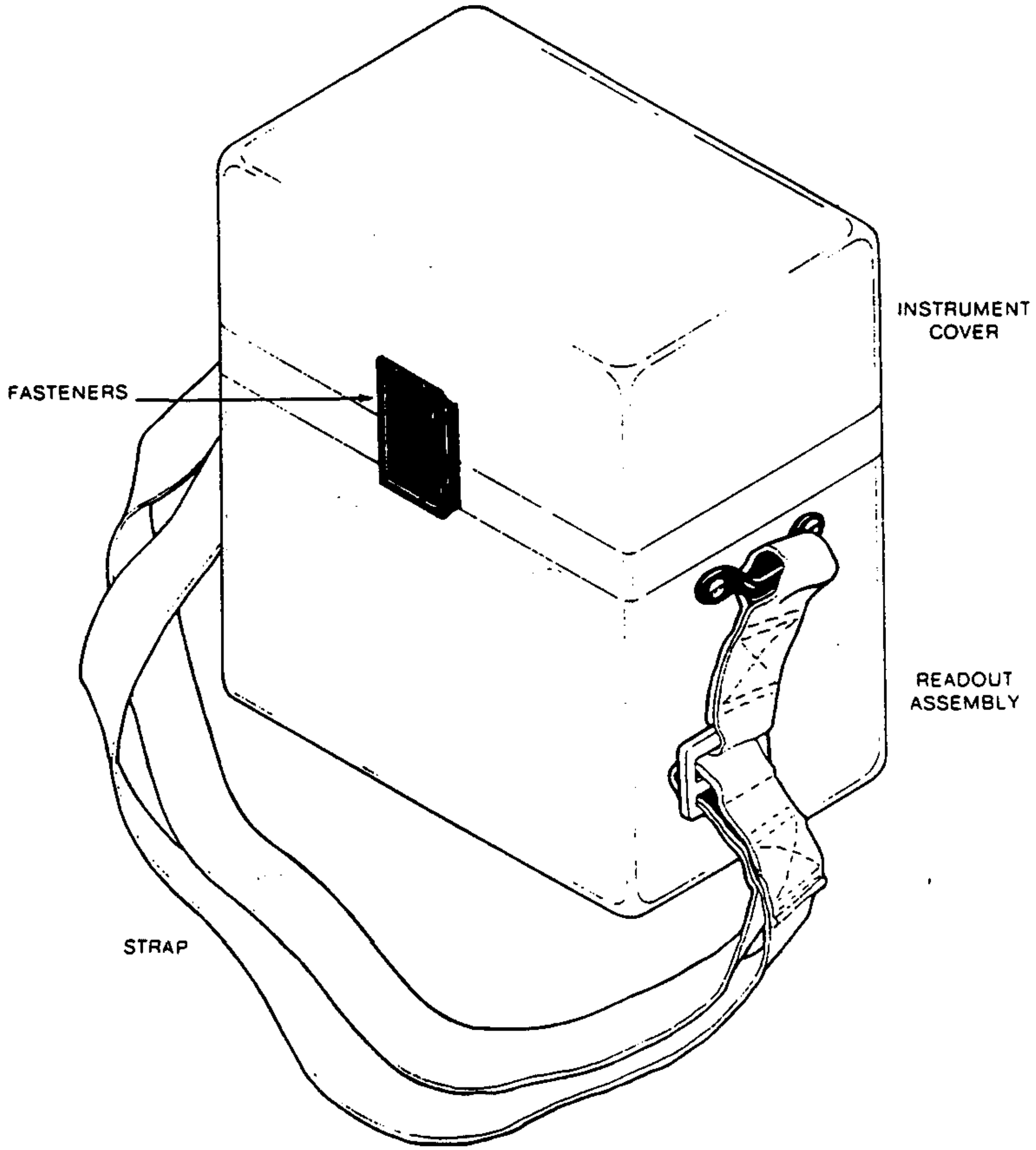


Figure 1. Unpacking the Photoionizer

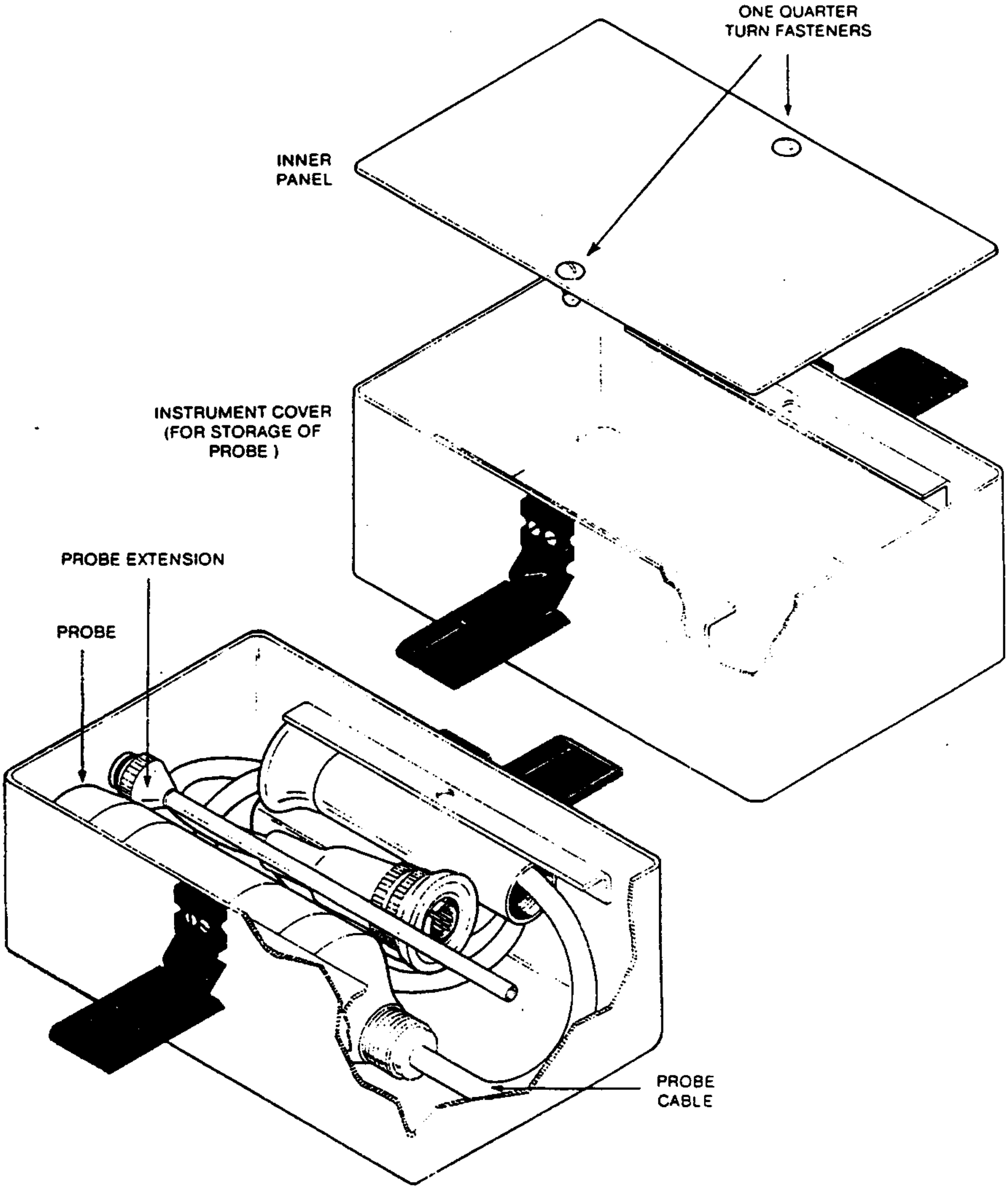


Figure 1. (Continued)

TABLE II

BRIEF DESCRIPTION OF INSTRUMENT CONTROLS AND FUNCTIONS*

Control	Function
Six Position Switch	OFF - Shuts off all power and removes DC voltages.
	ON - In any other function position or measuring mode, the electronics are on.
	BATTERY CHECK - Indicates the condition of the battery. If needle position is in lower portion of green battery arc, the instrument should be recharged.
	STANDBY - UV lamp is off but electronics are on. This position will conserve power and extend the useful operating time between recharges of the battery. This position is also utilized to adjust the electronic zero.
	RANGES - 0-20, 0-200, 0-2000 direct reading ranges available at minimum gain for benzene. More sensitivity is available by adjusting the span potentiometer.
Zero Potentiometer	A ten turn potentiometer is employed to adjust the zero electronically when the instrument is placed in the standby position with the probe attached. This eliminates the need for a hydrocarbon free gas.
Span Potentiometer	A ten turn counting potentiometer is utilized for upscale setting of the meter on calibration gas. Counter-clockwise rotation increases the sensitivity (~10 times). This pot can increase the sensitivity to make the instrument direct reading for nearly any gas which the instrument responds to.

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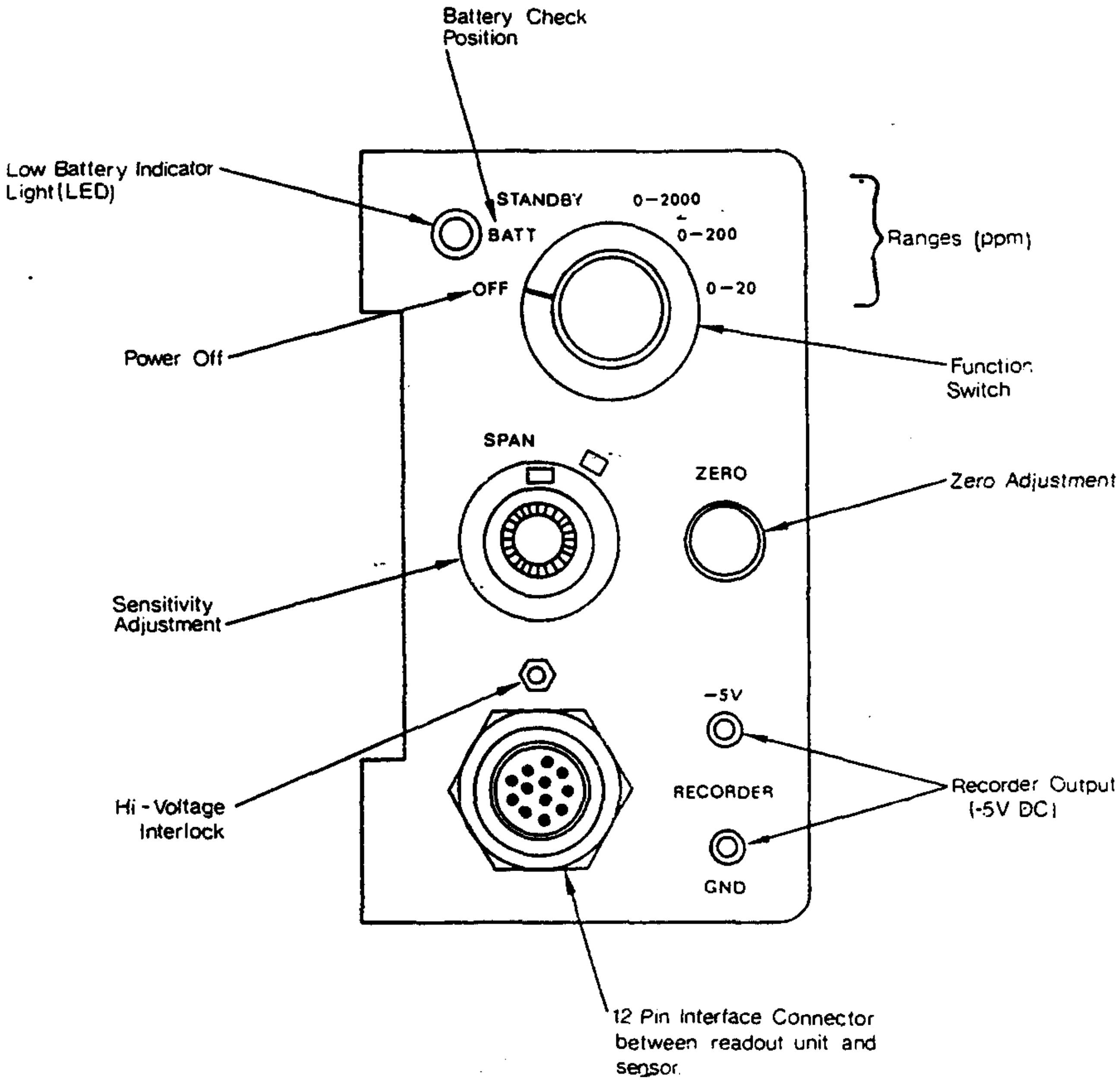
*For position of layout controls see Figure 2.

Figure 2 Control Panel Functions



To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counterclockwise rotation yields a downscale deflection. Note: no zero gas is needed, since this is an electronic zero adjustment (see below). If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 or 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

The instrument is now ready for calibration or measurement by switching the function switch to the proper measurement range. The instrument is supplied calibrated to read directly in **ppm (v/v) 0-20, 0-200, 0-2000 of benzene with the span position set at 9.8**. For additional sensitivity, the span potentiometer is turned counterclockwise (smaller numbers) to increase the gain. By changing the span setting from 10.0 to 1.0 the sensitivity is increased approximately ten fold. Then, the 0-20, 0-200, and 0-2000 ppm scales become 0-2, 0-20, and 0-200 ppm full scale, respectively. This span control is also utilized to make the instrument scale read directly in ppm of the compound being measured. E.g., it is adjusted to match the value of a calibration gas to that same reading on the instrument scale. The span control can be utilized to calibrate nearly any compound, measured by photoionization, to be direct reading on the 0-20 ppm range. For example, gain settings of 4.5 or 8.9, respectively, will provide direct reading capability (0-20, 0-200 ppm) for vinyl chloride and trichloroethylene, respectively. For a listing of approximate gain setting values see Table IV.

A small DC operated fan is used to pull air through the photoionization sensor at a flow rate of three to seven hundred centimeters per minute (ca. 0.5 lpm). The fan provides nearly instantaneous response times (Figure 3) while consuming little power. The characteristics of a fan are such that it cannot tolerate a significant pressure drop without affecting the flow rate and therefore either the instrument reading or response time. Since photoionization is essentially a nondestructive technique, changes in flow rate do not affect the signal but if a large pressure drop is imposed at the inlet of the probe, the sample may not reach the sensor.

TABLE III

VERIFICATION OF ELECTRONIC ZERO FOR PHOTOIONIZATION ANALYZER*

Sample	Instrument Reading (ppm)	% of F.S.
Room Air	0.7	35
Room Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.1	5
Zero Air	0.25	12.5
Zero Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.04	2

---

*Maximum Gain = 2 ppm full scale.

TABLE IV

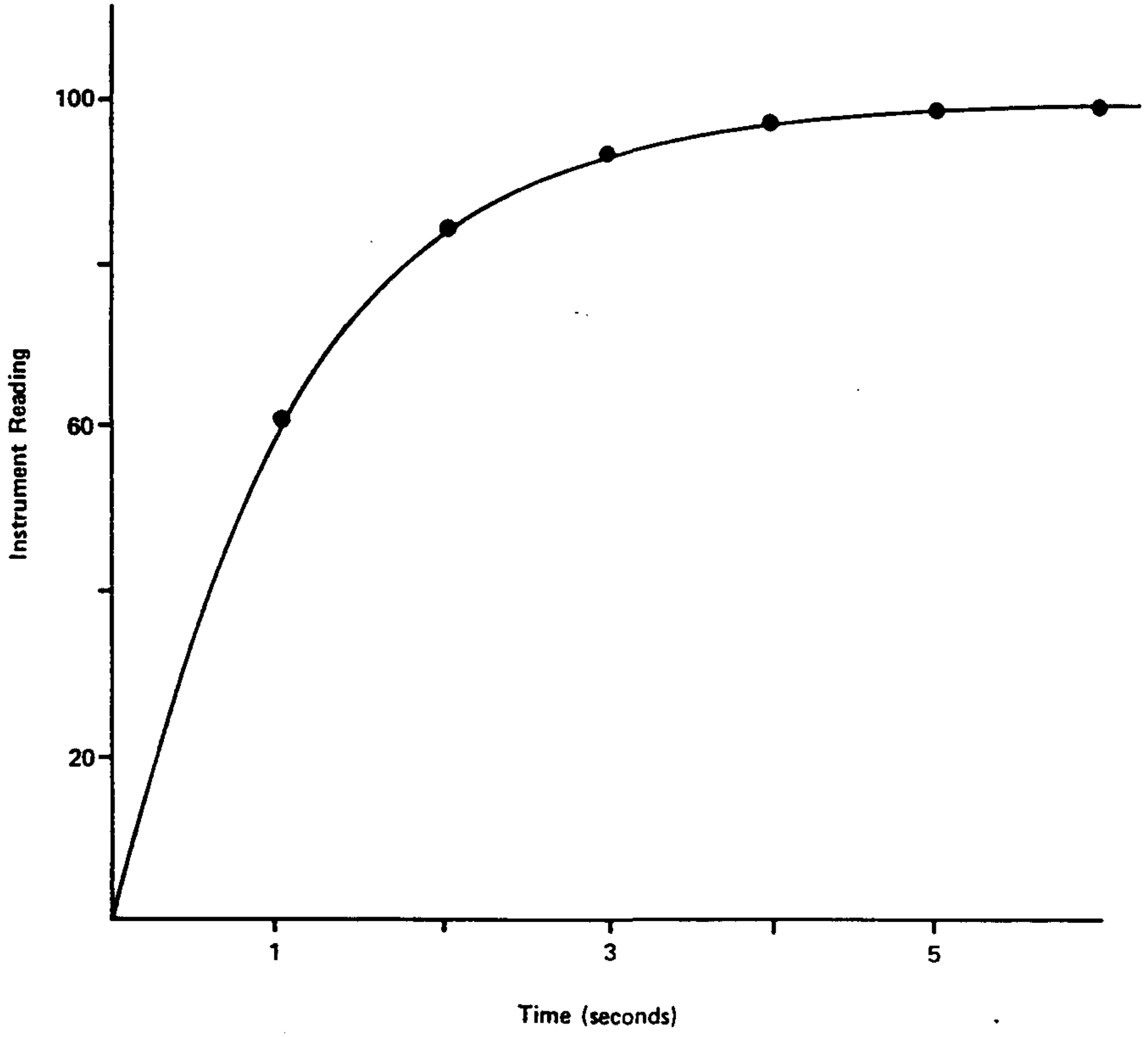
RELATIVE PHOTOIONIZATION SENSITIVITIES* FOR VARIOUS GASES

Chemical Grouping	Relative Sensitivity	Examples
Aromatic	10.0	Benzene, Toluene, Styrene
Aliphatic Amine	10.0	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinvlidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexene
Unsaturated	3-5	Acrolein, Propylene, Cyclohexene, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C_5-C_7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	—
Paraffin (C_1-C_4)	0	Methane, Ethane . . .

---

*Sensitivities in ppm (v/v).

Figure 3. Time Response for the Photoionization Analyzer.



The instrument was designed to measure trace gases over a concentration range from less than 1 ppm to 2000 ppm. Higher levels of various gases (to percentage range) can be measured but the recommended procedure is to dilute the sample with clean air to a concentration of less than 500 ppm. This is generally within the linear range of the instrument and if the measured concentration is multiplied by the dilution ratio the correct concentration in the stream can be determined. A typical calibration curve is shown in Figure 4. Note that the calibration curve for benzene (the photoionization standard) is linear (over more than three decades) up to about 600 ppm (v/v).

