137979

- U. S. Environmental Protection Agency. 1982. Test methods for evaluating solid waste. 2nd ed. SW-846.
- U. S. Environmental Protection Agency. 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. 2nd ed. EPA-600/4-84-076.

3.0 RESPONSIBILITIES

The site coordinator (field team leader) or his designee is responsible for ensuring that all groundwater sampling is performed in accordance with the project specific sampling plan, this SOP, and the appropriate QA/QC SOP. In addition, the site coordinator must ensure that all field workers are fully apprised of these SOPs. The project engineer/scientist should be contacted for specific instructions.

4.0 REQUIRED MATERIALS

The list below identifies typical pieces of equipment that may be used for a wide range of groundwater sampling applications. From this list, project specific equipment should be selected based upon project objectives, the depth to groundwater, purge volumes, analytical requirements and well construction.

- Purging/Sample Collection Equipment

  Bailers
  Centrifugal pump
  Submersible pump
  Peristaltic pump
  Bladder pump

- Related Sampling Equipment

  Thermometer
  pH meter
  Specific conductance meter
  Filtration apparatus (vacuum or pressure)
  Water-level measurement equipment

- General Materials

  Goggles or equivalent eye protection
  Distilled water and dispenser bottle
  Decontamination liquids
  Field data sheets and/or log book
  Sample preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First aid kit
  Key(s) for well locks
  Stopwatch

- Expendable Materials

  Pump tubing
  Bailer cord
  Gloves
  Filters

Chemical-free paper towels
Protective coverall, e.g., Tyvek

5.0 SAFETY PRECAUTIONS

Creosote and PCP are two chemical constituents which are health and safety concerns when conducting groundwater sampling. To reduce the potential for skin contact with these constituents, it is advisable that polyvinyl or other similar gloves be worn when conducting sampling activities. Safety shoes, hard hat, and safety glasses should also be worn.

6.0 PROCEDURE

6.1 Sample Bottle Preparation

Three general types of analyses are performed on groundwater samples (i) conventional pollutants, (ii) metallic pollutants, and (iii) priority pollutants and Appendix VIII constituents. The protocols for preparing the bottles for each type of analyses are discussed below.

6.1.1 Conventional Pollutants

1. Use new bottles with screw-type lids.

2. Prelabel and prepreserve (where appropriate) all bottles prior to shipping sample bottles to field.

3. Place bottles in suitable shipping packages, for example, ice chests with adequate packing material to reduce bottle breakage (see SOP 502).

6.1.2 Metallic Pollutants

1. Use new polyethylene collapsible containers with plastic screw-type lids.

2. Clean new container:

   - Rinse with 1:1 nitric acid.
   - Rinse with tap water four times.
   - Rinse with distilled water four times.

3. Prelabel all containers prior to shipping sample bottles. Add preservative material at the job site.

4. Place container in suitable shipping package, for example, ice chests with adequate packing material to reduce bottle breakage.

6.1.3 Organics Other Than Volatiles

1. Use new bottles with screw-type lids. (For PAH use new amber bottles with Teflon lids.)

2. Clean new bottles:

   - Wash with hot soapy water.
   - Rinse with tap water three times.
   - Rinse with distilled water three times.
   - Wash with acetone.
   - Wash with hexanes (pesticide grade).

- Dry with pure nitrogen.

3. Prelabel and prepreserve bottles.

4. Place in suitable shipping package.

6.1.4 Volatile Organic Aromatics (VOAs)

1. Use new bottles with screw-type lids.
2. Clean new bottles:

   - Wash with hot soapy water.
   - Rinse with tap water three times.
   - Rinse with distilled water three times.
   - Air dry.
   - Heat for approximately three hours at 100°C.
   - Soak septum for approximately three hours in methanol, then heat at 100°C for 10-15 minutes.

6.2 Bailer Preparation

Clean stainless steel bailers for all sampling:

- Wash with hot soapy water.
- Rinse with tap water three times.
- Rinse with 1:1 nitric acid.
- Rinse with distilled water three times.
- Wash with acetone (pesticide grade).