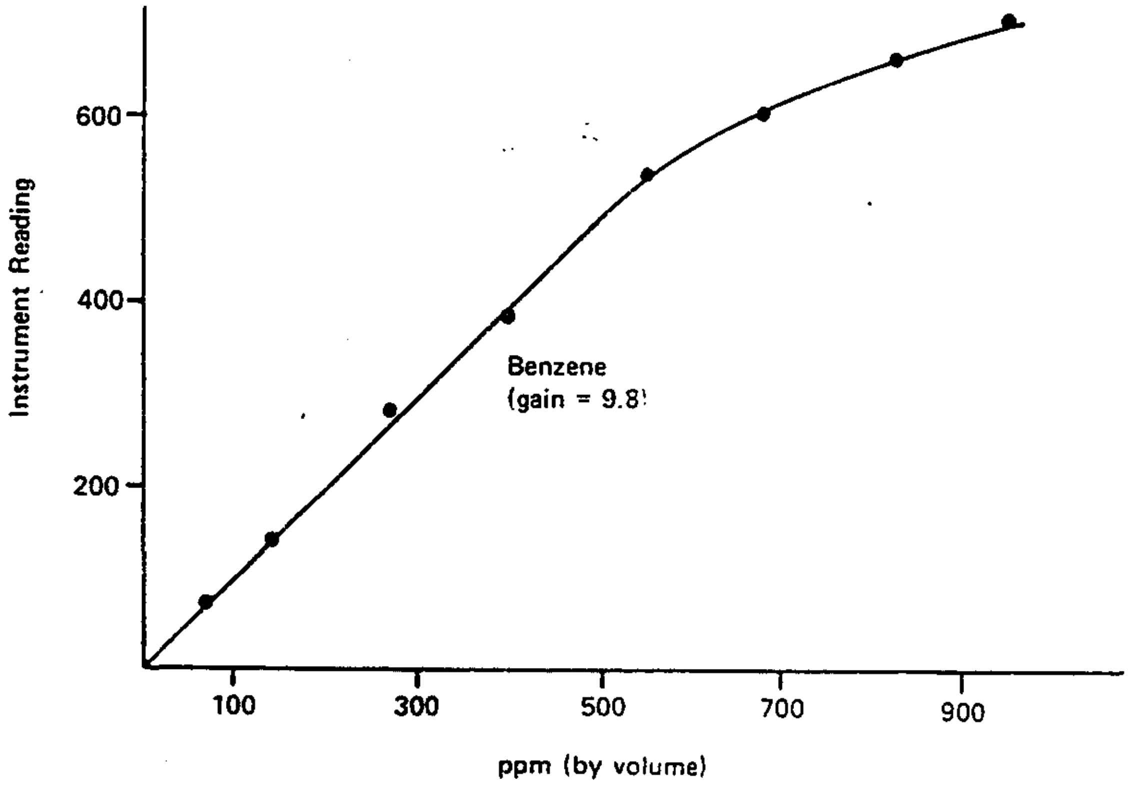
If the probe is held close to AC power lines or power transformers, an error may be observed. For measurements made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area, in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

The instrument is equipped with an automatic solid state battery protection circuit. When the battery voltage drops below ∿ 11 volts, this circuit will automatically turn off the power to the instrument. This prevents deep discharging of the battery and considerably extends the battery life. If the instrument is unintentionally left on overnight, the battery will be unharmed because of the battery protection circuit. If the instrument battery check reads low and the lamp doesn't fire, plug the charger into the instrument. The power to the analyzer should then be returned.

To charge the battery, place the mini phone plug into the jack on left side of the bezel prior to plugging charger into 120 VAC. When disconnecting charger, remove from 120 VAC before removing mini phone plug. The battery is completely recharged overnight (ca. 14 hours). To ensure that the charger is functioning, turn the function switch to the battery check position, place phone plug into jack and plug charger into AC outlet. The meter should go upscale if charger is working and is correctly inserted into the jack.

The instrument can be operated during the recharge cycle. This will lengthen the time required to completely recharge the instrument battery.

Figure 4. Typical Calibration Curve for Photoionization Analyzer.



SECTION 3

CALIBRATION

Static or dynamic gas generation systems can be utilized for calibration of the instrument. A number of such systems for generating test atmospheres for various gases have been described by G. O. Nelson in "Controlled Test Atmospheres," Ann Arbor Science Publishers, Ann Arbor, Michigan (1971).

The most convenient packages for calibration are the non-toxic analyzed gas mixtures available from HNU Systems in pressurized containers (Catalogue #101-350).

A rapid procedure for calibration involves bringing the probe and readout in close proximity to the calibration gas, cracking the valve on the tank and checking the instrument reading. This provides a useful spot check for the instrument.

The recommended and most accurate procedure for calibration of the instrument from a pressurized container is to connect one side of a "T" to the pressurize container of calibration gas, another side of the "T" to a rotameter and the third side of the "T" directly to the 8" extension to the photoionization probe (see Figure 5). Crack the valve of the pressurized container until a slight flow is indicated on the rotameter. The instrument draws in the volume of sample required for detection, and the flow in the rotameter indicates an excess of sample. Now adjust the span pot so that the instrument is reading the exact value of the calibration gas. (If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjuste if necessary.)

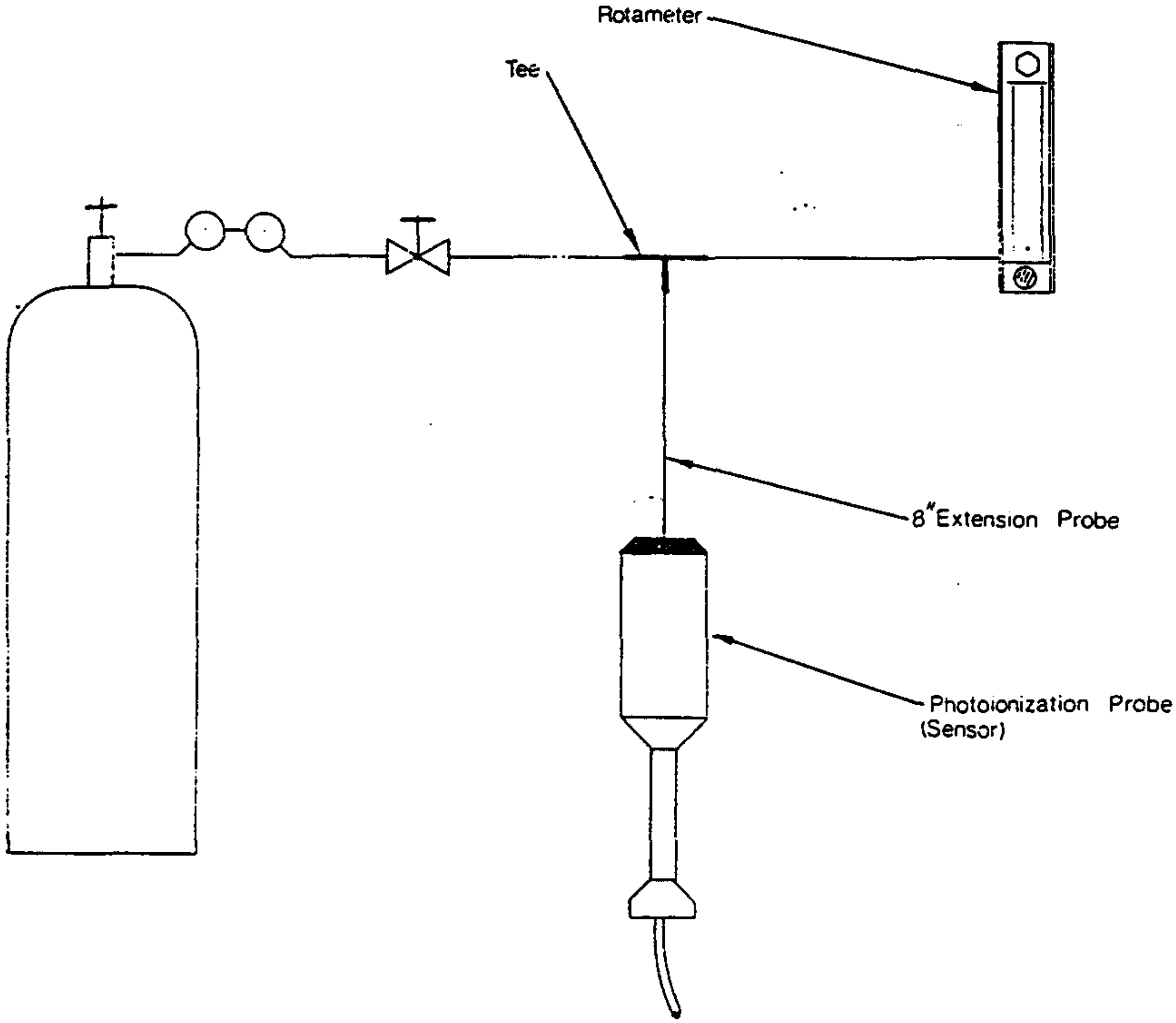


Figure 5. Recommended Calibration Procedure for Photoionization Analyzer

The calibration gas[*] should be prepared in the same matrix (air, nitrogen, hydrogen, etc.) in which it is to be measured, otherwise an inaccurate reading may be obtained. The increased response which is seen in oxygen free gases can be attributed to a reduction in the quenching of ions by oxygen (actually 0_2^-) and is typical of any ionization detector. The quenching effect of oxygen is constant from about ten percent 0_2 to very high levels.

If a gas standard prepared in nitrogen is to be used for measurements in air, fill a 0.5 or 1 liter bag with the standard then add 50 or 100 cc of pure oxygen to bring the level to 10-12%.

Any error between this value and 20% oxygen is quite small.

If the sample to be measured is in nitrogen, standards should be prepared in nitrogen. This will result in an increase in sensitivity of approximately 4.

---

[*] Calibration with toxic gases should be performed in a hood since the 101 is a non-destructive analyzer.

SECTION 4

DETECTION PRINCIPLE AND THEORY

The detection principle of this portable instrument is photoionization. A wide variety of organic compounds and some inorganic conpounds can be measured with this technique. Photoionization (with ~ 10 eV photons) applied to the analysis of trace gases in air can eliminate fragment ion formation (signals) from the major components of air yet still allow the ionization of many impurities of interest in industrial atmospheres. This is demonstrated by the listing of ionization potentials* in Tables V-XVII. Note the high (12 eV) ionization potentials for the major components of air. In addition, the choice of a sufficiently low ionization energy often permits the selective ionization of one or two components in a complex gas mixture.

While the ionization potential serves as a rough guide to whether or not a response is obtained, it does not predict what the quantitive response actually is. In some cases, a species with an ionization potential 10.3 or 10.4 eV will give a response. In these cases, however, the response is usually low because of its low ionization efficiency at 10 eV. A partial list of actual relative sensitivities obtained with a photoionization analyzer is given in Table XVIII. The use of the tables should allow a determination of the specificity of the instrument in a given application on many industrial processes; this instrument may not respond to the starting materials or by-products but will respond to a product. An example of this is seen in the vinyl chloride monomer plants where neither ethylene or dichloroethane is detected but vinyl chloride is detected.

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* Ionization potential is defined as the energy required to move an electron an infinite distance from the nucleus or more simply, the energy required to produce a positive ion and an electron.

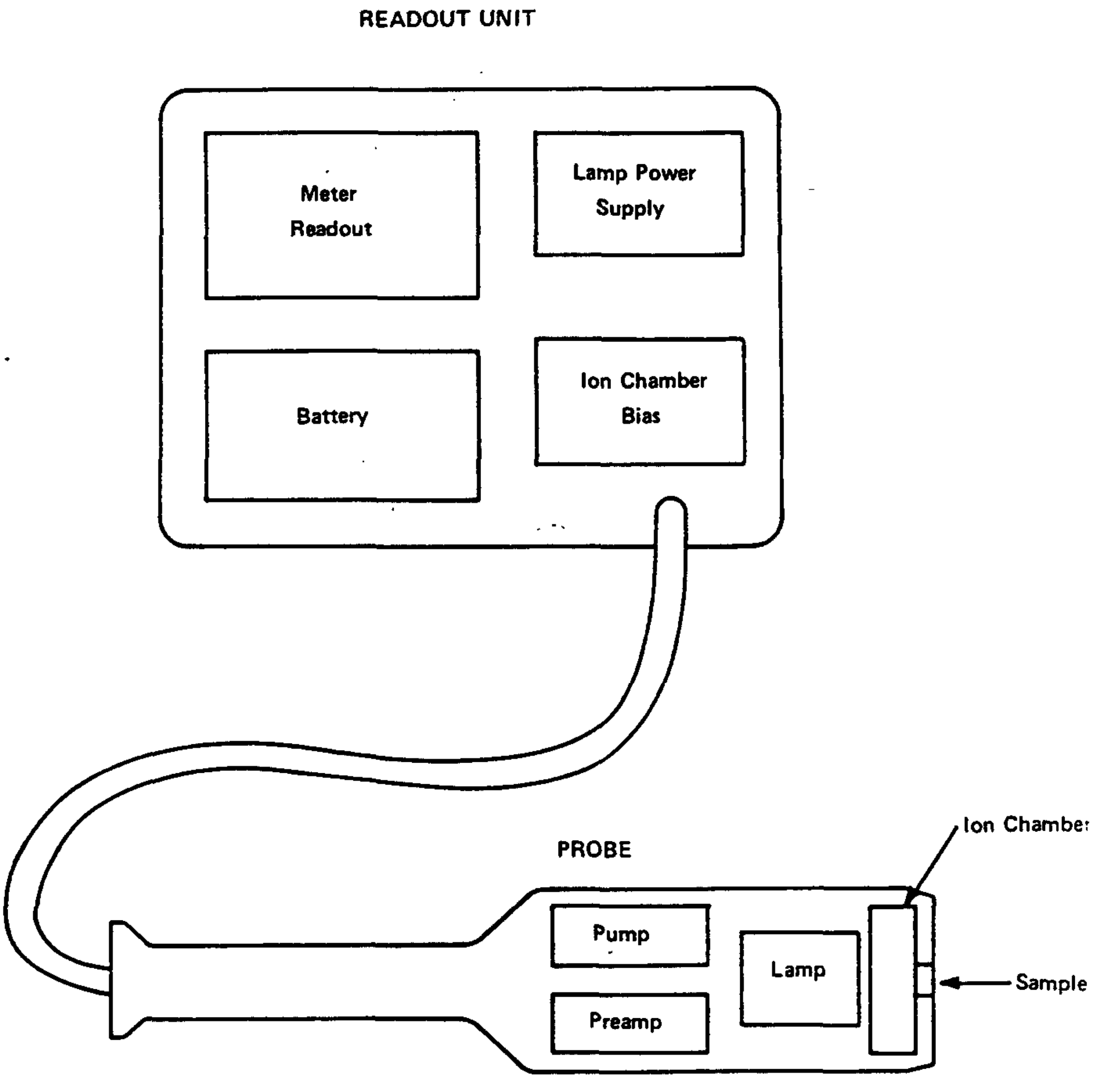

Figure 6. Block Diagram of Portable Photoionization Analyzer.

A block diagram of the major components of the photoionization analyzer is shown in Figure 6. The instrument is separated into two units interconnected by multiconductor electrical cable. The probe contains a fan for moving the air into the sensor, the ultraviolet lamp which is ignited by applying a DC voltage between the anode and cathode, the ionization chamber which contains a pair of electrodes and is adjacent to the lamp, and a signal amplifier. The photons ($\sim$ 10 eV) which are emitted from the lamp pass through a UV transmitting window and into the ionization chamber where absorption of the UV radiation by a molecule which has an ionization potential of 10 eV or less will lead to ion formation via:

$$RH + h\nu \rightarrow RH^{+} + e^{-}$$

A positively biased high voltage electrode is used to push any ions formed by absorption of UV to the collector electrode where the current (proportional to concentration) is measured. This current is then converted to a proportional voltage by the amplifier in the probe. An electrical diagram of the instrument is depicted in Figure 7. The amplifier is gain stabilized by negative feedback and provides a voltage source output to drive the analog meter readout as well as the gain control network. The sensitivity of the instrument is controlled by changing the loop gain of the amplifier. A 12 volt battery provides the primary power for a high efficiency DC-DC converter which supplies the various potentials required for instrument operation.

SECTION 5

TROUBLESHOOTING

If problems occur while using the photoionization analyzer, it is recommended that the following troubleshooting guide be followed before consulting the factory.

5.1 General Aid to Fault Determination

Check battery condition. Recharge if necessary (Section 2). Turn the instrument on. Look into the Sample Inlet of the probe unit. A violet colored glow from the UV light source should be observed in all positions of the mode switch except the standby position. If unstable readings are obtained a faulty probe cable or electrical connection could be the problem. To check, hold the probe normally and flex the cable firmly. Watch the meter for fluctuations as the cable is stressed. Individual wires in the readout can be checked in a similar way. Check the coaxial connector on the amplifier board in the probe.

In the more sensitive ranges, a fluctuation in the reading may be noted if a hand or other large object is placed in very close proximity to the probe. This is normal for the instrument and will not result in an error in the measurement as long as the probe is held stationary while the measurement is being taken.

If the probe is held close to AC power lines or power transformers an error may be observed. If measurements are to be made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

5.2 Disassembly of Instrument

PROBE - Turn the function switch to th the probe connector from the readout unit. en near the base of the probe (see Figure 8.) the probe shell in the other, and gently pu t housing from the shell. Loosen the screws the end cap and ion chamber from the lamp ar 1 so that the ion chamber doesn't fall out of ıe slide out of the lamp housing. Turn the enc the top of it; the ion chamber should fall c the top of the lamp housing and tilt slightl of the housing. The amplifier board can be m bly by unsnapping the coaxial connection anc

To reassemble this unit, first slide th Place the ion chamber on top of the lamp hou ng the contacts are properly aligned. Place th and replace the two screws. The screws shou the "O" ring. DO NOT OVERTIGHTEN. Line up housing with the pins inside the probe shell into the probe shell. DO NOT FORCE the asse ly one way.

READOUT UNIT - Turn the function switch the probe from the readout unit before disas Remove the accessory power jack plug. Loose h and, holding the instrument by the bezel, re and control panel can be removed by unscrewi panel, including the function switch, zero a s Electrically disconnecting this module is sir with Molex connectors.

SECTION 5

TROUBLESHOOTING

If problems occur while using the p recommended that the following troublesh consulting the factory.

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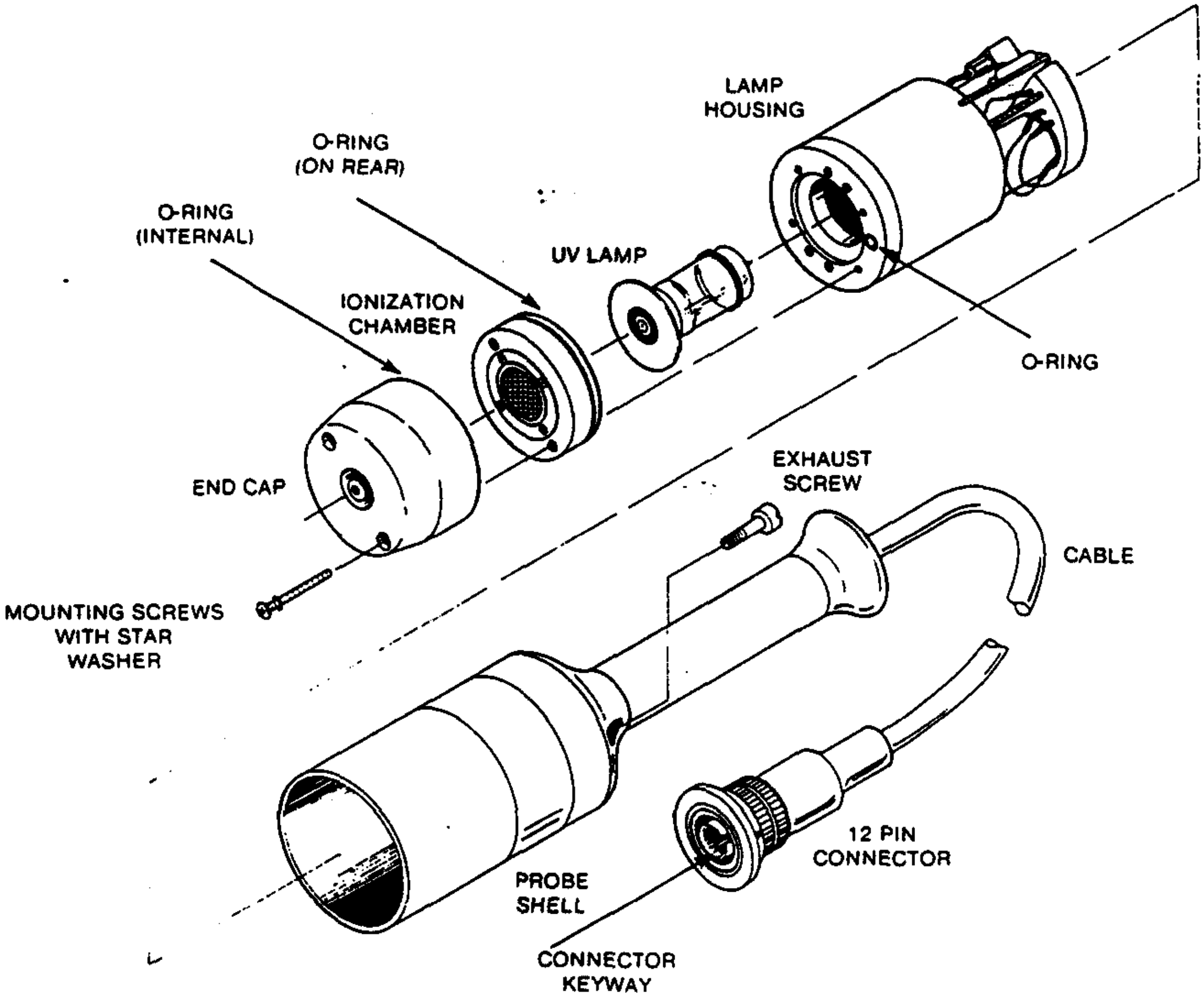