6.5.3 Centrifugal Pump

6.5.3.1 Direct Connection Method

1. Establish direct connection to the monitoring well using pipe connections, extensions, and elbows, with Teflon tape wrapping on all threaded connections. Pipe material may be steel or other suitable material. If the centrifugal pump will subsequently be used for sample collection, a sample isolation chamber will be placed in the suction line configuration as shown in Figure 2.

2. Prime the pump by adding tap water or water from the well to the pump housing until the housing begins to overflow.

3. Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity.

4. Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement should be performed three times to obtain an average rate. Pumping will be observed at all times to determine if pumping rates are continuous, fluctuating, or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

5. Collect purged water in buckets and dispose of in plant wastewater treatment systems, if available.

6. Collect samples after the required purge volume has been withdrawn. Remember to fill VOA vials first and <u>do not</u> filter VOA samples.

7. Decontaminate all suction line parts after each well use.

6.5.3.2 Down Well Suction Line Method

1. Lower a new suction line into the well. The suction line will have a total length at least great enough to extend to the water table and account for several feet of drawdown. All connections will be made using Teflon ferrules and Teflon thread wrapping tape.

2. Prime the pump by adding tap water or well water to the pump housing until the housing begins to overflow.

3. Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity.

4. Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement should be performed three times to obtain an average rate. Pumping will be observed at all times to determine if pumping rates are continuous, fluctuating or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

5. Collect purged water in buckets and dispose of in plant wastewater treatment system, if available.

6. Collect samples after the required purged volume has been withdrawn. Remember to fill VOA vials first and do not filter VOA samples.

7. Close valve at the pump on the line whenever pumping terminates or pumping is stopped. This practice will minimize the return to the well of water which has contacted the inside of the pump housing.

8. Decontaminate all suction line tubing after each use if tubing is to be reused or use new tubing.

6.5.4 Submersible Pump

1. Prior to using a submersible pump, a check will be made of well diameter and alignment. A 1.75-inch diameter decontaminated cylindrical tube about the length and diameter of the pump should be lowered to the bottom of each monitoring well to determine if the alignment or plumbness of a well is adequate to accommodate the submersible pump. The well alignment survey may also be used to determine the total depths of wells. All observations will be entered in the field log book.

2. Lower the submersible pump into the monitoring well taking notice of any roughness or restrictions within the riser.

3. Count the graduations on the pump discharge line and stop lowering when the stainless steel portion is below the uppermost section of the static water column and also within the middle to bottom screened portion of the monitoring well. Secure the safety line to the well casing.

4. Connect the power cord to the power source (for example, rechargeable battery pack or auto battery monitor) and turn the pump on (forward mode).

5. Monitor drawdown continuously by remaining near the well at all times and listening to the pump. If drawdown continues to the extent that the well is pumped dry, the well will be allowed to recharge. The rate of recharge will be approximately determined by re-starting the submersible pump after a ten (10) minute waiting period. The pumping rate shall be remeasured and/or the total discharge volume collected to determine the recharge volume.

6. Direct the pump discharge to a graduated bucket or a bucket of known capacity.

7. Measure the pumping rate in gallons per minute by recording the time required to fill the bucket. Flow measurements shall be performed three times to obtain an average rate.

8. Collect purged water in buckets and dispose of in plant wastewater treatment system, if available.

9. Collect samples after purging.

10. Fill VOA vials first and do not filter VOA samples. Fill bottles directly from the discharge line of the pump taking care not to touch sample bottles to the discharge line.

11. Decontaminate pump, discharge line and power cord after each use.

6.5.5 Well (Bladder) Pump

1. Using a cleaned pump and tubing assembly, connect the line assembly to the pump by first attaching the cable and then connecting the sample and gas lines.

2. Lower pump down the well by unrolling the line off the spool until the pump touches bottom. Raise the pump 3 to 5 feet off the bottom or until 6 to 8 feet of tubing remains out of the well.

3. Secure the cable to hold the pump at the desired depth.

4. Connect the gas line to the control box. The discharge line should be placed in a container to collect the purged water (i.e., a 55 gallon drum).

5. Connect the gas supply to the control box and adjust pressure according to the manufacturer's manual.

6. Turn on control box and adjust inflate delay to obtain the best pumping cycle.

7. The pumping rate should be calculated to determine the length of time the pump should run to purge the well. Conductance and pH may be used to determine when enough water has been purged.