Figure 8. Component Parts of Probe

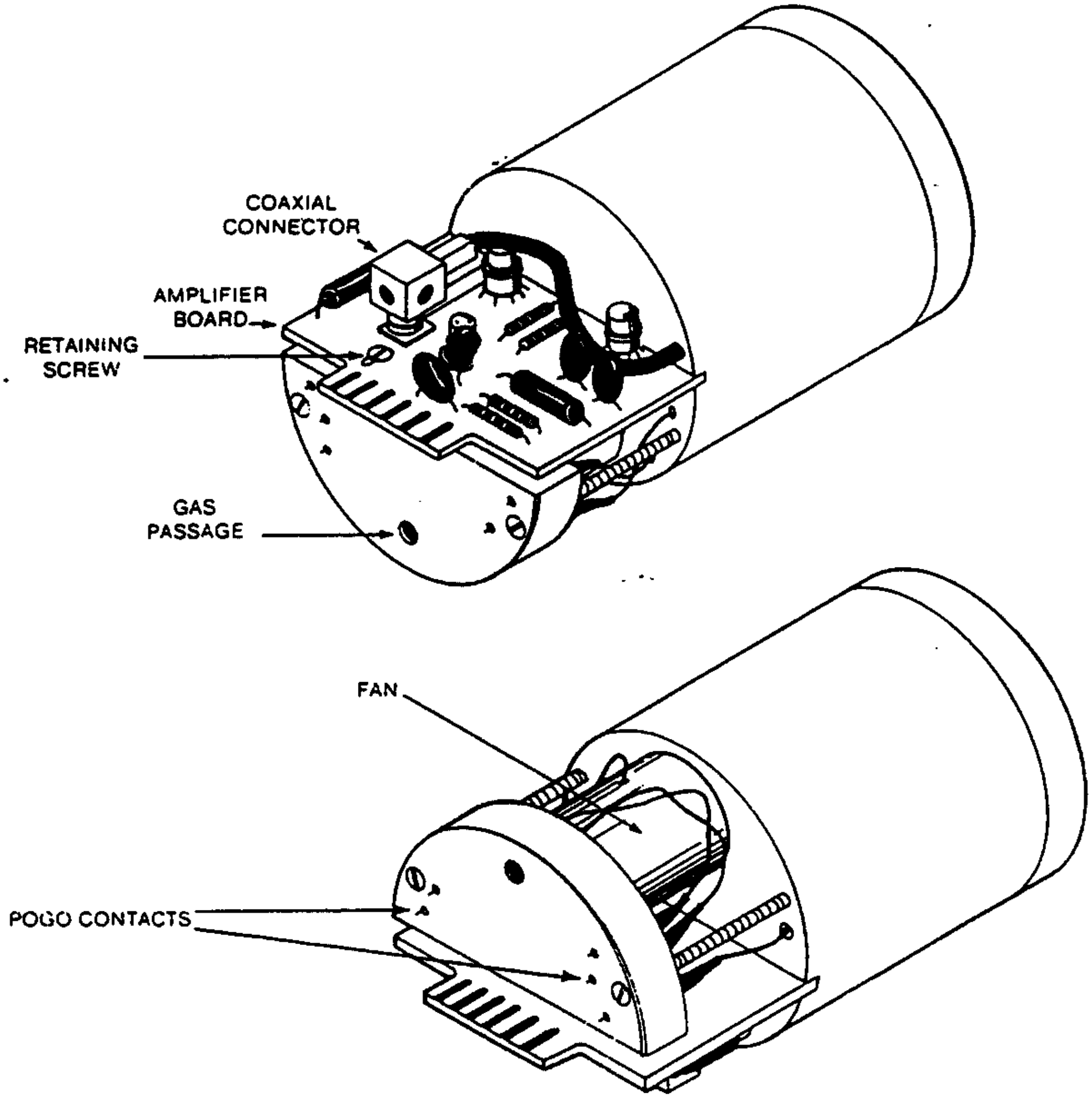


Figure 9. Component Parts of Lamp Housing

5.3 Specific Faults

1. No meter response in any switch position (including BATT CHK)

   A. Broken meter movement

      (1) Tip instrument rapidly from side to side. Meter needle should move freely, and return to zero.

   B. Electrical connection to meter is broken

      (1) Check all wires leading to meter and clean the contacts of quick-disconnects.

   C. Battery is completely dead

      (1) Disconnect battery and check voltage with a volt-ohm meter.

   D. Check 2 amp fuse

   E. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others

   A. Power supply defective

      (1) Check power supply voltages per Figure 11. If any voltage is out of specification, consult the factory.

   B. Input transistor or amplifier has failed

      (1) Rotate zero control; meter should deflect up/down as control is turned.

      (2) Open probe. Both transistors should be fully seated in sockets

   C. Input signal connection broken in probe or readout

      (1) Check input connector on printed circuit board. Should be firmly pressed down.

      (2) Check components on back side of printed circuit board. All connections should be solid, and no wires should touch any other object.

      (3) Check all wires in readout for solid connections.

3. Instrument responds correctly in BATT CHK, AND STBY, but not in measuring mode.

   A. Check to see that light source is on (See General Faults section.)

      (1) Check high voltage power supply (see Figure 11).

      (2) Open end of probe, remove lamp and check high voltage on lamp contact ring.

      (3) If high voltage is present at all above points, light source has most likely failed. Consult the factory.

4. Instrument responds correctly in all positions, but signal is lower than expected.

   A. Check span setting for correct value.

   B. Clean window of light source

   C. Double check preparation of standards. See Section 3.

   D. Check power supply 180 V output. See Figure 11.

   E. Check for proper fan operation. Check fan voltage. See Figure 11.

   F. Rotate span setting. Response should change if span pot is working properly.

5. Instrument responds in all switch positions, but is noisy (erratic meter movement).

   A. Open circuit in feedback circuit. Consult the factory.

   B. Open circuit in cable shield or probe shield. Consult the factory.

6. Instrument response is slow and/or irreproducible.

   A. Fan operating improperly. Check fan voltage. See Figure 11.

   B. Check calibration and operation. See Sections 2 and 3.

7. Low battery indicator.

   A. Indicator comes on if battery charge is low.

   B. Indicator also comes on if ionization voltage is too high.

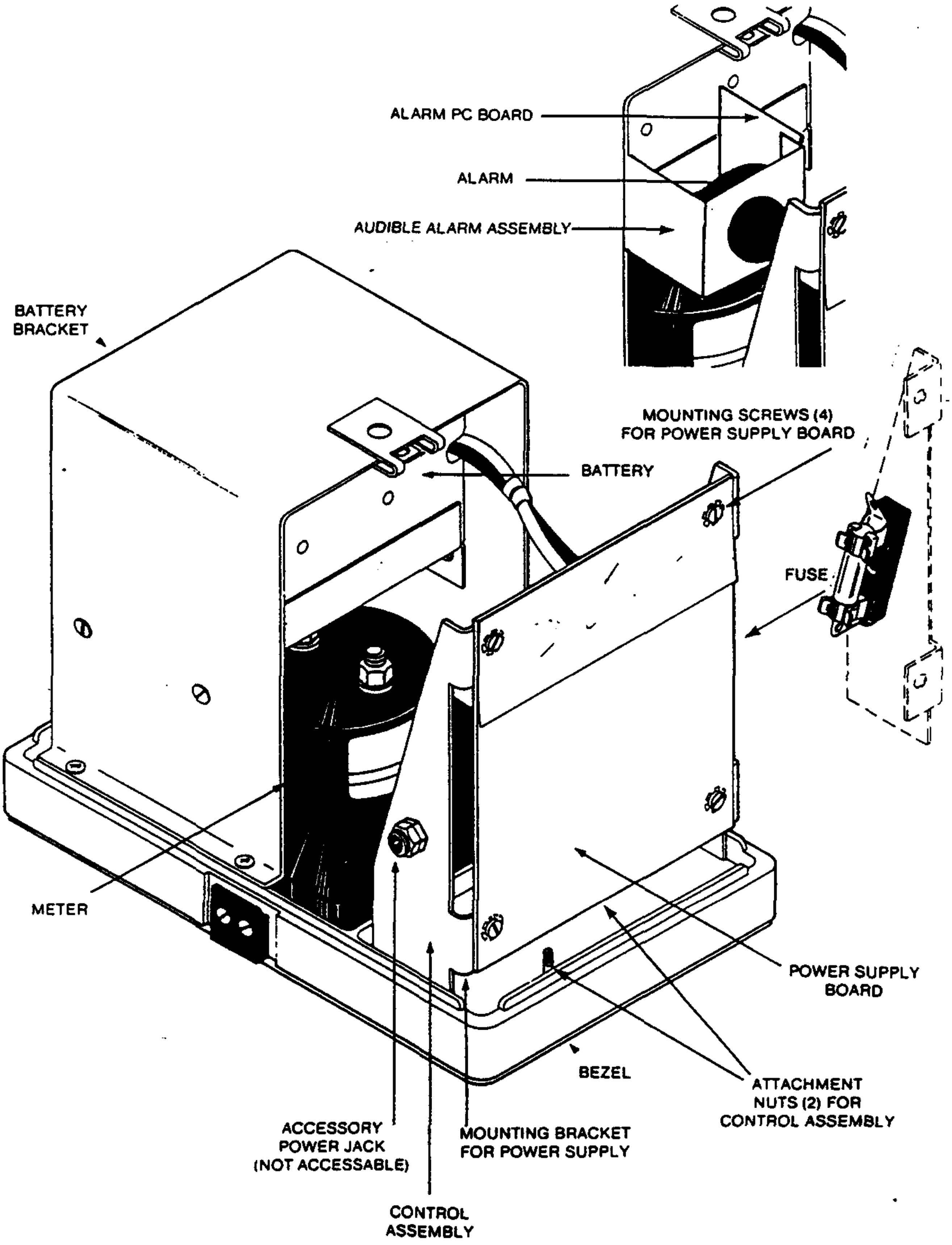
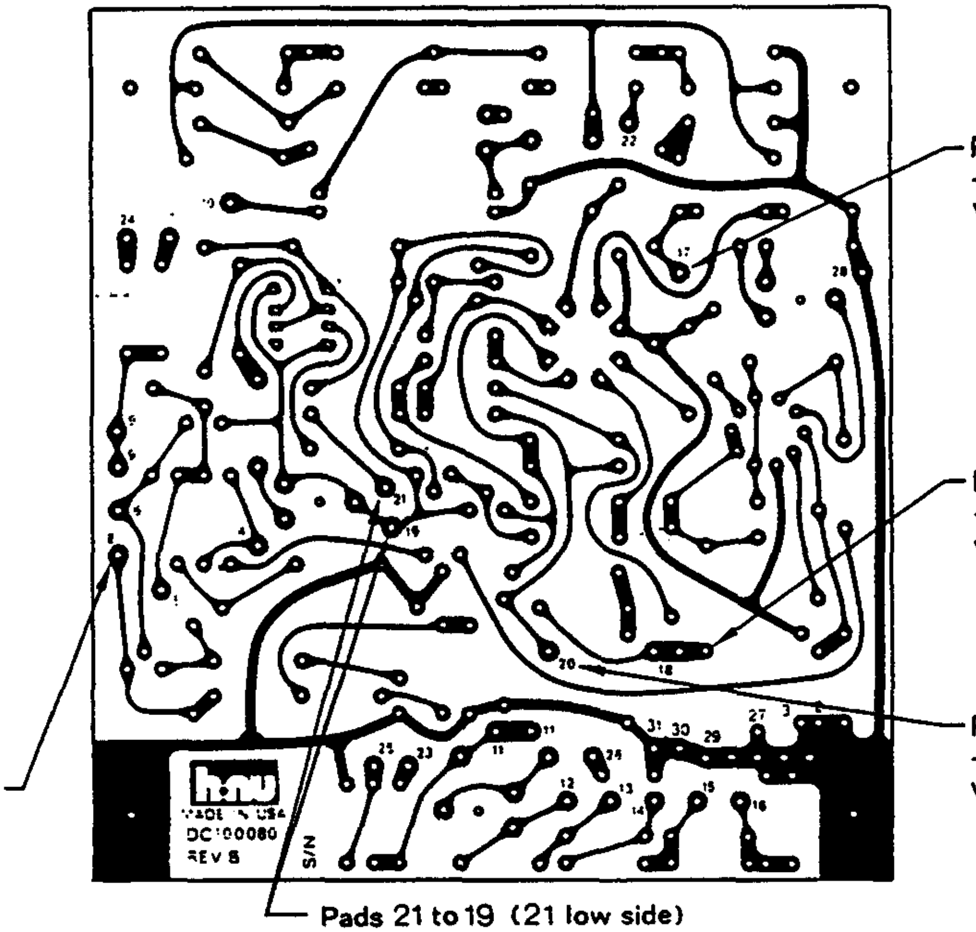


Figure 10. Component Parts of Readout Unit

1. All voltages measured with probe connected and instrument mode switch in BATT CHK position.
2. All measurements referred to ground (pads 2,3 and 27) except pad 21 measured to pad 19 and pad 8 to pad 11.



Pad 17
+180 to +181
Volts

Pad 18
+18 to +21
Volts

Pad 20
-9.5 to -10.5
Volts

ad 8 -11 to
-14 Volts
Battery Voltage

Pads 21 to 19 (21 low side)
(4.5 to 5.5 Volts)

All Voltages Respect to Ground							
pads	voltage	pads	voltage	pads	voltage	pads	voltage
1	− 5.7V	9	− 12.2V	17	180V	25	0
2	GRD	10	− 12.1V	18	− 19.4V	26	0
3	GRD	11	0	19	− 10.6V	27	GRD
4	−10 7V	12	0	20	− 9.7V	28	0
5	− 11.3V	13	0	21	− 14.5V	29	GRD
6	− 12.1V	14	0	22	− 400V	30	GRD
7	0	15	0	23	0	31	GRD
8	− 12.2V	16	0	24	0		

Figure 11 Power Supply PC Board

REPLACEMENT PARTS LIST

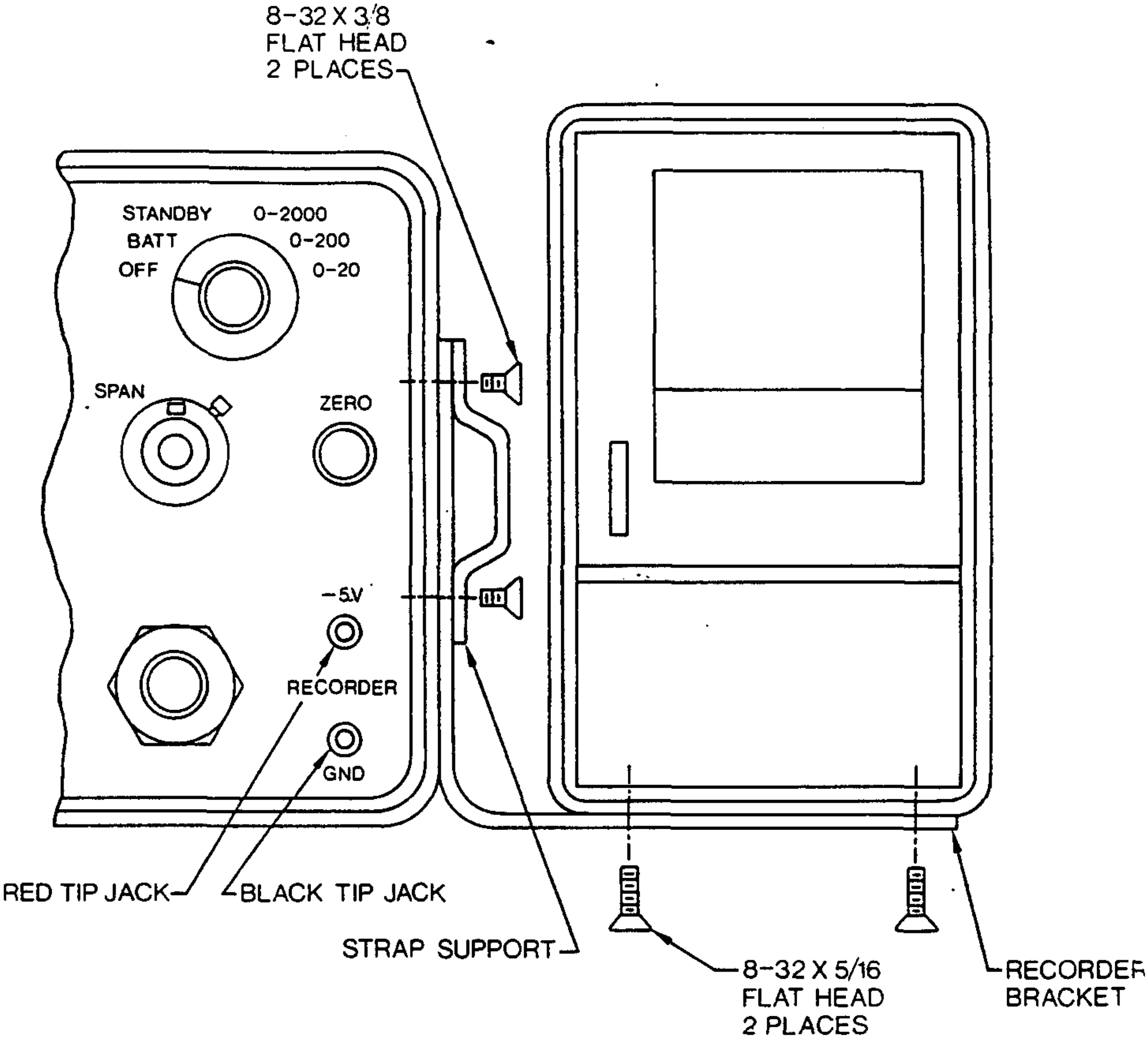
MODEL PI-101

PART NO.	ASSEMBLY
79-AC100004	Probe Shell Assembly
79-AC100005A1	Ion Chamber Assembly, sm. aperture
79-AC100005A2	Ion Chamber Assembly, sm. aperture, gold
79-AC100005A3	Ion Chamber Assembly, lg. aperture
79-AC100005A4	Ion Chamber Assembly, lg. aperture, gold
79-AC100107	Fan/Light Source Assembly
79-AB100059	Amplifier Board
79-PA100010	"O" Ring Kit
79-AA100012	Battery
79-AC100013A1	Charger, 115 Volt
79-AC100013A2	Charger, 240 Volt
45-DA101316	Pot (span)
45-DA100029-1	Pot (zero)
79-AA10011	Probe Extension
54-DA100053	End Cap for Probe
54-DA100049	Exhaust Screw
80-101-095	9.5 eV Replacement Lamp
80-101-102	10.2 eV Replacement Lamp
80-101-111	10.2 eV Selected Lamp (Specify Application)
80-101-117	11.7 eV Replacement Lamp
25-680-402	Front Meter Glass
79-AB100187A1	Probe Cable with Connector ($5/ft. over 3')
18-37-06J-14-12P	12 Pin Connector
18-MDL-2	Fuses, box of 12
10-39-12	Grayhill Switch
79-AB100095	Battery Charger Board
79-AC100082	Power Supply Board
79-AB100536	Audible Alarm Board

PARTS LIST
ACCESSORIES

PART No.	DESCRIPTION
101-300	Portable Recorder Has a 2" chart width with 2"/hour chart speed. Operates on 12 V DC power from analyzer. Complete with multiconductor interface cable for battery power & signal and mounting bracket for attaching recorder to side of analyzer.
101-301	Chart Paper For portable recorder, 6 rolls.
AB100378	Multiconductor Interface Cable For recorder, contains leads for connecting recorder to analyzer. (Included in part 101-300 above)
101-350	Calibration Gas Cylinder Contains 23 liters of span gas in air (300 psi) sufficient for 40-50 calibrations. (4" diameter by 12" high).
101-351	Regulator For use with calibration gas cylinder, Model 101-350, complete with gauges for reading both cylinder pressure and flow.
PA101534	Cleaning Compound For removing deposits from window of 9.5 or 10.2 eV lamp (NOT the 11.7 eV lamp).

SECTION 8
PI-101 RECORDER ASS'Y INSTRUCTIONS



NOTES:

1. Remove strap support on right side of PI-101 case.
2. Mount recorder bracket between case & strap support using 8-32 X 3/8 screws supplied.
3. Mount recorder to bracket using 8-32 X 5/16 screws supplied.
4. Connect harness to plug on rear of recorder. Insert power plug into receptacle on side of case. Insert red pin plug into red tip jack and black pin plug into black tip jack on PI-101 front panel.

SECTION 9

WARRANTY

HNU Systems Incorporated warrants that all items delivered under this order will be free from defects in material and workmanship when used under normal operating conditions. HNU's liability hereunder shall be limited to the repair or replacement of the articles ascertained to be defective within one (1) year after date of shipment (except that the light source warranty is limited to three (3) months and does not include breakage, and battery warranty is limited to three (3) months), provided, however that the Buyer shall give notice to HNU within thirty (30) days after discovery of such defective material and provided further that all defective material be shipped prepaid to the HNU plant within a reasonable time from the date of discovery of the defect and during such warranty period. After the repair or replacement, HNU will ship the said item to Buyer, transportation charges prepaid, to any point in the United States that Buyer may designate.

THE FOREGOING IS THE SOLE EXTENT OF HNU'S WARRANTY AND NO OTHER STATEMENTS OR WARRANTIES, EXPRESSED OR IMPLIED, SHALL BE HONORED. UNDER NO CIRCUMSTANCES SHALL HNU BE SUBJECT TO ANY LIABILITY FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Publications on Photoionization Available from HNU Systems, Inc.

101-10 Industrial Hygiene Monitoring With A Variable
Selectivity Photoionization Analyzer,
J.N. Driscoll and J.H. Becker,
American Laboratory, November 1979.

101-11 HNU Model 101 - Selected Case Histories-Hazardous Waste.

101-12 Instrumentation for "On Site" Survey and Identification
of Hazardous Waste,
J.N. Driscoll and G.F. Gewitt,
Industrial Hygiene News, May 1982

101-17 Instrument Calibration with Toxic and Hazardous
Materials,
J.H. Becker, J.N. Driscoll, D. Renaud, P. Tiffany,
C. Sylvia,
Industrial Hygiene News, July 1983.

ADDENDUM

The following changes to the Instruction Manual should be noted for all Model 101 Photoionization Analyzers equipped with 11.7, 9.5 eV light sources, or calibrated on species other than benzene.

Page

3 Table I

Performance: Consult specifications sheet accompanying instrument.

11 Paragraph 2: *Consult specifications sheet for span setting specific for gas on which instrument was calibrated.*

NOTE: Gain settings listed apply to 10.2 eV lamp. Different gain settings are used with other lamps. Consult factory.

13 Table III

NOTE: Data obtained using 10.2 eV lamp.

14 Table IV

NOTE: Data obtained using 10.2 eV lamp.

18 Figure 4

NOTE: Data obtained using 10.2 eV lamp.

24 Paragraph 1, Line 6: "The photons which are emitted from the lamp, pass through a UV transmitting window and into the ionization chamber where absorption of the UV radiation by a molecule which has an ionization potential equal to or less than the energy of the light source will lead to ion formation via;" (continued)

25 Figure 7: For the 9.5 eV light source, the lamp voltage changes to +450 volts.

HNU MODEL 101 SPECIFICATION SHEET

Serial #____________________

Calibration____________________________ By__________________________

Range:____

Span Pot Setting:____

Light Source Energy: 9.5 eV_____________ 10.2 eV_________ 11.7 eV______

Sensitivity:____

Detection Limit:____

Accessories:____

____

____

____

MDA Scientific, Inc.
405 Barclay Blvd.
Lincolnshire, Illinois 60069
Phone: 800-323-2000 (in IL 312/634-2800)
Telex: 72-6399 MDA-USA • Fax: 312-634-1371

9 85 - 1'

Bedienungsanleitung
Operating Instructions

COMPUR 4100 SD

Monitox HCN

Compur-Electronic GmbH

Gasspurenwarnsystem
COMPUR 4100 SD HCN

Das Gasspurenwarnsystem COMPUR 4100 SD HCN besteht aus

Gasdetektor	(Warngerät mit Anzeige)
Gasgenerator	(Prüfgerät)
Konsole	(empfohlenes Zubehör)
Protokollheft	(empfohlenes Zubehör)

Das System ist speziell für die MAK-Wert-Überwachung ausgelegt.

ACHTUNG!
Trotz der stark vereinfachten Bedienung durch den Endbenutzer ist das Monitox 4100 SD für HCN trotzdem ein komplexes Meßgerät, das eine sichere Funktion nur bei sorgfältiger Beachtung dieser Bedienungsanleitung und regelmäßiger Kontrolle durch die für den Einsatz des Gerätes Verantwortlichen gewährleistet. Dies gilt besonders für den regelmäßigen Zellenersatz sowie den täglichen Funktionstest. Das Einstellen der Warnschwellen liegt ebenso ganz in der Verantwortung des Betriebes; COMPUR empfiehlt die strenge Einhaltung der MAK-Werte. Eine Reparatur ist wegen des Ex-Schutzes nur durch den Hersteller zulässig.

Das Gerät wird von COMPUR mit folgenden Einstellwerten ausgeliefert:

Alarmschwellen:
1. bei MAK = 10 ppm HCN
2. bei 2 MAK = 20 ppm HCN

Die Detektorzelle wird bei HCN Konzentrationen über 1000 ppm irreversibel geschädigt. Dadurch geht die Anzeige nicht mehr auf „Null" zurück. In diesen Fällen muß die Zelle ausgetauscht werden.

Abb. 1
Picture 1

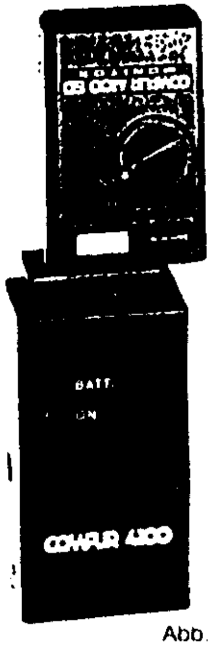
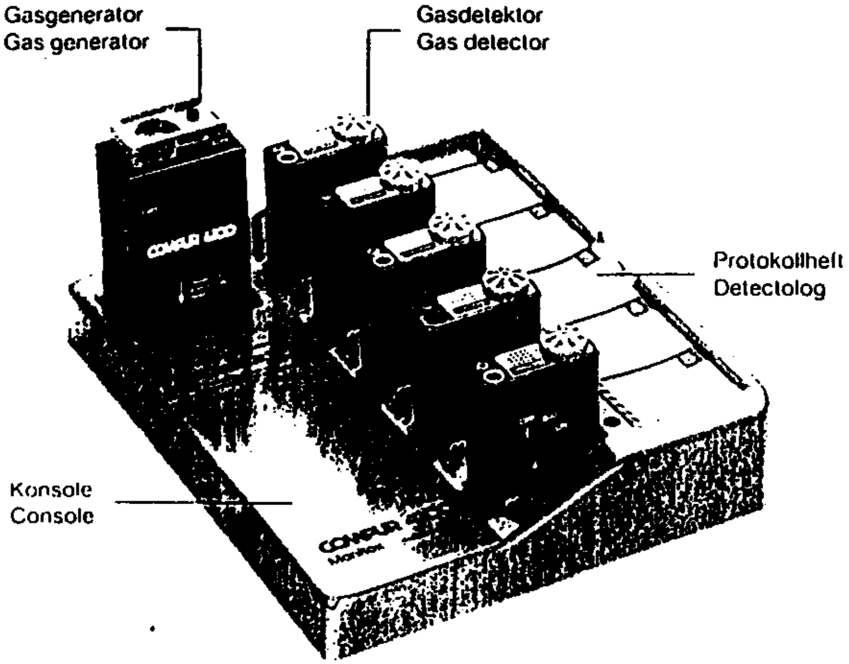


Abb. 2
Pictur



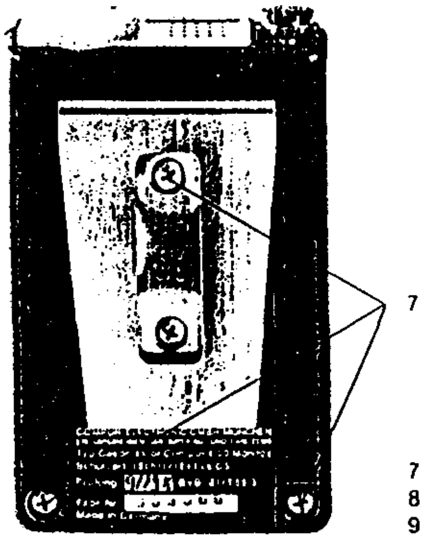


Abb. 3
Picture 3

7	Gehäuseschrauben	7	housing scre
8	Dosimeterstecker	8	dosimeter pl
9	Ohrhörerstecker	9	earphone plu

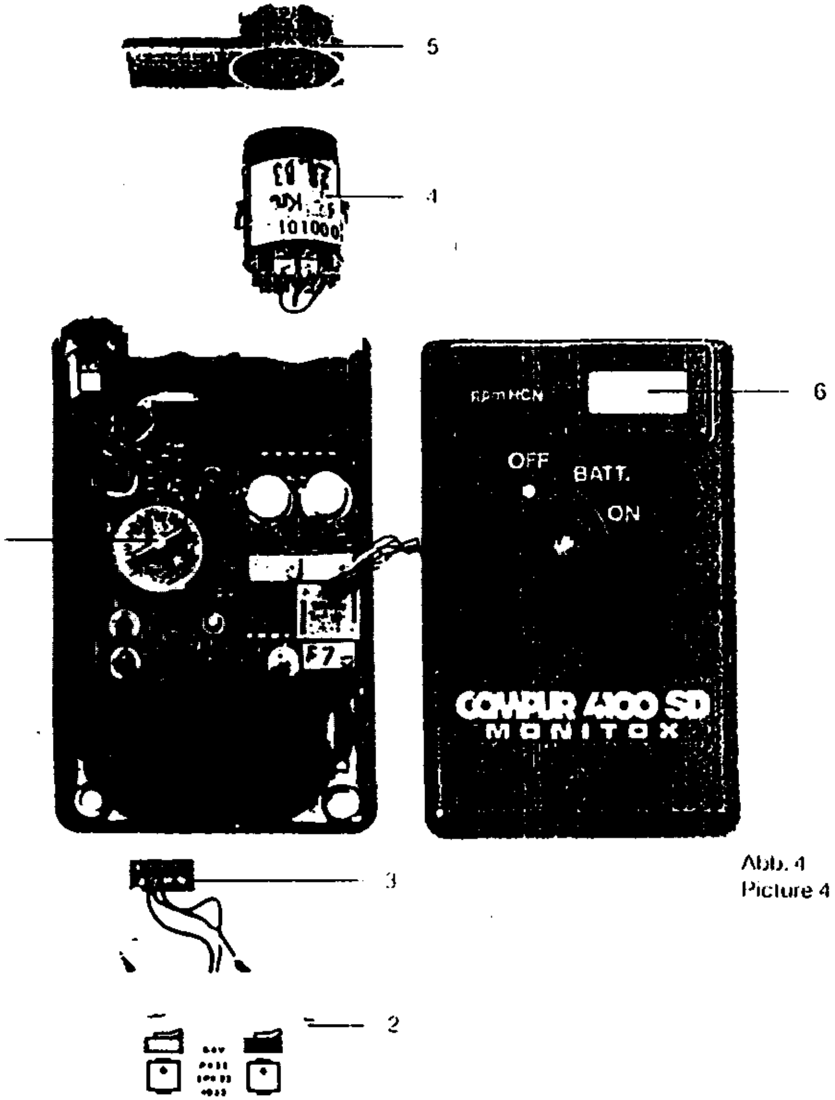


Abb. 4
Picture 4

1 Ein-/Aus-Schalter	1 On-/Off-switch
2 Batteriebehälter	2 battery pack
3 Stecker des Batteriebehälters	3 battery pack connector
4 Detektorzelle	4 detector cell
5 Filterkappe	5 filter cap
6 Display	6 display

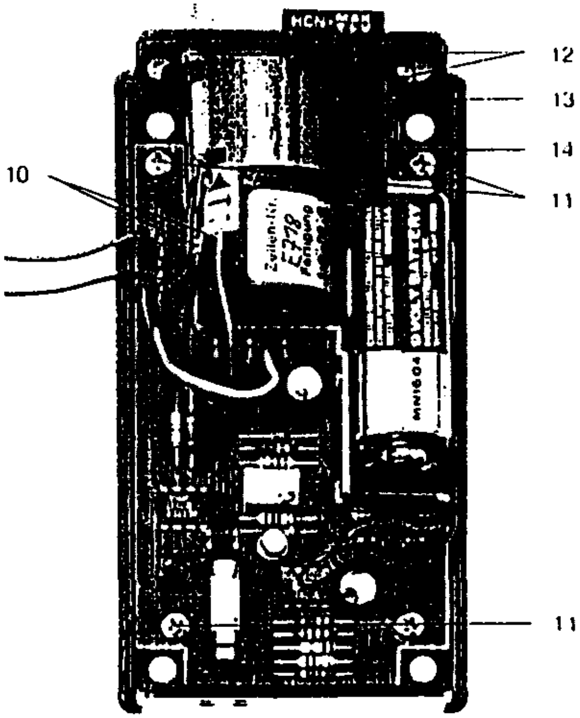


Abb. 5
Picture 5

10 Lüfteranschlüsse	10 fan leads
11 Leiterplattenschrauben	11 pcb-screws
12 Befestigungsschrauben	12 fan screws
13 Schaltstift	13 switch pin
14 Schalter	14 switch

6.

inweise zur Fehlersuche

hler	Hinweis
tterietest Detektor ht nicht	Batterien wechseln (5.1.)
nktionstest mit nerator geht nicht	a) Evtl. mit 2. Detektor nachprüfen, ob Generator o. k., sonst b) b) Filterkappe wechseln (5.2.), wenn nicht verschmutzt, c) c) neue Sensorzelle einbauen (5.3.).
enerator liefert cht genug Gas	Zelle befeuchten, d. h. mit Feuchthaltekappe mehrere Tage stehen lassen, sonst Generatorzelle wechseln (5.4.).
n Generator uchtet rote LED im Test auf	Generatorbatterie ersetzen (5.5.).

6.

Zubehör und Verbrauchsmaterial

Bestellnummern für Verkaufseinheiten

1. Gasdetektor HCN Digitalanzeige, 2 Alarmschwellen mit Dosimeter-Anschluß	U 5306 203
2. Zelle HCN mit Filterkappe	U 5800 103
3. Filterkappe HCN (10 Stück)	U 5810 341
4. Batterie PX 23 (1 Stück)	U 4990 001
5. Gasgenerator HCN	U 5390 300
6. Generatorzelle HCN	U 5820 300
7. Kalibriergasadapter	U 5900 106
8. Meßleitung: Eichen	U 5900 112
9. Digitalvoltmeter	U 5900 018
10. Stromgenerator	U 5900 023
11. Kalibrierkabelsatz für Stromgenerator	U 5900 125
12. Protokollheft	U 5900 004
13. Ohrhörer	U 5900 002

Table of Contents

ıs Detection and Warning System
)MPUR 4100 SD Monitox HCN

ı COMPUR 4100 SD Monitox Gas
ection and Warning System comprises

as detector	(alarm unit with digital display)
as generator	(test unit)
onsole	(recommended accessory)
eteclolog	(recommended accessory)

e system is especially designed to
nitor the TLV of HCN.

AUTION!
though the 4100 SD Monitox for HCN has en highly simplified for ease of operation the user, it is nevertheless a complex easuring instrument which will operate iably only if these operating instructions e carefully observed and if the instrument checked regularly by the safety officer.

This applies in particular to the regular replacement of the cells and daily functional tests. *The responsibility for any changes made in the alarm threshold settings must be borne entirely by the operator;* COMPUR recommends the strict observance of the TLV. Since the unit is designed to be intrinsically safe, all repairs must be made by the manufacturer or other approved personnel.

COMPUR offers the instrument with the following factory settings:
first alarm threshold = at TLV = 10 ppm
second alarm threshold = at 2 TLV = 20 ppm

The detector cell will be destroyed if the detector is permanently exposed to a HCN-concentration exceeding 1000 ppm. In this case the cell has to be replaced.

1.

Technical Description of the COMPUR 4100 SD Monitox Detector for HCN

1.1.

Applications

The COMPUR 4100 SD Monitox is a *personal monitor for HCN.*

It is designed to be worn attached to the clothing near the breathing zone of the person to be protected. The detector produces an audible first alarm when the HCN-concentration exceeds the TLV (factory setting: 10 ppm) and a second alarm, when it exceeds 2 x TLV.

Independent of the alarm setting, the digital display shows the actual HCN-concentration in ppm (parts per million) in the nominal range of 0 – 100 ppm HCN.

In conjunction with the COMPUR 4102 Dosimeter, the unit can be employed to register HCN-concentrations at confined spaces ranging from 0 to 10 x TLV.

The COMPUR 4100 SD Monitox cannot be used to measure process gas streams or in presence of continuous high HCN-concentrations.

1.2.

Mode of Operation

Ambient air diffuses through the filter inser (a dust filter) (5) to the *measuring cell.* The measuring cell, a dual-electrode *electrochemical cell with an organic* electrolyte gel, generates an output curre proportional to the partial pressure of HCN in the air.

A series of electronic amplifiers supply a voltage signal which is fed to the comparator for the alarm threshold. If the first alarm threshold is exceeded, an intermittent tone is produced; if the second alarm threshold has been exceeded a dual tone signal is produced by the tone generator and loudspeaker (or earphone in very loud areas). The standardised analog signal corresponding to the actual HCN-concentrations (the TLV corresponds to 80 mV) can be fed to the Dosimeter.

The same signal is fed to the AD-converter driving the digital display. The display is adjusted to give a reading of 10 ppm at 80 mV input.

The 4100 SD Monitox consists of two separate power circuits (via two miniature batteries); *the circuit for the analogue part* is separated from that for the alarm-generation.

When the „on-off" switch is moved to the „Batt." position, the batteries will be tested *before the instrument is turned on.* In this switch position, the batteries are electronically tested under the high load of the final tone stages. If one of the batteries fails to reach the predetermined lower theoretical limit, no alarm will be heard

3.

chnical Data for the COMPUR 4100 SD Monitox for HCN

nformity certificate		BVS 82.013
fety class		EEx ib II C T 6
mensions		104,4 x 62 x 24 mm
eight (with batteries)		approx. 150 g
wer supply		2 x PX 23 (5,6 V)
ttery service life		approx. 1000 h.
splay range		0 – 100 ppm
arm volume		min. 80 dBA / 30 cm
arm levels		2 alarms, adjustable
sponse time		$T_{20} < 10$ s $T_{90} < 3$ min.
me to alarm	20 ppm	< 15 s
	50 ppm	< 3 s
onnection possibilities		earphone, dosimeter
mperature range		0 – 50 °C
elative humidity		10% – 95%
ero point drift		< 1 ppm / 6 months
ensitivity drift		< 15% / 6 months
ervice life of the cell		min. 6 months (dependant on dose)

1.4.

Cross-sensitivities

Test components	Test *concentration*	Indication *in ppm HCN*
SO_2	5000 ppm / 40% rH	10
NO_2	10 ppm	- 6
NH_3	1000 ppm	10
CO	1000 ppm	—
CO_2	1000 ppm	—
H_2	1000 ppm	—
CH_2:CHCN	10 ppm	—
CH_3CN	200 ppm	—
$(CH_3)_3N$	500 ppm	17
CH_3OH	200 ppm	—
$COCl_2$	5 ppm	10
Cl_2	10 ppm	5
HCl	10 ppm	7
H_2S	2 ppm	10
Hydrocarbons, saturated	2% vol.	—
Hydrocarbons, unsaturated	1% vol.	—
Aromatic compounds (also alcylated)	200 ppm	—

2.

Technical Description of the COMPUR 4100 SD Monitox Gas Generator for HCN

2.1.

Applications

The HCN gas generator serves to enhan the reliability of the Monitox gas detectio and warning system. The Monitox detect must undergo a functional test by placin on the generator before each use. The generation of a gas concentration exceeding the TLV ensures that the detec will respond reliably during use (picture

The gas generator, however, is not desig to generate a calibration gas of known concentration. Daily testing of the Monit detector does not mean that the user is n recommended to change cell sequentiall

The COMPUR 4100 Gas Generator must not be exposed to or used in explosive atmospheres.

N.B.: The generator cell may dry out at *very low relative humidity in the air* this case, it is necessary to put the moisture cap delivered with the generator on top of the generator always when it is not in use.