8. After purging is completed, the pump should be removed and the sample collected as outlined in Section 6.5.1.

6.5.6 Sample Filtration

Depending on the parameters to be analyzed for and the state and federal regulations some samples may require filtration before being placed in the sample containers. Filtration can be performed directly using the peristaltic pump as described in Section 6.5.2, or the groundwater sample can be placed in an intermediate container and filtered using a vacuum or pressure apparatus. When using a vacuum or pressure filtration apparatus, the pH and conductivity of the sample are measured before filtering. A clean funnel is used for each sample. The funnels are cleaned using the procedure outlined in Section 6.

7.0 QUALITY CONTROL

Quality control begins with the preparation of a concise sampling plan which identifies the location, number, and specific methods to be employed by field personnel in the collection of groundwater samples. Second, the guidance provided in this SOP should be adhered to unless otherwise specified in the sampling plan. Both the sampling plan and this SOP should be reviewed by all personnel participating in field collection activities. Both documents should be available in the field for reference.

A trip blank will accompany the sample bottle shipment and be returned to the laboratory for analysis as specified by the project engineer/scientist. One trip blank per sampling event is the minimum requirement.

A field blank will be collected by pouring laboratory distilled water into a laboratory cleaned bailer. The water is collected and distributed to the appropriate sample bottles. One field blank, each day groundwater monitoring wells are sampled, is the minimum requirement.

Other SOPs which discuss procedures for sample labeling, preservation, shipment, chain-of-custody, quality assurance/quality control and sampling equipment decontamination should be used and referred to frequently.

8.0 DOCUMENTATION

A number of different documents will be completed and maintained as a part of the groundwater sampling. These documents will provide a summary of the sample collection procedures and conditions, shipment method, the analysis requested and the custody history. The list of documents is as follows:

- Groundwater sample collection record.
- Sample labels.
- Chain-of-custody forms.
- Shipping receipts.

Sample labels shall be completed at the time each sample is collected and will include the information listed below.

- Client or project name.
- Sample number.
- Designation (i.e., identification of sample point number).
- Analysis.
- Preservative (e.g., filtration, acidified pH 2 HNO_3).
- Sample collection date.
- Sampler's initials.

The chain-of-custody form is to record sample collection and transfer of custody. Information such as the sample collection date, sample identification and origination, and client or project name shall be entered on each chain-of-custody record. In accordance with

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40 CFR 261.4(d) the following information must accompany all groundwater samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply. Such information is as follows.

- Sample collector's name, mailing address and telephone number.
- Analytical laboratory's name, mailing address and telephone number.
- Quantity of each sample.
- Date of shipment.
- Description of sample..

The chain-of-custody form provides a location for entry of the above listed information.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

FIELD DATA SHEET FOR GROUNDWATER SAMPLING

PLANT:	DATE OF WELL LEVELS: DATE OF SAMPLING:	**SAMPLED BY:**
PROJECT:	**SAMPLING METHOD:**	**WEATHER:**

Site No.	Time	Well Dia. (in.)	Depth of Well (ft) (including stickup)	Depth to H_2O in Well (ft)	Depth of H_2O in Well (ft)	Number of Bails Removed	Dry at Number of Bails Removed	In-situ Measurements								
								pH (units)				Conductivity (umhos/cm)				Temp. (C°)