This ensures a correct gas concentration for the detector test

2.

lode of Operation

e switch on the generator is activated by cing the detector in the matching *recess* the generator head.

small fan feeds a flow of air past the nerator *cell directly to the detector cell.* the same time, gas is generated ectrolytically in the generator cell in such amount that the gas concentration is gh enough to cause the detector to spond within 10 seconds (alarm threshold ppm). The period of gas generation is dicated by the green LED.

The red LED indicates when the battery *must be replaced.*

After a 10 seconds interval, gas production is terminated and the fan conveys pure air *until the detector is removed.*

This functional test of the detector checks any of the following defects:

- clogging of the dust filter
- a malfunctioning cell
- a malfunctioning electronics system
- *a malfunctioning generator.*

.3.

echnical Data of the COMPUR 4100 SD Monitox ias Generator for HCN

imensions	133 x 65 x 40 mm
/eight (incl. batteries)	approx. 250 g
mperature range	0 °C – 50 °C
ower supply	9 volt alkali battery, leakproof, e.g. Mallory 1604
enerator cell service life	approx. 3000 tests or for 1 year
attery service life	approx. 3000 tests

3.

Use of the detector and generator

3.1.

Detector actuation and functional test

Battery Test

Turn the switch on the COMPUR 4100 SD Monitox to "Batt.". If the battery has sufficient power to operate the detector for eight hours, an audible (intermittent) tone will be heard. The LCD-display is switched off at the "Batt." test position. If no tone is emitted, this indicates that at least one of the batteries is exhausted. For safety reasons both batteries should be replaced (refer to section 5.1.).

When the audible tone has been heard (to preserve batteries, the test should be as short as possible), the switch is moved to "ON". *The tone will cease. The LCD-display* is operating now. It must show "0" ppm after some seconds.

Functional Test (picture 2)

Place the detector on top of the generator as illustrated.

As soon as the detector sounds its alarm, it must be removed from the generator. The detector is ready for operation once the alarm has ceased.

If the detector alarm does not sound within ten seconds the detector has to be checked and serviced. If necessary, the filter cap has to be replaced (see point 5.2.).

It is advisable to record the test and assignment of the gas detector in the detectolog.

The battery test and functional test must be performed prior to each use to thus ensure maximum safety.

During the gas test the LCD-display must show the *response* of the cell to HCN-concentration as well. As the alarm threshold is factoryset at 10 ppm the alarm should sound at 10 ppm. As the display reads a new value every second, the time for alarm and display of 10 ppm may be different.

.

e of the Gas Detector

gas detector must be worn in the ithing zone of the person to be protected the filter cap (5) should not be covered iy way.

rubber lip on the carrying clip makes it sible to securely attach the Monitox to les of clothing (e.g. the breast pocket).

is is not deemed adequately secure, the n supplied with the Monitox can be ied in the holes of the carrying clip. enables the Monitox to be worn around neck.

all possible, the filter cap should be tected from water, dust-laden air or dirt. n, the battery and functional tests (refer oint 3.1.) should be performed before detector is put into operation.

CN gas concentration in the vicinity of sensor exceeds the set alarm value, the m will sound after a delay dependent on gas concentration (The higher the centration, the more quickly the MPUR 4100 SD Monitox will respond).

alarm sounds at a level of at least 80 dB distance of about 30 centimeters inches).

3.3.

Connecting the Earphone

When the detector is being utilised in an area with high background noise, the optional earphone should be used to be sure that the alarm will not go unnoticed. The earphone is connected to the earphone socket (9) on the detector. This socket disconnects the internal loudspeaker. If the earphone is being used, it is important that the tests also be conducted with the earphone plugged into the detector (refer to point 3.1.). When the earphone is not being used, the socket should be closed with the plastic plug.

3.4.

Connecting the Dosimeter

The COMPUR 4102 Mini-Dosimeter can be connected to the 4100 SD (refer to operating instructions for the 4102).

The generator test can also be carried out with the Dosimeter connected to the COMPUR 4100 SD if the detector is turned 180° about its longitudinal axis relative to the position shown in point 3.1. and then placed on the generator in that way, that the cell fits into the recess on the generator. The functional test is then started by pushing the generator button with one's finger.

The plug should be replaced in the Dosimeter socket whenever the Dosimeter is not being used.

3.5.

Digital Display

Additional to the warning-function of the COMPUR 4100 SD Monitox its digital display (6) gives a direct reading of the actual HCN concentration.

Thus it is possible to determine HCN-concentrations below and above the TLV-level, giving the skilled worker and industrial hygienist the means to detect unusual conditions of HCN-concentrations with high accuracy and resolution.

The COMPUR 4100 SD Monitox is, however, even with its digital display, primary a measuring and warning device for personal protection.

It has not been designed for measurement in process-control; moreover exposures to high HCN-concentrations for any length of time must be avoided, as the accuracy of the reading will suffer.

3.6.

Detector Deactivation and Storage

a) brief period of inactivity (up to a month

   the detector is deactivated
   (switch to "OFF")

b) Prolonged inactivity and storage

   It is advisable to open the Monitox and remove both the cell and batteries, to provide them from leaking and corrodi the interior of the Monitox (refer to the sections on cell and battery replaceme 5.3.).

   Before reutilizing the Monitox a new c has to be installed.

alibration Instruction for the etector COMPUR 4100 SD lonitox

enhance the intrinsic accuracy of the tector for HCN it is necessary to calibrate detector either with a HCN nitrogen xture with definite concentration of HCN make an electronic adjustment by means the COMPUR current generator 5900 023.

1.

ccessories required

1 1
alibration with gas

calibration cap to place onto Monitox

flow meter

millivoltmeter 0 – 2000 mV;
input resistance ≥ 1 M Ω

tubing, set of test cables, screw-driver

calibration gas, known concentration, about 10 ppm HCN in pure N_2

emark: The generation and above all the stability time of HCN calibration gas is not without problems. So if only a small number of detectors are to be calibrated, the electronic method should be prefered.

1 2
alibration – Electronical Method
cture 6 and 7)

calibration unit (current generator)

millivoltmeter 0 – 2000 mV,
input resistance ≥ 1 M Ω

set of test cables, screw-driver

4.2.

Zero calibration and gain adjustment with calibration gas

4.2.1.
Preparation

The Monitox is opened and positioned with the electronic components upward on a non-slip surface. The cover with the digital display is carefully put aside with the display upward.

Then the unit is switched on via "Batt." position to "ON". The LCD-display should read 00 ppm after several seconds.

The excellent zero-point stability of the cells will normally make unnecessary to adjust *the zero-point. Deviations from zero are* caused mostly by fault sensor cells.

For zero-checking remove sensor cell.

4.2.2.
Zero-Adjustment

Connect Millivoltmeter to tie down point (MP 2) and GND (MP 1) (picture 6). If the reading is not zero in clean air, and also is not zero without sensor cell, potentiometer (R 9) (offset voltage) has to be varied until the reading is zero.

Note: If reading is zero without cell and not zero with the cell, it may need up to one hour to stabilize the cell. If a cell has been removed for a longer period without short-circuiting the two connectors, the time to stabilize may be up to one day. A new cell therefore has short-circuit on the small pcb, that must be broken away before inserting the cell.

4.2.3.
Gain Adjustment with gas

The special calibration adapter is tightly put onto the dust filter on top of the detector cell.

Adjust a calibration-gas flow through the calibration cap; flow rate should be approx. 100 ccm per minute and the inlet must be the smaller pipe; to avoid pressure variations the outlet should be free of obstacles. After 5 minutes the display of the Monitox has reached its final value.

Connect millivoltmeter to tie down point (MP 2) and GND (MP 1). Depending on the concentration of the calibration gas the *following voltage should be displayed:* (adjust by means of pot R 7)

$$U = \frac{[c] \text{ in ppm}}{10 \text{ ppm}} \times 80 \text{ mV}$$

The display of the Monitox must show the gas concentration. In the opposite, adjust pot (R 15) until correct reading is shown.

4.2.4.
Gain-Adjustment with the current calibrator

Each detector cell produced by COMPUR is supplied with an indication of the output *current at 10 ppm HCN. (Never throw away* packings of replacement cells before having noted this indication!!!)

Remove detector cell. Insert calibration cable with the plug board into plug connector for detector cell. The gold contacts must touch the spring contacts. Connect other side of the cable to the current generator.

Make sure of correct polarity of plugs. Switch on generator, turn button till generator display shows output current of detector cell.

Remark: Display always shows actual value of current. If it is zero, check the contacts!

Connect voltmeter to tie down point (MP and GND. Adjust sensibility by means of pot (R 7) until 80 mV is displayed. Monito must now display 10 ppm. In opposite, adjust pot (R 15).

4.3.

Setting the Alarm thresholds

The alarms of the standard version are to be set on 10 ppm (first alarm 1 TLV) and 20 ppm (second alarm 2 x TLV).

To set the alarm levels, push the 2 mini-switches (S 1) to the right. The display of the Monitox shows now the level of the 1st *alarm threshold. This can be adjusted by* means of the potentiometer (R 30).

To adjust the 2nd alarm level, push the upper switch to the left. The display shows now the 2nd alarm threshold. This can be adjusted by means of the potentiometer (R 29).

After having adjusted the alarm levels, push both mini switches to the left. The Monito display shows now the actual concentrati of HCN.

4.4.

Concluding the adjustment operations

After the settings have been made, turn th switch on the pcb to "OFF"-position. Mak *sure that the switch-handle on the cover* also in the "OFF"-position. Then carefully replace the cover and fold the connecting *cable between pcb and display so that it* neither squeezed in nor cracked. Tighten the screws. The Monitox is now ready for *operation.*

5.

Maintenance and Servicing Instructions

5.1.

Battery Replacement

1. Turn switch (7) to "OFF".
2. Remove three screws (12).
3. Turn detector over and remove front cover.
   Attention: Do not attempt to remove the cable between front panel and pbc!
4. Lift out battery housing, disconnect plug.
5. Unscrew and remove battery lids.
   Replace batteries with +pole towards lid.
   Replace lids.
6. Plug-in battery plug. Ensure cable and cable socket in right position.
7. Replace battery housing and front cover, carefully adjust the cable of the front panel, so that it is not damaged by fixing the front panel; then tighten the screws.
8. Repeat battery test.

5.2.

Filter Cap Replacement

1. Remove screws (7) (picture 4) and open detector.
2. Carefully remove sensor cell together with filter cap (5). Pull cap off cell (4).
3. Attach new filter cap (with identical gas label HCN) and return sensor cell to original position.
   Filter cap order number appears on plate attached to inside of front panel and is listed in section 6.
4. Replace front cover and tighten screws
5. Repeat performance test.

5.3.

Sensor Cell Replacement

1. Open detector (see 5.1.).
2. Remove cell together with filter cap.
3. Remove new cell and filter cap from storage container, pull transparent cap off the cell and replace this by the new filter cap. Correct position of filter cap is shown in illustration.
   Remove short-circuit protection attached to pcb by breaking it away.
4. Proceed current calibration (4.2.4.).
5. Replace sensor cell with filter cap in proper position.
6. Close Monitox.

5.4.

Generator Cell Replacement

(picture 5)

1. Open housing
   (as when replacing battery)
2. Unsolder fan leads (10).
3. Loosen four screws (11) and three screws (12).
4. Remove outlet, gas cell and fan through the front.
5. Carefully insert replacement unit U 5820 300 consisting of outlet, cell and fan and tighten screws (12).
6. Tighten screws (11). Align circuit board so that pin (13) reliably actuates switch (14) when gas detector attached.
7. Resolder fan leads (10).
8. Reassemble generator and tighten screws.
9. Testing: Use properly functioning gas detector for same gas. Switch to "ON", attach. Alarm must sound after about eight seconds.

5.5.

Generator Battery Replacement

Loosen four screws on rear housing panel. Carefully remove front cover. For correct positioning of battery, refer to illustration 5.

5.6.

Troubleshooting

Malfunction	Remedy
Battery test: no response	Replace batteries (5.1.)
Generator test: no response	a) Repeat test using 2nd detector, if no response, b) b) Replace filter cap (5.2.), if not dirty, c) c) Insert new sensor cell (5.3.)
Generator does not supply enough gas	Use moisturizing cap for several days, otherwise replace generator cell (5.4.).
Red LED lights up during test	Replace generator batteries (5.5.).

6.

Accessories and consumabl

Part Numbers

1. Gas detector digital display, 2 alarm *thresholds with* Dosimeter output	U 5306 2
2. HCN cell with filter cap	U 5800
✓3. HCN filter cap (10 pcs.)	U 5810 3
4. Battery PX 23 (1 pc.)	U 4990 0
✓5. HCN gas generator	U 5390 3
✓6. HCN generator cell	U 5820 3
7. Calibration gas adapter	U 5900
8. Measuring cable: calibration	U 5900 1
9. Digital Voltmeter	U 5900 0
10. *Current calibrator*	U 5900 0
11. Calibration cable used in connection with current calibrator	U 5900 1
12. Detectolog	U 5900 0
13. Earphone	U 5900 0

APPENDIX C

Certificate of Participation

Basic Hazardous Waste Operations Health and Safety Training

WARZYN

This certifies that ______________________________

of ______________________________

has completed the Basic Hazardous Waste Operations Health and Safety Seminar offered by Warzyn Engineering Inc. This training seminar complies with the following Health and Safety guidelines.

- EPA Order 1440.2, Health and Safety Requirements for Employees Engaged in Field Activities
- EPA Order 1440.3, Respiratory Protection
- 29 CFR 1910.134(e), OSHA Respiratory Protection Training Requirements
- 29 CFR 1910.120(e), OSHA Standards to Protect Workers in Hazardous Waste Operations

____
Signed, Instructor

____
Date Completed

APPENDIX D

MEDICAL MONITORING PROGRAM

I. Medical Monitoring Program

All personnel assigned to work on sites which contain or are suspected to contain hazardous wastes will be placed under the corporate medical surveillance program. Other personnel may be placed in the medial surveillance program if they're assigned to other tasks which may have health implications.

A. Purpose

The purpose of the medical monitoring program is to:

- Establish baseline health data of the employee
- Monitor effects of occupational exposure on the health of the employee
- Determine whether employees can use or wear certain respiratory protection
- Medical Surveillance Program

B. Medical Surveillance Program

The medical surveillance program will consist of an entry level and annual physical administered by the physician of record for Warzyn Engineering Inc. The following is the medical protocol and required examination procedures for all employees of Warzyn Engineering who are involved in working on hazardous waste sites or are otherwise directly handling hazardous waste materials.

1. Medical Health History

   Physician review of past health history, personal profile, acute infectious diseases, allergies, immunization history, system (skin, head, eyes, ears, nose, teeth, throat, neck, breasts, lungs, heart, G.I., bones and joints). Review of current medications, personal and family emotions.

2. Record of body frame, height, weight, blood pressure (supine and standing), pulse rate (suprine and standing), respiratory rate and oral temperature. Complete assessment of skin, extremities, head/neck, eyes, ears, nose, throat, neck, lymph nodes, abdomen, respiratory, cardiovascular, genitourinary, musculoskeletal and neurological. If any abnormalities are noted, complete comments are to be provided.

3. To include FVC, FEV, FEV1, FEF, MMEFR, MVV, FRC and Residual Volume. For detection of resprictive and obstructive lung diseases, chronic disorders (such as emphysema, bronchitis and pericarditis).

   Ventilation Studies
   Breathing Mechanics
   Diffusion Studies
   Lung Compartments
   Distribution Studies
   Arterial Blood Studies

4. Audiometry (Range from 500 - 8000 Hz)

5. Opthamology Examination

   Tests include assessment of muscle balance, eye coordination, depth perception peripheral vision, far vision near vision, tonometry, color discrimination and glaucoma test.

6. Maximal Stress Treadmill Exercise Test (12 point lead EKG)

   Resting EKG
   Treadmill Stress Test (heart rate, BP, symptoms, ST segment, and arrhythmias)

   (NOTE: Treadmill need only be performed for initial physical and every 3 years thereafter. EKG sufficient between these years.)

7. Blood Counts

   RBC, WBC, (leukocytes, neutrophils, lymphocytes, monocytes, eosinophils, basophils), hemoglobin, hematocrit, MCV, MCN, MCHC and platelets.

8. Blood Chemistry Profile

   NA, K, Ca, PO4, CO2, Fe, Cl, blood urea nitrogen, total protein, total bilirubin, alkaline phosphatase, SGOT, SGPT, LDH, Creatinine, uric acid, triglycerides, cholesterol, glucose, albumin, etc.

   Heavy Metals - Lead

9. Urinalysis

   Initial - Measurement of pH, sp.gr., color and character. Chemical analysis of albumin, protein, glucose, bilirubin, ketones and occult blood.

   24 Hour - Heavy Metals (cadmium, mercury and arsenic)

10. Stool Occult Blood

NOTE: Physician is specifically requested to identify physiological and phychological limitations of patient in regard to wearing of respiratory protection. The following factors should be considered as excluding the patient from the wearing of a respirator:

- Emphysema
- Chronic obstructive pulmonary disease
- Bronchial asthma
- X-ray evidence of pneumonconiosis
- Evidence of reduced pulmonary function
- Coronary artery disease or cerebral blood vessel disease
- Severe or progressive hypertension
- Anemia (pernicious)
- Diabetes (insipidus or mellitus)
- Punctured eardrum
- Pneumomediastinum gap
- Communication of the sinus through the upper jaw to the oral cavity
- Experiences claustrophobia or undue anxiety when wearing a respirator

The attending physician is to submit:

a. To each employee, a written summary of the examination;

b. To Warzyn Engineering Inc., a complete copy of all examination results and tests; and

c. To a file in his office all medical examination results on all Warzyn Engineering Inc.'s employees who are sent for testing, and review this file for each examination process requested.

Upon completion of the physical examination, the attending physician will submit to Warzyn Engineering and to each employee a written summary of the examination including a statement of the employee's ability to wear respiratory protective equipment. Copies of the doctor's certification will be filed in the employee's personnel file and in the site safety officer's health and safety file. Any emergency medical information pertinent to the employee will be included on the individual employee fact sheet carried by the employee on a hazardous waste site. That face sheet is maintained by the site safety officer at each project location.

If an employee is believed to have been exposed as a result of site work, a physical exam will be performed as soon as possible. Otherwise, medical monitoring is accomplished through the yearly physical.

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[jap-601-89e]

APPENDIX E

ACETONE

ACT

Common Synonyms
Dimethyl ketone
Propanone
2-Propanone

Watery liquid   Colorless   Sweet odor

Floats and mixes with water. Flammable, irritating vapor is produced.

[illegible]

Fire

FLAMMABLE
Flashback along vapor trail may occur
Vapor may explode if ignited in an enclosed area

[illegible]

Exposure

VAPOR
Irritating to eyes, nose and throat
If inhaled, may cause difficult breathing or loss of consciousness

[illegible]

LIQUID
Irritating to eyes
Not irritating to skin

Water Pollution

Dangerous to aquatic life in high concentrations
May be dangerous if it enters water intakes

[illegible]

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Disperse and flush

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Ketone
3.2 **Formula:** CH_3COCH_3
3.3 **IMO/UN Designation:** 3.1/1090
3.4 **DOT ID No.:** 1090
3.5 **CAS Registry No.:** 67-64-1

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Sweetish; pleasant, resembling that of mint or fruit; pungent, sharp, penetrating residual, ketonic, pleasant, non-residual

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor canister or air-supplied mask; synthetic rubber gloves, chemical safety goggles or face splash shield

5.2 **Symptoms Following Exposure:** INHALATION: vapor irritating to eyes and mucous membranes, acts as an anesthetic in very high concentrations. INGESTION: low order of toxicity but very irritating to mucous membranes. SKIN: prolonged excessive contact causes defatting of the skin, possibly leading to dermatitis.

5.3 **Treatment of Exposure:** INHALATION: if victim is overcome, remove to fresh air and call a physician; administer artificial respiration if breathing is irregular or stopped. INGESTION: if victim has swallowed large amounts and is conscious and not having convulsions, induce vomiting and get medical help promptly; no specific antidote known. SKIN: wash well with water. EYES: flush with water immediately for at least 15 min. Consult a physician.

5.4 **Threshold Limit Value:** 750 ppm
5.5 **Short Term Inhalation Limits:** 1000 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 1; LD_{50} = 5 to 15 g/kg (dog)
5.7 **Late Toxicity:** Not pertinent
5.8 **Vapor (Gas) Irritant Characteristics:** If present in high concentrations, vapors cause moderate irritation of the eyes or respiratory system. Effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to the skin because it is very volatile and evaporates quickly from the skin.
5.10 *Odor Threshold:* 100 ppm
5.11 **IDLH Value:** 20000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 4°F O.C.; 0°F C.C.
6.2 **Flammable Limits in Air:** 2.6%–12.8%
6.3 *Fire Extinguishing Agents:* Alcohol foam, dry chemical, carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water in straight hose stream will scatter and spread fire and should not be used.
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 869°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 3.9 mm/min
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 *Neutralizing Agents for Acids and Caustics:* Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 18

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
14,250 ppm/24 hr/sunfish/killed/tap water
13,000 ppm/48 hr/mosquito fish/TL_m/ turbid water
8.2 *Waterfowl Toxicity: Not pertinent*
8.3 **Biological Oxygen Demand (BOD):** (Theor) 122%, 5 days
8.4 **Food Chain Concentration Potential:** None noted

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Technical 99.5% plus 0.5% water; Reagent 99.5% plus 0.5% water
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	0
Poisons	0
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	1
Water	2
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 58.08
12.3 **Boiling Point at 1 atm:** 133°F = 56.1°C = 329.3°K
12.4 **Freezing Point:** −138°F = −94.7°C = 178.5°K
12.5 **Critical Temperature:** 455°F = 235°C = 508°K
12.6 **Critical Pressure:** 682 psia = 46.4 atm = 4.70 MN/m^2
12.7 **Specific Gravity:** *0.791 at 20°C (liquid)*
12.8 **Liquid Surface Tension:** Not pertinent
12.9 **Liquid Water Interfacial Tension:** Not pertinent
12.10 **Vapor (Gas) Specific Gravity:** 2.0
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.127
12.12 **Latent Heat of Vaporization:** 220 Btu/lb = 122 cal/g = 5.11 X 10^5 J/kg
12.13 **Heat of Combustion:** −12,250 Btu/lb = −6808 cal/g = −285.0 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 23.42 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 7.25 psia

NOTES

BENZENE

BNZ

Common Synonyms	Watery liquid	Colorless	Gasoline-like odor
Benzol *Benzole*	Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur
Vapor may explode if ignited in an enclosed area

Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat
If inhaled, will cause headache, difficult breathing, or loss of consciousness.

Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.

Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water
or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS
May be dangerous if it enters water intakes

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Restrict access

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: C_6H_6
3.3 IMO/UN Designation: 3.2/1114
3.4 DOT ID No.: 1114
3.5 CAS Registry No.: 71-43-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic, rather pleasant aromatic odor, characteristic odor

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask, hydrocarbon-insoluble rubber or plastic gloves, chemical goggles or face splash shield, hydrocarbon-insoluble apron such as neoprene
5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death
5.3 Treatment of Exposure: *SKIN*: flush with water followed by soap and water, remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen
5.4 Threshold Limit Value: 10 ppm
5.5 Short Term Inhalation Limits: 75 ppm for 30 min
5.6 *Toxicity by ingestion: Grade 3. LD_{50} = 50 to 500 mg/kg*
5.7 Late Toxicity: Leukemia
5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation *of eyes or respiratory system. The effect is temporary*
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin
5.10 *Odor Threshold: 4.68 ppm*
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 12°F C.C.
6.2 Flammable Limits in Air: 1.3%-7.9%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air *and may travel considerable distance to a* source of ignition and flash back
6.7 Ignition Temperature: 1097°F
6.8 *Electrical Hazard: Class I, Group D*
6.9 Burning Rate: 6.0 mm/min
6.10 Adiabatic Flame Temperature: *Data not available*
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 *Flame Temperature: Data not available*

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No *reaction*
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and *Caustics: Not pertinent*
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: *Not pertinent*
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity:
5 ppm/6 hr/minnow/lethal/distilled water
20 ppm/24 hr/sunfish/TL_m/tap water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days
8.4 Food Chain Concentration Potential: None

9. *SHIPPING INFORMATION*

9.1 *Grades of Purity:*

Industrial pure	99 + %
Thiophene-free	99 + %
Nitration	99 + %
Industrial 90%	85 + %
Reagent	99 + %

9.2 Storage Temperature: Open
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U-V-W

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	3
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	*Classification*
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 78.11
12.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K
12.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K
12.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K
12.6 Critical Pressure: 710 psia = 48.3 atm = 4.89 MN/m²
12.7 Specific Gravity: 0.879 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.9 dynes/cm = 0.0289 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 2.7
12.11 Ratio of Specific Heats of Vapor (Gas): 1.061
12.12 Latent Heat of Vaporization: 169 Btu/lb = 94.1 cal/g = 3.94 X 10^5 J/kg
12.13 Heat of Combustion: −17,460 Btu/lb = −9698 cal/g = −406.0 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 *Heat of Polymerization: Not pertinent*
12.25 Heat of Fusion: 30.45 cal/g
12.26 Limiting Value: Data not available
12.27 *Reid Vapor Pressure: 3.22 psia*

NOTES

n-BUTYL ACETATE

BCN

Common Synonyms

Acetic acid, n-butyl ester
Butyl acetate
Butyl ethanoate

Watery liquid — Colorless — Pleasant fruity odor

Floats on water. Flammable irritating vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, dizziness, headache or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk, and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
Fouling to shoreline.
May be dangerous if it enters water intakes.

Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-flammability
Mechanical containment

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Ester
3.2 **Formula:** $CH_3COO(CH_2)_3CH_3$
3.3 ***IMO/UN Designation:*** *3.2/1123*
3.4 **DOT ID No.:** 1123
3.5 **CAS Registry No.:** 123-86-4

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Characteristic; agreeable fruity (in low conc.), disagreeable (in higher conc.); nonresidual

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** All-purpose canister mask, chemical safety goggles, rubber gloves
5.2 **Symptoms Following Exposure:** SKIN: prolonged or frequently repeated exposures may lead to drying. INHALATION: headaches, dizziness, nausea, irritation of respiratory passages and eyes.
5.3 ***Treatment of Exposure:*** *EYES: in case of contact, flush with water for at least 15 min.* INHALATION: remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen. INGESTION: induce vomiting and call a physician.
5.4 **Threshold Limit Value:** 150 ppm
5.5 **Short Term Inhalation Limits:** 300 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 2, LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 10 ppm
5.11 **IDLH Value:** 10,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 99°F O.C.; 75°F C.C.
6.2 **Flammable Limits in Air:** 1.7%-7.6%
6.3 **Fire Extinguishing Agents:** Foam, dry chemical, carbon dioxide
6.4 ***Fire Extinguishing Agents Not to be Used:*** Water in straight hose stream will scatter and spread fire and should not be used
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Not pertinent
6.7 ***Ignition Temperature:*** *780°F*
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 4.4 mm/min
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and *Caustics:*** *Not pertinent*
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 34

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 44 ppm/48 hr/daphnia/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** *0.15 to 0.5 lb/lb, 5 days (theor.) 52%,* 5 days
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Urethane: 99.5% pure; 98%, commercial: 90-92%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 ***NAS Hazard Rating for Bulk Water*** **Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	0
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 116.16
12.3 **Boiling Point at 1 atm:** 259°F = 126°C = 399°K
12.4 **Freezing Point:** −100°F = −73.5°C = 199.7°K
12.5 **Critical Temperature:** 582.6°F = 305.9°C = 579.1°K
12.6 **Critical Pressure:** 455 psia = 31 atm = 3.1 MN/m^2
12.7 **Specific Gravity:** *0.875 at 20°C (liquid)*
12.8 **Liquid Surface Tension:** 14.5 dynes/cm = 0.0145 N/m at 25°C
12.9 **Liquid Water Interfacial Tension:** (est.) 57 dynes/cm = 0.057 N/m at 22°C
12.10 **Vapor (Gas) Specific Gravity:** *Not pertinent*
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.058
12.12 **Latent Heat of Vaporization:** 133 Btu/lb = 73.9 cal/g = 3.09 X 10^5 J/kg
12.13 **Heat of Combustion:** −13,130 Btu/lb = −7294 cal/g = −305.4 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 0.5 psia

NOTES

CARBON DISULFIDE

CBB

Common Synonyms	Watery liquid	Colorless to yellow	Rotten egg to sweet odor
Carbon bisulfide	Sinks in water. Flammable, irritating vapor is produced		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self contained breathing apparatus and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with dry chemical or carbon dioxide.
Water and foam may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Restrict access
Evacuate area

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Carbon disulfide
3.2 **Formula:** CS_2
3.3 **IMO/UN Designation:** 3.1/1131
3.4 **DOT ID No.:** 1131
3.5 **CAS Registry No.:** 75-15-0

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Faint sweetish, disagreeable, offensive, like that of decaying cabbage

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Only self-contained breathing mask with full face, approved by the United States Bureau of Mines, is recommended. If the vapor concentration exceeds 2% by volume or is unknown, supplied-air respiratory equipment of appropriate design with full face masks should be used by all persons entering contaminated area. Masks should be used only for emergency situations and should be located accordingly. Almost any type of industrial clothing is satisfactory. Splashes of small quantity are not harmful to fabrics, and evaporation from clothing is quite rapid. Clothing should, however, be removed and the skin washed with water. Goggles should be used when there is any danger of CS_2 splashes or spray.

5.2 **Symptoms Following Exposure:** ACUTE EXPOSURE: mild to moderate irritation of skin, eyes, and mucous membranes from liquid or concentrated vapors, headache, garlicky breath, nausea, vomiting, diarrhea (even after vapor exposures), and occasionally abdominal pain; weak pulse, palpitations, fatigue, weakness in the legs, unsteady gait, vertigo; mania, hallucinations of sight, hearing, taste, and smell in acute, massive vapor exposures, central nervous depression with respiratory paralysis; death may occur during coma or after a convulsion.

5.3 **Treatment of Exposure:** INHALATION: remove victim promptly from contaminated area. Administer oxygen and artificial respiration if needed. SKIN CONTACT: wash affected areas with copious quantities of water. INGESTION: induce vomiting and follow with gastric lavage and saline cathartics.

5.4 **Threshold Limit Value:** 10 ppm

5.5 **Short Term Inhalation Limits:** 200 ppm for 10 minutes, 100 ppm for 30 minutes and 50 ppm for 60 minutes

5.6 **Toxicity by Ingestion:** Grade 2 (rat LD_{50} = 0.1 - 0.99 g/kg)

5.7 **Late Toxicity:** Non-specific liver cell damage in rats; higher incidence of upper respiratory disease in humans

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.

(Continued)

6. FIRE HAZARDS

6.1 **Flash Point:** −22°F C.C.
6.2 **Flammable Limits in Air:** 1.2%-50%
6.3 **Fire Extinguishing Agents:** Dry chemical, carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water and foam may be ineffective on fire
6.5 **Special Hazards of Combustion Products:** Toxic gases are generated; wear self-contained breathing apparatus
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 212°F
6.8 **Electrical Hazard:** Contact of the liquid or vapor with the surface of a lighted electric light bulb could result in ignition
6.9 **Burning Rate:** 2.7 mm/min
6.10 **Adiabatic Flame Temperature:** Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 38

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 35 ppm/48 hr/mosquito fish/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Commercial, technical, USP
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** Inerted
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid

11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	4
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	3
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 76.14
12.3 **Boiling Point at 1 atm:** 115°F = 46.3°C = 319.5°K
12.4 **Freezing Point:** −168.9°F = −111.6°C = 161.6°K
12.5 **Critical Temperature:** 523°F = 273°C = 546°K
12.6 **Critical Pressure:** 1100 psia = 76 atm = 7.7 MN/m²
12.7 **Specific Gravity:** 1.26 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 32 dynes/cm = .032 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 48.4 dynes/cm = .0484 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** 2.6
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.292
12.12 **Latent Heat of Vaporization:** 153 Btu/lb = 85 cal/g = 3.559 X 10^5 J/kg
12.13 **Heat of Combustion:** −5814 Btu/lb = −3230 cal/g = −135.2 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 13.80 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 10.3 psia

5. HEALTH HAZARDS (Continued)

5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure and may cause secondary burns on long exposure.
5.10 **Odor Threshold:** 0.21 ppm
5.11 **IDLH Value:** 500 ppm

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

CHLOROBENZENE

CRB

Common Synonyms

Monochlorobenzene
Phenyl chloride
Benzene chloride
MCB

Watery liquid — Colorless — Sweet, almond odor

Sinks in water. Flammable vapor is produced.

Avoid contact with liquid and vapor. Keep people away.
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.

Exposure

CALL FOR MEDICAL AID

VAPOR
If inhaled, will cause coughing or dizziness.
Not irritating to eyes, nose and throat.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** C_6H_5Cl
3.3 **IMO/UN Designation:** 3.3/1134
3.4 **DOT ID No.:** 1134
3.5 **CAS Registry No.:** 108-90-7

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Mild amine odor; sweet, almond-like; aromatic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor-acid gas respirator where appropriate; neoprene or vinyl gloves; chemical safety spectacles, plus face shield where appropriate; rubber footwear, apron or impervious clothing for splash protection; hard hat.
5.2 **Symptoms Following Exposure:** Irritating to skin, eyes and mucous membranes. Repeated exposure of skin may cause dermatitis due to defatting action. Chronic inhalation of vapors or mist may result in damage to lungs, liver, and kidneys. Acute vapor exposures can cause symptoms ranging from coughing to transient anesthesia and central nervous system depression.
5.3 **Treatment of Exposure:** Get medical attention for all eye exposures and any serious over-exposures. Treat the symptoms. INHALATION: remove to clean air; administer oxygen as needed. INGESTION: dilute by drinking water; if vomiting occurs, administer more water. Administer saline laxative. EYES: flush thoroughly with water. SKIN: remove contaminated clothing; wash exposed area with soap and water.
5.4 **Threshold Limit Value:** 75 ppm
5.5 **Short Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg (rat, rabbit)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors are nonirritating to the eyes and throat.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 0.21 ppm
5.11 **IDLH Value:** 2,400 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 84°F C.C.; 97°F O.C.
6.2 **Flammable Limits in Air:** 1.3%-7.1%
6.3 **Fire Extinguishing Agents:** Carbon dioxide, dry chemical, foam or water spray
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Burning in open flame can form toxic phosgene and hydrogen chloride gases.
6.6 **Behavior in Fire:** Heavy vapor can travel a considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 1184°F
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** (est.) 4.6 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 20 ppm/96 hr/bluegill/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 0.3 lb/lb, 5 days
8.4 **Food Chain Concentration Potential:** Data not available

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** 99.5%, technical
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-X

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	0
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 112.56
12.3 **Boiling Point at 1 atm:** 270°F = 132°C = 405°K
12.4 **Freezing Point:** −50.1°F = −45.6°C = 227.6°K
12.5 **Critical Temperature:** 678°F = 359°C = 632°K
12.6 **Critical Pressure:** 656 psia = 44.6 atm = 4.52 MN/m²
12.7 **Specific Gravity:** 1.11 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 33 dynes/cm = 0.033 N/m at 25°C
12.9 **Liquid Water Interfacial Tension:** 37.41 dynes/cm = 0.03741 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.094
12.12 **Latent Heat of Vaporization:** 135 Btu/lb = 75 cal/g = 3.140×10^5 J/kg
12.13 **Heat of Combustion:** (est.) 12,000 Btu/lb = 6700 cal/g = 280×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 20.40 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 0.5 psia

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

JUNE 1985

CHLORODIFLUOROMETHANE

MCF

Common Synonyms

Freon-22
Genetron-22
Isotron-22
Ucon-22
Monochlorodifluoromethane
Eskimon-22

Liquefied compressed gas   Colorless   Faint odor

Liquid sinks and boils in water. Visible vapor cloud is formed.

Stop discharge if possible
Avoid contact with liquid
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

Not flammable
POISONOUS GASES ARE PRODUCED WHEN HEATED
Wear goggles and self-contained breathing apparatus
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID

VAPOR
Not irritating to eyes, nose or throat.
If inhaled, will cause dizziness or loss of consciousness.
Move to fresh air
If breathing has stopped, give artificial respiration
If breathing is difficult, give oxygen

LIQUID
Will cause frostbite.
Flush affected areas with plenty of water
DO NOT RUB AFFECTED AREAS

Water Pollution

Not harmful to aquatic life.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Disperse and flush

2. LABEL

2.1 **Category:** Nonflammable gas
2.2 **Class:** 2

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** $CHClF_2$
3.3 **IMO/UN Designation:** 2.0/1018
3.4 **DOT ID No.:** 1018
3.5 **CAS Registry No.:** 75-45-6

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquefied gas
4.2 **Color:** Colorless
4.3 **Odor:** Faint ethereal; like carbon tetrachloride

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Rubber gloves; goggles.
5.2 **Symptoms Following Exposure:** Inhalation of greater than 10% concentration in air may cause narcosis. Liquid may cause frostbite.
5.3 **Treatment of Exposure:** Remove victim to non-contaminated area and apply artificial respiration if breathing has stopped. Call a physician immediately. Oxygen inhalation may be utilized.
5.4 **Threshold Limit Value:** 1,000 ppm
5.5 **Short Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Not pertinent
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors are nonirritating to the eyes and throat.
5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to the skin because it evaporates quickly. Liquid may cause frostbite.
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Decomposition gases are toxic and irritating.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not flammable
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not flammable
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** None
8.2 **Waterfowl Toxicity:** None
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Propellant grade
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Safety relief

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-C-I-J

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Nonflammable gas
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	0
Health	
Vapor Irritant	0
Liquid or Solid Irritant	0
Poisons	1
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	0
Aesthetic Effect	0
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Gas
12.2 **Molecular Weight:** 86.48
12.3 **Boiling Point at 1 atm:** —40.9°F = —40.5°C = 232.7°K
12.4 **Freezing Point:** Not pertinent
12.5 **Critical Temperature:** 204.8°F = 96.0°C = 369.2°K
12.6 **Critical Pressure:** 716 psia = 48.7 atm = 4.93 MN/m²
12.7 **Specific Gravity:** 1.41 at —40°C (liquid)
12.8 **Liquid Surface Tension:** (est.) 15 dynes/cm = 0.015 N/m at —41°C
12.9 **Liquid Water Interfacial Tension:** Data not available
12.10 **Vapor (Gas) Specific Gravity:** 3.0
12.11 **Ratio of Specific Heats of Vapor (Gas):** (est.) 1.13
12.12 **Latent Heat of Vaporization:** 101 Btu/lb = 55.9 cal/g = 2.34×10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 212.6 psia

NOTES

JUNE 1985

1,1-DICHLOROETHANE

DCH

Common Synonyms	Oily liquid	Colorless	Chloroform like ethereal
Ethylidene chloride Ethylidene dichloride Chlorinated hydrochloric ether	*Sinks and mixes with water*		

Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves)
Stop discharge if possible. Keep people away
Shut off ignition sources and call fire department
Avoid contact with liquid
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire	**Flammable.** **POISONOUS GAS MAY BE PRODUCED IN FIRE OR WHEN HEATED.** **Containers may explode in fire.** Wear goggles and self-contained breathing apparatus Extinguish with alcohol foam, carbon dioxide, or dry chemical Water may be ineffective on fire
Exposure	CALL FOR MEDICAL AID **LIQUID** **If swallowed may cause nausea, vomiting and faintness.** **Irritating to skin and eyes.** Flush affected areas with plenty of water IF IN EYES, hold eyelids open and flush with plenty of water IF SWALLOWED and victim is CONSCIOUS have victim drink water or milk and induce vomiting
Water Pollution	**Dangerous to aquatic life in high concentrations.** **May be dangerous if it enters water intakes.** Notify local health and wildlife officials Notify operators of nearby water intakes

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability.
Restrict access.
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** $C_2H_4Cl_2$
3.3 **IMO/UN Designation:** Not listed
3.4 **DOT ID No.:** 2362
3.5 **CAS Registry No.:** 75-34-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Oily liquid
4.2 **Color:** Colorless
4.3 **Odor:** Chloroform