SITE NO.	OBSERVATIONS

CHAIN OF CUSTODY RECORD

PLANT CODE

PROJECT NAME

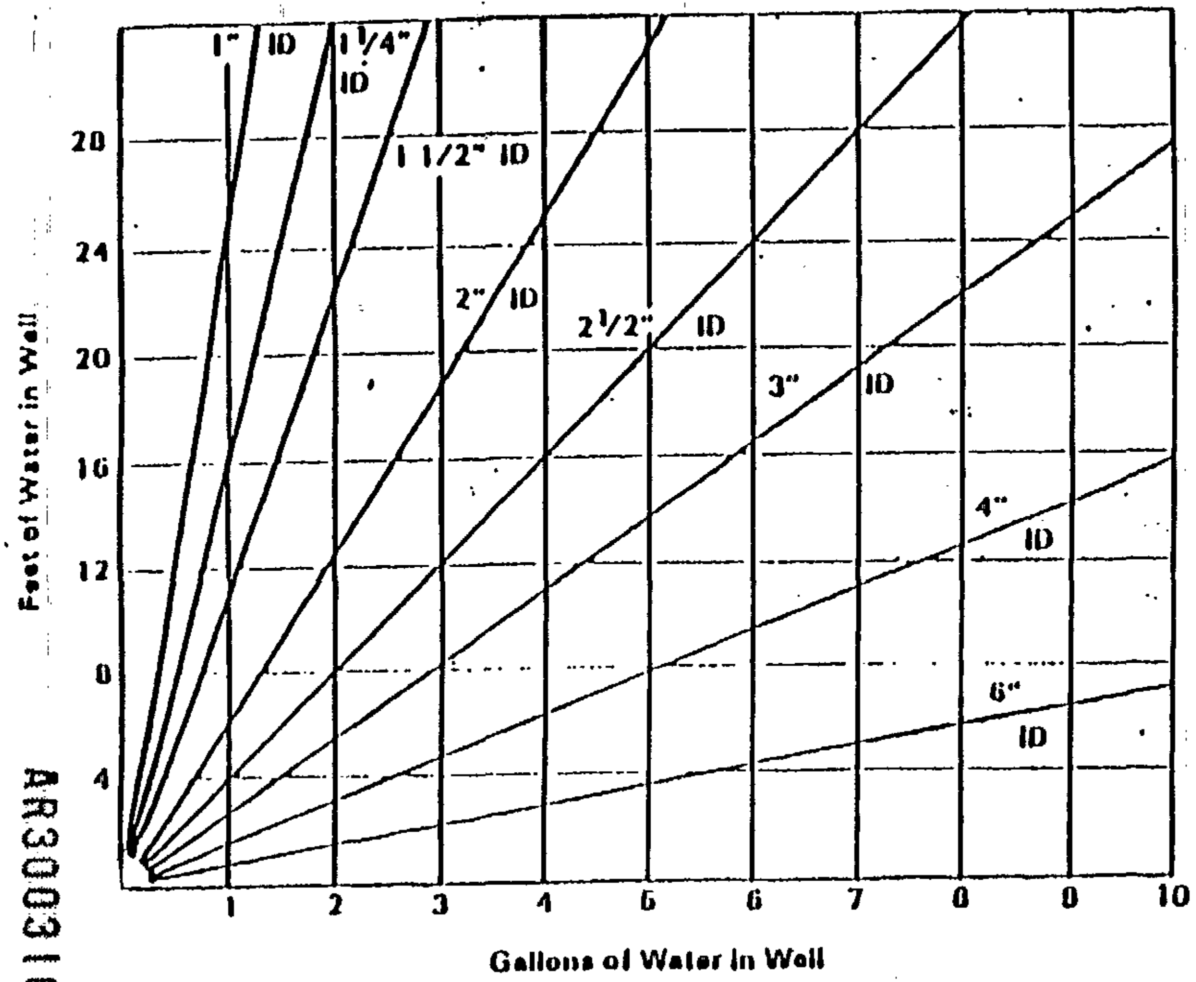
SAMPLERS *(Signature)*

STA. NO.	DATE	TIME	COMP.	GRAB	[illegible]	STATION LOCATION	NUMBER OF CONTAINERS						REMARKS OR OBSERVATIONS

Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received for Laboratory by: *(Signature)*	Date	Time	Remarks:	

DISTRIBUTION: Original accompanies shipment; Copy to Coordinator Field Files.

PAG[illegible] OF



(a) Graphical Explanation

Volume/Linear Ft. of Pipe		
ID(In)	Gal	Liter
1/4	0.003	0.010
3/8	0.006	0.022
1/2	0.010	0.038
3/4	0.023	0.087
1	0.041	0.154
2	0.163	0.618
3	0.367	1.39
4	0.653	2.47
6	1.47	5.56