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** In areas of poor ventilation or high concentration, a self-contained breathing apparatus with full face mask should be worn. Chemical workers goggles, rubber gloves, and protective clothing should be worn
5.2 **Symptoms Following Exposure:** INHALATION: Irritation of respiratory tract. Salivation, sneezing, coughing, dizziness, nausea, and vomiting. EYES: Irritation, lacrimation, and reddening of conjunctiva. SKIN: Irritation. Prolonged or repeated skin contact can produce a slight burn. INGESTION: Ingestion incidental to industrial handling is not considered to be a problem. Swallowing of substantial amounts could cause nausea, vomiting, faintness, drowsiness, cyanosis, and circulatory failure
5.3 **Treatment of Exposure:** Call a doctor. INHALATION: Remove from contaminated area, keep warm and quiet. If breathing has stopped, give artificial respiration. Administer oxygen. EYES: Flush with large amounts of water or weak bicarbonate of soda solution. SKIN: Dilute with large amounts of water. Remove contaminated clothing. INGESTION: Attempt to empty stomach; dilute by administering fluids (tap water, soapy water, salt water, or milk)
5.4 **Threshold Limit Value:** 200 ppm
5.5 **Short Term Inhalation Limits:** 250 ppm
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
5.7 **Late Toxicity:** Chronic exposure may cause liver damage and dermatitis. Animal experimentation has shown this compound to be slightly embryo-toxic and to retard fetal development
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** 4,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 57°F O.C. – 22°F C.C.
6.2 **Flammable Limits in Air:** 5.6% to 11.4%
6.3 **Fire Extinguishing Agents:** Alcohol foam, water, foam, CO_2, dry chemical, carbon tetrachloride
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** When heated to decomposition emits highly toxic fumes to phosgene.
6.6 **Behavior in Fire:** Explosion hazard
6.7 **Ignition Temperature:** 856°F
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** Data not available
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** Data not available
7.3 **Stability During Transport:** Data not available
7.4 **Neutralizing Agents for Acids and Caustics:** Data not available
7.5 **Polymerization:** Data not available
7.6 **Inhibitor of Polymerization:** Data not available
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
TL_m (Marine pinperch) 250 to 275 mg/l
24-hour TL_m Brine shrimp: 320 mg/l
24-hour TL_m Pinperch: 160 mg/l
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Percent, 0.05 g/g for 10 days Percent, 0.002 g/g for 5 days
8.4 **Food Chain Concentration Potential:** Data not available

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Data not available
9.2 **Storage Temperature:** Cool
9.3 **Inert Atmosphere:** Data not available
9.4 **Venting:** Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Not listed
11.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed
11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 98.97
12.3 **Boiling Point at 1 atm:** 135.14°F = 57.3°C = 330.5°K
12.4 **Freezing Point:** −143.32°F = −97.4°C = 175.75°K
12.5 **Critical Temperature:** 502.7°F = 261.5°C = 534.65°K
12.6 **Critical Pressure:** 734.8 psia = 50 atm = 5.065 MN/m²
12.7 **Specific Gravity:** 1.174 at 20°C
12.8 **Liquid Surface Tension:** 24.75 dynes/cm = 0.02475 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** Data not available
12.10 **Vapor (Gas) Specific Gravity:** 3.42
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.136 at 20°C (68°F)
12.12 **Latent Heat of Vaporization:** 131.6 Btu/lb = 73.1 cal/g = 3.06×10^5 J/kg
12.13 **Heat of Combustion:** −4,774 Btu/lb = −2,652 cal/g = -111×10^5 J/kg
12.14 **Heat of Decomposition:** Data not available
12.15 **Heat of Solution:** Data not available
12.16 **Heat of Polymerization:** Data not available
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 7.35 psia

NOTES

1,2-DICHLOROETHYLENE

DEL

Common Synonyms	Liquid	Colorless	Sweet pleasant odor
Acetylene dichloride sym-dichloroethylene Dioform cis-1, 2-dichloroethylene trans-1, 2-dichloroethylene	Sinks in water. Flammable, irritating vapor is produced.		

Wear goggles and self-contained breathing apparatus
Shut off ignition sources. Call fire department
Stop discharge if possible. Keep people away
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

FLAMMABLE.
POISONOUS GASES MAY BE PRODUCED IN FIRE.
Containers may explode in fire
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Extinguish with dry chemicals, foam or carbon dioxide
Water may be ineffective on fire
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID

VAPOR
If inhaled will cause dizziness, nausea, vomiting, or difficult breathing.
Move victim to fresh air
If breathing has stopped, give artificial respiration
If breathing is difficult, give oxygen.

LIQUID
Harmful if swallowed
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials
Notify operators of nearby water intakes

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Restrict access
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: ClCH = CHCl
3.3 IMO/UN Designation: 3.2/1150
3.4 DOT ID No.: 1150
3.5 CAS Registry No.: 540-59-0

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ethereal, slightly acrid; pleasant, chloroform-like

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Rubber gloves; safety goggles; air supply mask or self-contained breathing apparatus
5.2 Symptoms Following Exposure: Inhalation causes nausea, vomiting, weakness, tremor, epigastric cramps, central nervous depression. Contact with liquid causes irritation of eyes and (on prolonged contact) skin. Ingestion causes slight depression to deep narcosis.
5.3 Treatment of Exposure: INHALATION: remove from further exposure; if breathing is difficult, give oxygen; if victim is not breathing, give artificial respiration, preferably mouth-to-mouth; give oxygen when breathing is resumed; call a physician. EYES: flush with water for at least 15 min. SKIN: wash well with soap and water. INGESTION: give gastric lavage and cathartics.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; oral LD_{50} = 770 mg/kg (rat)
5.7 Late Toxicity: Produces liver and kidney injury in experimental animals
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 4,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 37°F C.C.
6.2 Flammable Limits in Air: 9.7%-12.8%
6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Phosgene and hydrogen chloride fumes may form in fires.
6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 860°F
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: 2.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Will not occur under ordinary conditions of shipment. The reaction is not vigorous.
7.6 Inhibitor of Polymerization: None used
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Commercial
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	2

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 97.0
12.3 Boiling Point at 1 atm:
cis: 140°F = 60°C = 333°K
trans: 118°F = 48°C = 321°K
12.4 Freezing Point:
cis: −114°F = −81°C = 192°K
trans: −58°F = −50°C = 223°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.27 at 25°C (liquid)
12.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 30 dynes/cm = 0.030 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 3.34
12.11 Ratio of Specific Heats of Vapor (Gas): 1.1468
12.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0×10^5 J/kg
12.13 Heat of Combustion: −4,847.2 Btu/lb = −2,692.9 cal/g = -112.67×10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

DICHLOROMETHANE

DCM

Common Synonyms

Methylene chloride
Methylene dichloride

Watery liquid — Colorless — Sweet, pleasant odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable
POISONOUS GASES ARE PRODUCED WHEN HEATED
Wear goggles and self-contained breathing apparatus.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea and dizziness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Disperse and flush

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** CH_2Cl_2
3.3 **IMO/UN Designation:** 9.0/1593
3.4 **DOT ID No.:** 1593
3.5 **CAS Registry No.:** 75-09-2

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Pleasant, aromatic; like chloroform; sweet, ethereal

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor canister mask, safety glasses, protective clothing.
5.2 **Symptoms Following Exposure:** INHALATION: anesthetic effects, nausea and drunkenness. CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose.
5.3 **Treatment of Exposure:** INHALATION: remove from exposure. Give oxygen if needed. INGESTION: no specific antidote. CONTACT WITH SKIN AND EYES: remove contaminated clothing, wash skin or eyes if affected.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 500 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 2, LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 205-307 ppm
5.11 **IDLH Value:** 5,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable under conditions likely to be encountered
6.2 **Flammable Limits in Air:** 12%-19%
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Dissociation products generated in a fire may be irritating or toxic.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 1184°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not pertinent
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Not pertinent
8.2 **Waterfowl Toxicity:** Not pertinent
8.3 **Biological Oxygen Demand (BOD):** Not pertinent
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Aerosol grade, technical grade
9.2 **Storage Temperature:** Data not available
9.3 **Inert Atmosphere:** Inerted
9.4 **Venting:** Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-X

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	0
Reactivity (Yellow)	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 84.93
12.3 **Boiling Point at 1 atm:** 104°F = 39.8°C = 313.0°K
12.4 **Freezing Point:** −142°F = −96.7°C = 176.5°K
12.5 **Critical Temperature:** 473°F = 245°C = 518°K
12.6 **Critical Pressure:** 895 psia = 60.9 atm = 6.17 MN/m^2
12.7 **Specific Gravity:** 1.322 at 20°C (liquid)
12.8 **Liquid Surface Tension:** Not pertinent
12.9 **Liquid Water Interfacial Tension:** Not pertinent
12.10 **Vapor (Gas) Specific Gravity:** 2.9
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.199
12.12 **Latent Heat of Vaporization:** 142 Btu/lb = 78.7 cal/g = 3.30 X 10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 16.89 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 13.9 psia

NOTES

ETHYLENE DICHLORIDE

EDC

Common Synonyms	Liquid	Colorless	Sweet odor
1, 2-Dichloroethane Ethylene chloride EDC Brocide Dutch liquid Glycol dichloride	Sinks in water. Flammable, irritating vapor is produced		

Avoid contact with liquid and vapor. Keep people away
Wear goggles, self-contained breathing apparatus, and rubber overclothing
(including gloves)
Shut off ignition sources and call fire department
Stop discharge if possible
Stay upwind and use water spray to "knock down" vapor
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

FLAMMABLE.
POISONOUS GASES ARE PRODUCED IN FIRE
Flashback along vapor trail may occur
Vapor may explode if ignited in an enclosed area
Wear goggles, self-contained breathing apparatus, and rubber overclothing
(including gloves)
Extinguish with dry chemical, foam, or carbon dioxide
Water may be ineffective on fire
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat
If inhaled, will cause nausea, dizziness or difficult breathing
Move to fresh air
If breathing has stopped, give artificial respiration
If breathing is difficult, give oxygen

LIQUID
Will burn skin and eyes
Harmful if swallowed
Remove contaminated clothing and shoes
Flush affected areas with plenty of water
IF IN EYES, hold eyelids open and flush with plenty of water
IF SWALLOWED and victim is CONSCIOUS, have victim drink water
or milk and have victim induce vomiting
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm

Water Pollution

Dangerous to aquatic life in high concentrations
May be dangerous if it enters water intakes

Notify local health and wildlife officials
Notify operators of nearby water intakes

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Disperse and flush

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** $ClCH_2CH_2Cl$
3.3 **IMO/UN Designation:** 3.2/1184
3.4 **DOT ID No.:** 1184
3.5 **CAS Registry No.:** 107-06-2

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Ethereal; chloroform-like; ether-like

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Clean, body-covering clothing and safety glasses with side shields. Respiratory protection: up to 50 ppm, none; 50 ppm to 2%, 1/2 hr or less, full face mask and canister; greater than 2%, self-contained breathing apparatus.
5.2 **Symptoms Following Exposure:** Inhalation of vapors causes nausea, drunkenness, depression. Contact of liquid with eyes may produce corneal injury. Prolonged contact with skin may cause a burn.
5.3 **Treatment of Exposure:** INHALATION: if victim is overcome, remove him to fresh air, keep him quiet and warm, and get medical attention immediately; if breathing stops, give artificial respiration. INGESTION: induce vomiting, call a physician; treat the symptoms. EYES: flush immediately with copious amounts of flowing water for at least 15 min. SKIN: remove clothing and wash skin thoroughly with soap and water; wash contaminated clothing before reuse.
5.4 **Threshold Limit Value:** 10 ppm
5.5 **Short Term Inhalation Limits:** 200 ppm for 5 min. during any 3-hour period
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 **Odor Threshold:** 100 ppm
5.11 **IDLH Value:** 1,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 60°F O.C., 55°F C.C.
6.2 **Flammable Limits in Air:** 6.2%-15.6%
6.3 **Fire Extinguishing Agents:** Foam, carbon dioxide, dry chemical
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases (hydrogen chloride, phosgene) are generated.
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 775°F
6.8 **Electrical Hazard:** Class I, group D
6.9 **Burning Rate:** 1.6 mm/min
6.10 **Adiabatic Flame Temperature:** Data Not Available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data Not Available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
150 ppm/*/pin perch/TL_m/salt water
*Time period not specified
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 0.002 lb/lb, 5 days
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Commercial
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	3
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 98.96
12.3 **Boiling Point at 1 atm:** 182.3°F = 83.5°C = 356.7°K
12.4 **Freezing Point:** −32.3°F = −35.7°C = 237.5°K
12.5 **Critical Temperature:** 550°F = 288°C = 561°K
12.6 **Critical Pressure:** 735 psia = 50 atm = 5.1 MN/m^2
12.7 **Specific Gravity:** 1.253 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 32.2 dynes/cm = 0.0322 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** (est.) 30 dynes/cm = 0.03 N/m at 25°C
12.10 **Vapor (Gas) Specific Gravity:** 3.4
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.118
12.12 **Latent Heat of Vaporization:** 138 Btu/lb = 76.4 cal/g = 3.2×10^5 J/kg
12.13 **Heat of Combustion:** (est.) 3400 Btu/lb
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 21.12 cal/g
12.26 **Limiting Value:** Data Not Available
12.27 **Reid Vapor Pressure:** 2.7 psia

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data Not Available
6.12 **Flame Temperature:** Data Not Available

TETRACHLOROETHYLENE

TTE

Common Synonyms	Watery liquid	Colorless	Sweet odor
Tetracap Perclene Perchloroethylene Perk	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible
Avoid contact with liquid and vapor
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire	Not flammable Poisonous gases are produced when heated
Exposure	CALL FOR MEDICAL AID **VAPOR** Irritating to eyes, nose and throat. If inhaled, will cause difficult breathing, or loss of consciousness. Move to fresh air If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **LIQUID** Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Not listed
3.2 **Formula:** $Cl_2C=CCl_2$
3.3 **IMO/UN Designation:** 6.0/1897
3.4 **DOT ID No.:** 1897
3.5 **CAS Registry No.:** 127-18-4

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Ethereal; like chloroform; mildly sweet

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.
5.2 **Symptoms Following Exposure:** Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.
5.3 **Treatment of Exposure:** INHALATION: if illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.
5.4 **Threshold Limit Value:** 50 ppm
5.5 **Short Term Inhalation Limits:** 100 ppm for 60 min.
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 5 ppm
5.11 **IDLH Value:** 500 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic, irritating gases may be generated in fires.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not flammable
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not flammable
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** Data not available

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Dry cleaning and industrial grades: 95+%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	0
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 165.83
12.3 **Boiling Point at 1 atm:** 250°F = 121°C = 394°K
12.4 **Freezing Point:** —8.3°F = —22.4°C = 250.8°K
12.5 **Critical Temperature:** 657°F = 347°C = 620°K
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.63 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 31.3 dynes/cm = 0.0313 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 44.4 dynes/cm = 0.0444 N/m at 25°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.116
12.12 **Latent Heat of Vaporization:** 90.2 Btu/lb = 50.1 cal/g = 2.10 X 10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

NOTES

TETRAHYDROFURAN

THF

Common Synonyms
Diethylene oxide
Tetramethylene oxide
THF

Liquid | Colorless | Faint fruity odor

Floats and mixes with water. Flammable, irritating vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, headache or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-high flammability
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Ether
3.2 Formula: $CH_2CH_2CH_2CH_2$-O
3.3 IMO/UN Designation: 3.1/2056
3.4 DOT ID No.: 2056
3.5 CAS Registry No.: 109-99-9

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ether-like, similar to acetone

5. *HEALTH HAZARDS*

5.1 Personal Protective Equipment: Self-contained breathing apparatus; goggles or face shield; rubber or plastic gloves.
5.2 Symptoms Following Exposure: Vapors cause nausea, dizziness, headache, and anesthesia. Liquid can de-fat the skin and cause irritation. Liquid also irritates eyes.
5.3 Treatment of Exposure: INHALATION: remove victim from contaminated area; administer artificial respiration and oxygen if necessary. INGESTION: gastric lavage and saline cathartics are usually helpful; subsequent treatment is symptomatic and supportive. SKIN OR EYE CONTACT: wash with copious amounts of water.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: *Grade 3; LD_{50} = 50 to 500 mg/kg*
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 20-50 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 6°F C.C.; —4°F O.C.
6.2 Flammable Limits in Air: 1.8%-11.8%
6.3 Fire Extinguishing Agents: Dry chemical or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Irritating vapor is generated when heated
6.6 Behavior in Fire: May explode. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 610°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4.7 mm/min
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable unless 0.1% of peroxides has accumulated because of prolonged storage in presence of air. When concentrated by evaporation of solution, they explode.
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: 0.025% butylated hydroxytoluene (BHT) present to prevent peroxide formation.
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 41

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. *SHIPPING INFORMATION*

9.1 Grades of Purity: Data not available
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: Padded
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	2
Aesthetic Effect	0
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	3

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 72.10
12.3 Boiling Point at 1 atm: 151°F = 66°C = 339°K
12.4 Freezing Point: —163.3°F = —108.5°C = 164.7°K
12.5 Critical Temperature: 512.6°F = 267.0°C = 540.2°K
12.6 Critical Pressure: 753 psia = 51.2 atm = 5.19 MN/m²
12.7 Specific Gravity: 0.888 at 20°C (liquid)
12.8 Liquid Surface Tension: 28 dynes/cm = *0.028 N/m at 20°C*
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.083
12.12 Latent Heat of Vaporization: 180 Btu/lb = 98 cal/g = 4.1 X 10^5 J/kg
12.13 Heat of Combustion: —14,990 Btu/lb = —8330 cal/g = —348.8 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.7 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

TOLUENE

TOL

Common Synonyms

Toluol
Methylbenzene
Methylbenzol

Watery liquid — Colorless — Pleasant odor

Floats on water. Flammable, irritating vapor is produced.

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Aromatic Hydrocarbon
3.2 **Formula:** $C_6H_5CH_3$
3.3 **IMO/UN Designation:** 3.2/1294
3.4 **DOT ID No.:** 1294
3.5 **CAS Registry No.:** 108-88-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Pungent; aromatic, benzene-like; distinct, pleasant

5. HEALTH HAZARDS

5.1 ***Personal Protective Equipment:*** *Air-supplied mask; goggles or face shield; plastic gloves.*
5.2 **Symptoms Following Exposure:** Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.
5.3 **Treatment of Exposure:** INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 600 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 2, LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** Kidney and liver damage may follow ingestion
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 0.17 ppm
5.11 **IDLH Value:** 2,000 ppm

6. FIRE HAZARDS

6.1 ***Flash Point:*** 40°F C.C.; 55°F O.C.
6.2 ***Flammable Limits in Air:*** 1.27%-7%
6.3 **Fire Extinguishing Agents:** Carbon dioxide or dry chemical for small fires, ordinary foam for large fires
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back
6.7 **Ignition Temperature:** 997°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 ***Burning Rate:*** *5.7 mm/min.*
6.10 **Adiabatic Flame Temperature:** Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 ***Reactivity Group:*** *32*

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
1180 mg/l/96 hr/sunfish/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 0%, 5 days; 38% (theor), 8 days
8.4 ***Food Chain Concentration Potential:*** None

9. SHIPPING INFORMATION

9.1 ***Grades of Purity:*** Research, reagent, nitration-all 99.8 + %; industrial contains 94 + %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120 less pure than industrial
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (*Blue*)	*2*
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 92.14
12.3 **Boiling Point at 1 atm:** 231.1°F = 110.6°C = 383.8°K
12.4 **Freezing Point:** −139°F = −95.0°C = 178.2°K
12.5 **Critical Temperature:** 605.4°F = 318.6°C = 591.8°K
12.6 **Critical Pressure:** 596.1 psia = 40.55 atm = 4.108 MN/m^2
12.7 **Specific Gravity:** 0.867 at 20°C (liquid)
12.8 ***Liquid Surface Tension:*** 29.0 dynes/cm = 0.0290 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 36.1 dynes/cm = 0.0361 N/m at 25°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.069
12.12 **Latent Heat of Vaporization:** 155 Btu/lb = 86.1 cal/g = 3.61 X 10^5 J/kg
12.13 **Heat of Combustion:** −17,430 Btu/lb = −9686 cal/g = −405.5 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 17.17 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 1.1 psia

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 *Flame Temperature:* Data not available

JUNE 1985

TRICHLOROETHYLENE

TCL

Common Synonyms

Trichloroethylene
Triclene, Algylen
Chlorylen
Gemalgene
Trethylene
Trichloran, Trilene

Watery liquid — Colorless — Sweet odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** $CHCl=CCl_2$
3.3 **IMO/UN Designation:** 9.0/1710
3.4 **DOT ID No.:** 1710
3.5 **CAS Registry No.:** 79-01-6