(b) Volume Factors

FIGURE 1
PURGE VOLUME CONFIGURATION

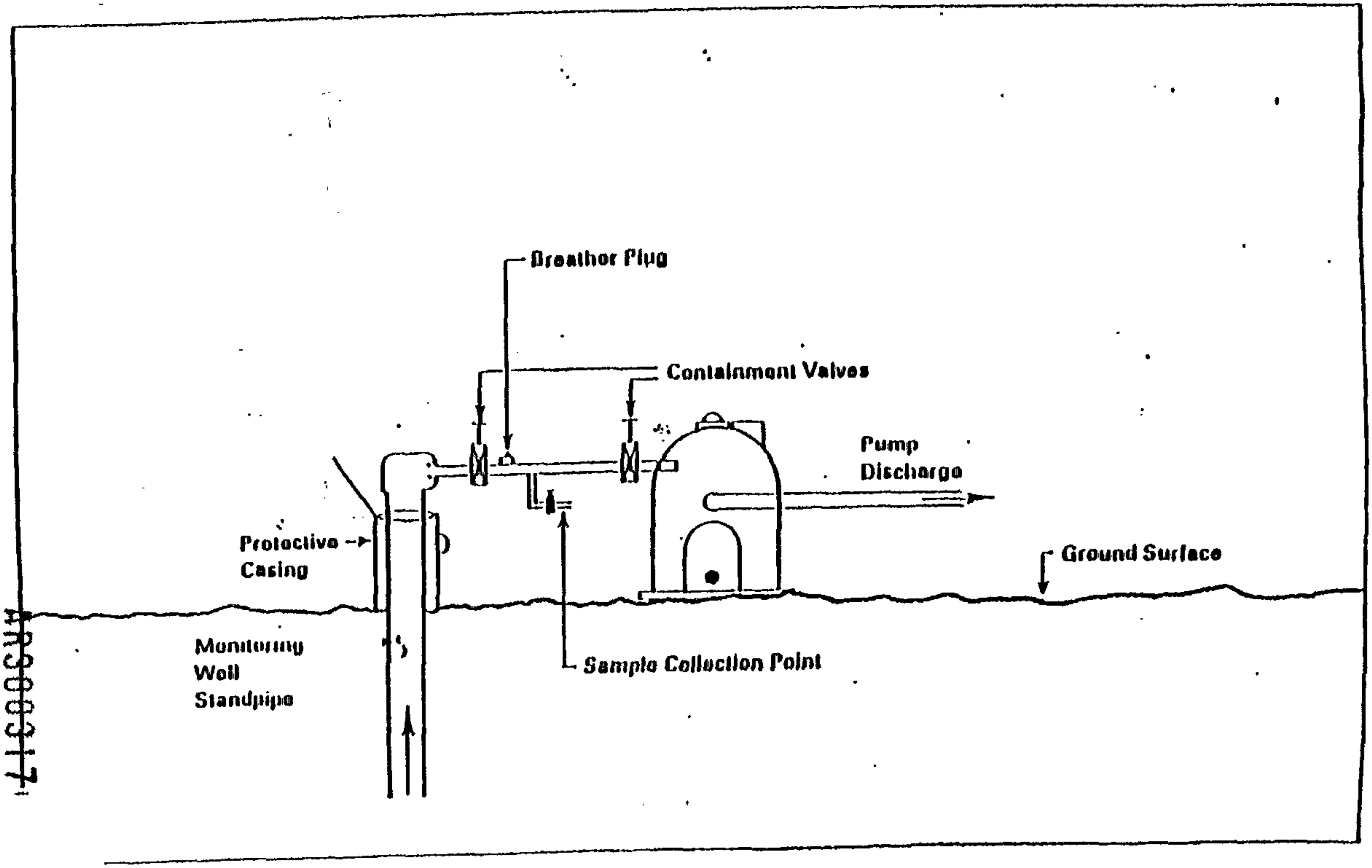


FIGURE 2

DOWN WELL SUNCTION LINE CONFIGURATION

KEYSTONE ENVIRONMENTAL RESOURCES
STANDARD OPERATING PROCEDURE

TITLE: LAKE AND STREAM BOTTOM SEDIMENT SAMPLING	Page:	1 of 6
	Date:	11/85
	Number:	202
	Revision:	0

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the methods to be used by Keystone Environmental Resources (Keystone) personnel to obtain sediment samples from lakes and stream bottoms. Lake and stream bottom sediment sampling is performed in order to define the chemical, physical, and/or biological composition of the sediment.

Sediment samples may be obtained directly from small streams using trowels or small shovels or from lakes and ponds using dredge/clam shell-type samplers. Sediment samples should not be collected from areas which may become exposed during low flow or low tide conditions.