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Chloroform-like; ethereal

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or vinyl gloves; chemical safety goggles, face-shield, neoprene safety shoes; neoprene suit or apron for splash protection.
5.2 **Symptoms Following Exposure:** INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slightly irritating sensation and lachrymation.
5.3 **Treatment of Exposure:** Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water.
5.4 **Threshold Limit Value:** 50 ppm
5.5 **Short Term Inhalation Limits:** 200 ppm for 30 min
5.6 **Toxicity by Ingestion:** Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 50 ppm
5.11 **IDLH Value:** 1,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 90°F C.C.; practically nonflammable
6.2 **Flammable Limits in Air:** 8.0%-10.5%
6.3 **Fire Extinguishing Agents:** Water fog
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases are produced in fire situations
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 770°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not pertinent
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
660 mg/l/40 hr/daphnia/kill/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 ***Biological Oxygen Demand (BOD):*** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Technical, dry cleaning, degreasing, extraction
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 131.39
12.3 **Boiling Point at 1 atm:** 189°F = 87°C = 360°K
12.4 **Freezing Point:** −123.5°F = −86.4°C = 186.8°K
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.46 at 20°C (liquid)
12.8 **Liquid Surface Tension:** *29.3 dynes/cm = 0.0293 N/m at 20°C*
12.9 **Liquid Water Interfacial Tension:** 34.5 dynes/cm = 0.0345 N/m at 24°C
12.10 **Vapor (Gas) Specific Gravity:** 4.5
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.116
12.12 **Latent Heat of Vaporization:** 103 Btu/lb = 57.2 cal/g = 2.4×10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 2.5 psia

NOTES

VINYL CHLORIDE

VCM

Common Synonyms
Chlorethylene
VCL
Vinyl C Monomer
VCM

Gas | Colorless | Sweet odor

Liquid floats and boils on water. Flammable, irritating visible vapor cloud is produced

Stop discharge if possible. Keep people away
Shut off ignition sources and call fire department
Stay upwind and use water spray to "knock down" vapor
Evacuate area in case of large discharge
Avoid contact with liquid and vapor
Notify local health and pollution control agencies

Fire

FLAMMABLE.
POISONOUS GAS IS PRODUCED IN FIRE.
Flashback along vapor trail may occur
May explode if ignited in an enclosed area
Wear self-contained breathing apparatus
Cool exposed containers and protect men effecting shutoff with water
Stop flow of gas if possible
Let fire burn
Extinguish small fires with dry chemical

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air
If breathing has stopped, give artificial respiration
If breathing is difficult, give oxygen

LIQUID
Will cause frostbite
Flush affected areas with plenty of water
DO NOT RUB AFFECTED AREAS

Water Pollution

Not harmful to aquatic life

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-high flammability
Evacuate area

2. LABEL

2.1 **Category:** Flammable gas
2.2 **Class:** 2

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Vinyl halides
3.2 **Formula:** $CH_2{=}CHCl$
3.3 **IMO/UN Designation:** 2.0/1086
3.4 **DOT ID No.:** 1086
3.5 **CAS Registry No.:** 75-01-4

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquefied compressed gas
4.2 **Color:** Colorless
4.3 **Odor:** Pleasant, sweet

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Rubber gloves and shoes; gas-tight goggles; organic vapor canister or self-contained breathing apparatus.
5.2 *Symptoms Following Exposure:* INHALATION: *high concentrations cause dizziness, anesthesia,* lung irritation. SKIN: may cause frostbite, phenol inhibitor may be absorbed through skin if large amounts of liquid evaporate
5.3 **Treatment of Exposure:** INHALATION: remove patient to fresh air and keep him quiet and warm; call a doctor; give artificial respiration if breathing stops. EYES AND SKIN: flush with plenty of water for at least 15 min.; for eyes, get medical attention; remove contaminated clothing
5.4 **Threshold Limit Value:** 5 ppm
5.5 **Short Term Inhalation Limits:** 500 ppm for 5 min
5.6 **Toxicity by Ingestion:** Not pertinent
5.7 **Late Toxicity:** Chronic exposure may cause liver damage
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin. May cause frostbite
5.10 **Odor Threshold:** 260 ppm
5.11 **IDLH Value:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** −110°F O.C.
6.2 **Flammable Limits in Air:** 4%-26%
6.3 **Fire Extinguishing Agents:** For small fires use dry chemical or carbon dioxide. For large fires stop flow of gas. Cool exposed containers with water
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Forms highly toxic combustion products such as hydrogen chloride, phosgene, and carbon monoxide
6.6 **Behavior in Fire:** Container may explode in fire. Gas is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 882°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 4.3 mm/min.

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Polymerizes in presence of air, sunlight, or heat unless stabilized by inhibitors.
7.6 **Inhibitor of Polymerization:** Not normally used except when high temperatures are expected. Then 40-100 ppm of phenol used.
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 35

8. WATER POLLUTION

8.1 *Aquatic Toxicity:* None
8.2 **Waterfowl Toxicity:** None
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 *Grades of Purity:* Commercial or technical 99+%
9.2 *Storage Temperature:* Under pressure, ambient. At atm. pressure, low
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Under pressure, safety relief. At *atm. pressure, pressure-vacuum*

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-B-C-D-E-F-G-Z

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable gas
11.2 ***NAS Hazard Rating for Bulk Water Transportation:***

Category	Rating
Fire	4
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	0
Aesthetic Effect	0
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	2

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	4
Reactivity (Yellow)	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Gas
12.2 **Molecular Weight:** 62.50
12.3 **Boiling Point at 1 atm:** 7.2°F = 13.8°C = 259.4°K
12.4 **Freezing Point:** −244.8°F = −153.8°C = −119.4°K
12.5 **Critical Temperature:** 317.1°F = 158.4°C = 431.6°K
12.6 **Critical Pressure:** 775 psia = 52.7 atm = 5.34 MN/m²
12.7 **Specific Gravity:** 0.969 at −13°C (liquid)
12.8 **Liquid Surface Tension:** 16.0 dynes/cm = 0.0160 N/m at 25°C
12.9 **Liquid Water Interfacial Tension:** (est.) 30 dynes/cm = 0.03 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** 2.2
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.186
12.12 **Latent Heat of Vaporization:** 160 Btu/lb = 88 cal/g = 3.7×10^5 J/kg
12.13 **Heat of Combustion:** −8136 Btu/lb = −4520 cal/g = -189.1×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** −729 Btu/lb = −405 cal/g = 16.9×10^5 J/kg
12.25 **Heat of Fusion:** 18.14 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 75 psia

6. FIRE HAZARDS (Continued)

6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** 5.490 (Est.)
6.12 **Flame Temperature:** Data not available

VINYLIDENE CHLORIDE

VCI

Common Synonyms

1, 1-Dichloroethylene
unsym-Dichloroethylene

Watery liquid — Colorless — Sweet odor

Sinks in water. Flammable, irritating vapor is produced.
Boiling point is 89°F

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Evacuate area in case of large discharge.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
POISONOUS GAS IS PRODUCED IN FIRE.
Containers may explode in fire.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Combat fires from safe distance or protected location.
Extinguish with dry chemical, foam, or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area.

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Vinyl halides
3.2 **Formula:** $CH_2=CCl_2$
3.3 **IMO/UN Designation:** 3.1/1303
3.4 **DOT ID No.:** 1303
3.5 **CAS Registry No.:** 75-35-4

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Sweet; like carbon tetrachloride or chloroform

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister or air-supplied mask; goggles or face shield; rubber gloves and boots.
5.2 **Symptoms Following Exposure:** Vapor can cause dizziness and drunkenness; high levels cause anesthesia. Liquid irritates eyes and skin.
5.3 **Treatment of Exposure:** INHALATION: if any illness develops, remove person to fresh air promptly, keep warm and quiet, and get medical attention; if breathing stops, start artificial respiration. INGESTION: not likely a problem; no known antidote; treat symptomatically. EYES OR *SKIN: flush with plenty of water for at least 15 min.; get medical attention for eyes; remove* contaminated clothing and wash before reuse.
5.4 **Threshold Limit Value:** 10 ppm
5.5 **Short Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 3; Oral LD_{50} = 24 hr = 84 mg/kg (adrenalectomized rat)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** 0°F O.C.
6.2 **Flammable Limits in Air:** 7.3%-16.0%
6.3 **Fire Extinguishing Agents:** Foam, carbon dioxide, dry chemical
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Toxic hydrogen chloride and phosgene are generated in fires.
6.6 **Behavior in Fire:** May explode in fire due to polymerization. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 955—1031°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** 2.7 mm/min.
6.10 ***Adiabatic Flame Temperature:*** Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** Copper and aluminum can cause polymerization
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Can occur if exposed to sunlight, air, copper, aluminum, heat
7.6 **Inhibitor of Polymerization:** 200 ppm methyl ether of hydroquinone, 0.6-0.8% phenol
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 35

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** 99%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** Padded
9.4 **Venting:** Pressure-vacuum

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y-Z

11. HAZARD CLASSIFICATIONS

11.1 *Code of Federal Regulations:* Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation**

Category	Rating
Fire	4
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	3
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	3

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	4
Reactivity (Yellow)	2

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm.:** Liquid
12.2 **Molecular Weight:** 96.95
12.3 **Boiling Point at 1 atm:** 88.9°F = 31.6°C = 304.8°K
12.4 **Freezing Point:** −187.6°F = −122.0°C = 151.2°K
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.21 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 24 dynes/cm = 0.024 N/m at 15°C
12.9 **Liquid Water Interfacial Tension:** 37 dynes/cm = 0.037 N/m at 22.7°C
12.10 ***Vapor (Gas) Specific Gravity:*** 3.3
12.11 **Ratio of Specific Heats of Vapor (Gas):** Data not available
12.12 **Latent Heat of Vaporization:** 130 Btu/lb = 72 cal/g = 3.0×10^5 J/kg
12.13 **Heat of Combustion:** −4860 Btu/lb = −2700 cal/g = -113.0×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** −333 Btu/lb = −185 cal/g = -7.75×10^5 J/kg
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 18.3 psia

APPENDIX C

ENDANGERMENT ASSESSMENT PLAN

HAGEN FARM RI/FS
ENDANGERMENT ASSESSMENT PLAN

INTRODUCTION

The endangerment assessment objective is to provide insight into the probability and magnitude of harm to public health and the environment, by potential release of hazardous materials from the site. The evaluation will be performed according to the procedures presented in the Superfund Public Health Evaluation Manual (ICF for EPA, 1986).

The steps to be taken in carrying out the endangerment assessment are as follows:

- Choose the indicator chemicals for the "no-action" alternative.
- Define the sources and quantify their release rates.
- Identify the possible migration pathways, exposure points and receptors.
- Quantify the combinations of the above three items that could plausibly result in human exposure to the contaminants.
- Compare the exposure point concentrations with the applicable or relevant regulatory standards or criteria.
- Where applicable regulatory criteria are unavailable for all of the indicator chemicals, evaluate the health risks in detail using the standard toxicity data.
- Human Intake/Toxicity Assessment-Sum the health risks for each route of exposure, indicator chemical and exposure point to obtain two overall risk values for the "no-action" alternative; one risk will be for carcinogenic health effects and the other for noncarcinogenic health effects.
- Summarize the results of the above steps.

The endangerment assessment will be prepared in two phases. A preliminary assessment will be developed as part of the Draft RI Report. A final endangerment assessment, incorporating results of the preliminary assessment, will be provided in the Final RI Report.

PRELIMINARY ASSESSMENT

The preliminary risk assessment identifies potential public health problems, determines on-site contaminants and identifies potential human exposure pathways. Potential release sources/mechanisms are determined along with human exposure points.

The preliminary assessment is qualitative and will identify additional data needs for the final endangerment assessment. The level of detail in the preliminary assessment will be based on available data from previous investigations (historical data) and the data obtained from Technical Memorandum No. 1 (Subtasks 2.1 and 2.2) covering initial site investigation activities.

The report generated from the preliminary risk assessment will contain, to the extent practicable, the following types of information:

- Identity of chemicals present at the site.
- Chemical concentrations measured in various media.
- Primary toxic effects associated with chemicals found at the site.
- Potential human exposure pathways identified at the site.
- Likelihood of chemical release and migration from the site; time over which releases/exposures are expected; basis for estimates; relevant information on hydrogeology, weather patterns and other environmental characteristics that would affect chemical migration.
- Potential for human exposure and chemicals and media that would be involved; estimates of number and locations of potentially affected populations; presence and characterization of sensitive populations.
- Uncertainty associated with existing information; major sources of the uncertainty; assumptions made in the analysis; and
- Relevant or applicable environmental standards for the chemicals of interest; comparison to concentrations found at the site (specifying point of consumption or concentrations at the source).

FINAL ENDANGERMENT ASSESSMENT

The following four main elements will be assessed in addressing the overall objective of the endangerment assessment:

- Hazard Identification
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

Environmental (ecological) impacts will be considered although emphasis will be placed on human health and well-being.

The above four elements are evaluated based upon the following specific components:

- Hazardous substances and/or hazardous wastes present in all relevant media (e.g., air, water, soil, sediment, biota);
- Environmental fate and transport mechanisms within specified environmental media, such as physical, chemical and biological degradation processes and hydrogeological evaluations and assessments;
- Exposure pathways and extent of expected exposure;
- Populations at risk;
- Toxicological properties of specified hazardous substances or hazardous wastes; and
- Extent of expected harm and the likelihood of such harm occurring (i.e., risk characterization).

KJD/jpl/SGW
[jpl-600-14d]

APPENDIX D

DATA MANAGEMENT PLAN

TABLE OF CONTENTS

INTRODUCTION

The purpose of this document is to define a Data Management Plan for the Hagen Farm Site RI/FS, which will be implemented to document and track investigation data and results. The plan identifies field and laboratory data documentation materials and procedures, project file requirements and project related progress reporting procedures and documents. Formats for documents are established in this Plan.

The forms and procedures defined will be used by Warzyn in the assembly, use and filing of data, both in the field and office and in the documentation of these activities.

FIELD DOCUMENTATION

A. Field Log Book

A daily log covering field activities and conditions is to be maintained by the on-site Team Leader in the field. The log is to be hand written in a bound, hard-covered field note book. Entries are to be made for all working days. Format shall be as follows:

Date ____________ Recorder ____________

Weather ____________

Present on Site ______ (list by employer) ______

____

Activities ______ (list by employer) ______

____

Equipment ______ (list by employer) ______

____

Visitors ______ (list by employer) ______

____

B. Field Reports

A weekly report summarizing field activities for the preceding week shall be issued from the field as a memorandum on the morning of the first workday of each week. This report shall be sent by overnight mail or hand delivered to the Warzyn Project Manager and the Respondent Project Manager. The form of this report shall be the same as for the Field Log Book.

C. Boring Logs

- Boring logs are to be recorded on standard forms provided by Waste Management, Inc.
- Boring logs will record time, date, location by on-site coordinate system, elevation, samples taken and soil sampling technique used.

D. Sampling Records (QAPP - Sampling Plan)

Document protocols for the identification and tracking of samples are presented in the QAPP (Volume 3).

E. Field Files

The following files shall be established and maintained in the field:

- Field Log Book
- Field Weekly Reports
- Correspondence
- Sampling Records
    - Laboratory Set-up Documentation
    - Container/Packaging Documentation
    - Sample Tags
    - Chain of Custody Records
    - Sample Tracking Matrix

LABORATORY DOCUMENTATION

A. Laboratory Log Book

Laboratory log books will record sample receipt dates, laboratory work dates and analysis issue dates. These records will be accessible for tracking purposes.

B. Laboratory Data

Written reports of laboratory analyses will first be issued to the Respondents. The Warzyn Project Manager will review and distribute the results to WDNR and U.S. EPA.

DATA ANALYSIS

A. Sample Tracking

The sample tracking will be initiated in the field using unique tags and labels for each sample. Sample numbers will be recorded in a bound daily notebook prior to shipping the samples to the laboratory. The laboratory will assign a unique sample number to each sample upon receipt. Further detail on laboratory sample tracking can be found in Appendix E of the QAPP (Volume 3).

B. Data Analysis

Procedures and forms for data analysis are not pre-established. Appropriate procedures are to be selected by the technical personnel performing the tasks. Comparative charting, graphing and mathematical modeling are among the procedures which may be used.

C. Reports

Detailed reports of analysis shall be prepared for all groups of data. The reports shall contain:

- The Data Analyzed
- Description of Analytical Procedure
- Discussion of Data Limitations
- Definition of Additional Data Requirements
- Discussion of Analytical Results
- Conclusions
- Recommendations

D. Filing

The following files shall be set up and maintained with regard to data analysis:

- Sample Tracking
- Laboratory Reports
- Analytical Reports

MANAGEMENT REPORTS

A. Monthly Progress Report (Technical)

A monthly report shall be prepared by Warzyn to define the technical progress of the project and shall be submitted to the Respondents' Project Manager by the seventh of each month. The Respondents' Project Manager will submit the monthly progress report to WDNR and U.S. EPA by the fifteenth of each month pursuant to Administrative Order by Consent (AOC). This report shall include the following:

1. Description of actions which have been taken toward achieving compliance with the AOC;
2. Results of sampling and tests received by the Respondents that have been through data validation, quality assurance checks;
3. Results of field measurements (e.g., surveying notes) and/or screening activities (e.g., HNu readings) will be reported as raw data.
4. Plans and procedures completed subsequent to U.S. EPA approval of the RI/FS Work Plan, during the past month as well as such actions, data, and plans which are scheduled for the next month;
5. Description of difficulties encountered during the reporting period, actions taken to rectify difficulties and changes in the schedule due to the difficulties; and
6. A summary of QA/QC activities, including documentation, will be presented.

B. Progress Chart

The basic work schedule for the project is contained in the project schedule (Appendix A of the Work Plan - Volume 2). It will be updated monthly to indicate current status in comparison with original schedule and issued as part of the Monthly Progress Reports described above.

C. Report Filing

Separate files are to be established for the Monthly Progress Reports and the Progress Charts.

TASK REPORTS

A. Final Report

The Final Reports will include the results of the Phase II and Phase III activities. The Final Reports will incorporate all technical memoranda authored during the respective phase.

B. Report Filing

A complete set of all reports will be maintained in Warzyn's office.

WORK PLAN AND SUPPORTING PLANS

A. Contents

The plans for the Hagen Farm RI/FS are:

- Project Work Plan
- Sampling Plan
- Quality Assurance Project Plan
- Health and Safety Plan
- Data Management Plan

These plans contain the necessary procedures for the Remedial Investigation. They include a detailed discussion of technical approach and an approximate schedule. These are "working documents" structured to accommodate changes during the course of the project. Revisions (i.e., changed pages or new pages) will be issued as necessary to reflect authorized changes in Work Plan activities.

B. Filing

The Work Plan and other planning documents are to be kept in the binders in which they are submitted. Revisions will be distributed in the form of addenda to individual plans.

C. Control

Copies of the planning documents will be numbered sequentially. A record will be maintained of the distribution of these copies. Receipts for revisions will be requested from holders of the copies.

DOCUMENT AND COMMUNICATION FILES

A. Data Furnished by the Respondents

Files of data furnished for use during the project are in the possession of Warzyn. Out cards shall be inserted for items taken from these files. File contents and structure are full described in Appendix F of the QAPP (Volume 3).

B. Communications

1. A communications control desk will be established at the RI/FS Contractor's office. Correspondence shall be routed to communications

control for filing and/or distribution. This function will be carried out by the Warzyn Project Manager.

2. Communication with U.S. EPA and WDNR shall be through the Respondents' Project Manager only.

3. Communication between the Respondents and Warzyn shall be between the respective project managers, or as otherwise directed by the Project Managers.

4. Internal communications shall be duly recorded. Copies of written communications and written notes of telephone conversations shall be forwarded to communications control.

5. Communications with vendors, Consultants' material suppliers or others, are to be recorded with copies to communications control. Copies of all such items are to be forwarded to the Respondents' Project Manager within five days.

6. <u>Communication Control</u>: Correspondence shall pass through communications control. Communications control will assign a sequential number to each document. This number will comprise two letters and a digit. The first letter will signify the writer and the second letter the addressee. The digit will be a sequential number. The letters to be used will be D for WDNR, W for Warzyn (if Warzyn is the RI/FS Contractor), E for EPA, R for the Respondents and X for all others. Separate sequence numbers shall be established for letters, notes of telephone conversations and internal memoranda. Thus:

   Letter WJ12 would be the twelfth letter from Warzyn to the Respondents.

   Telecon WE12 would be notes of the twelfth telephone conversation between Warzyn and EPA.

   Letter XW12 would be the twelfth letter received by Warzyn from an outside source.

7. <u>Reading File</u>: *A reading file containing copies of current* correspondence will be routed periodically, not less than weekly, to staff identified on the project organization chart (see QAPP -Volume 3).

DOCUMENT SUBMITTAL

The Work Plan and revisions shall be distributed by overnight delivery service or hand delivered. The Monthly Progress Reports to the Respondents' Project Manager may be distributed by mail or hand delivered. Documents will be submitted in the quantities required in the consent agreement and will be sent to the Respondents' Project Manager. Documents will be submitted to the U.S. EPA and WDNR by the Respondents' Project Manager.