Sediment samples collected for organic analyses should be taken from finer sediments, such as silts and clay. To collect such samples, sampling should be performed in areas of sediment deposition.

2.0 RELATED DOCUMENTS

- Keystone Environmental Resources Standard Operating Procedure. 1986. Decontamination of sampling equipment. Number 501.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Packaging and shipping of samples. Number 502.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Sample chain of custody. Number 506.
- U. S. Environmental Protection Agency, 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. EPA-600/4-84-076.

- U. S. Environmental Protection Agency, 1982. Handbook for sampling and sample preservation of water and wastewater. EPA-600/4-82-029.

3.0 RESPONSIBILITIES

The project scientist has the responsibility to identify the number and location of bottom sediment samples to be collected and the method of sample collection. It is the responsiblity of the field team leader to ensure that samples are collected in accordance with instructions from the project scientist and to make changes in the methods when necessary and appropriate.

4.0 REQUIRED MATERIALS

- Dredges (e.g., Ponar) and rope
- Shovels, long and short-handled
- Trowels, plastic and steel
- Sample bottles
- Sampling implements (e.g., spoons, scoops, tongue depressors)
- Chest waders, hip boots
- Boat
- Gloves
- Measuring tapes
- Buckets

- Distilled water
- Labels
- Field notebook/data sheets
- Safety gear (e.g., life jackets, rope)
- First aid kit
- Chemical-free paper towels

5.0 SAFETY PRECAUTIONS

The following discussion on safety is broken down into two cases; the first case is concerned with safety when wading to collect samples and the other when boating to collect samples.

5.1 Wading

Two people should be employed when collecting samples by wading unless the stream is small. Lake and pond shorelines may also be sampled by wading; two people should be used to sample and a safety line should be tied between them, with one person on shore at all times. Personal floatation devices should be worn when sampling in large streams and along lakes.

5.2 Boating

There are numerous safety precautions which must be considered when using a boat to collect samples. The following are some of the more important considerations.

- The sampling crew must be familiar with the safety regulations for the state and water body in which the sampling is to be done. A check with the appropriate regulatory agency is advisable before field sampling is initiated.

- Every person on board the boat should have and wear at all times a personal floatation device (life vest).

- If the boat is motorized, oars should be on board in case of emergency.

- Common sense should be employed at all times.

6.0 PROCEDURE

1. Review sampling plan to determine the proper location and method of sampling.

2. Determine depth of water at sample location. Enter depth into field notebook or on field data sheets.

3. Collect sample using selected gear.

6.1 Non-Dredge Sampling

1. Fill sample jar(s) with sediment using a clean implement such as a scoop, spoon, or tongue depressor.

2. Label samples, place in coolers, and prepare for shipment to laboratory (SOP 502).

3. Complete chain-of-custody record (SOP 506).

4. Decontaminate sampling gear in accordance with SOP 501, if required.

6.2 Dredge Sampling

1. Repeat steps 2 and 3 of section 6.0.

2. Secure rope to dredge.

3. Open dredge and lock into position.

4. Lower dredge through water column slowly to bottom.

5. Close the jaws of the dredge by jerking the dredge rope once or twice.

6. Pull the dredge up through the water column at a steady, even pace and empty contents into a clean pan or bucket.

7. Repeat steps 3, 4, 5, and 6 if sediment recovery is inadequate.

8. Repeat steps 2, 3, and 4 above for non-dredge sampling.

7.0 QUALITY CONTROL

If the sampling device is to be used at more than one location, the device should be decontaminated in accordance with SOP 501. Chain-of-custody records should be maintained in accordance with SOP 506. Samples should be kept cool at about 4°C soon after collection and remain cool until their arrival at the laboratory.

TITLE: LAKE AND STREAM BOTTOM SEDIMENT SAMPLING

8.0 DOCUMENTATION

A field record of sampling activities will be kept. The record of sampling activities should be in sufficient detail to allow the project scientist/engineer to understand how and where sediment samples were taken. A copy of the field record will be maintained in the project file.

KEYSTONE ENVIRONMENTAL RESOURCES
STANDARD OPERATING PROCEDURE

Page: 1 of 5
Date: 10/85
Number: 205
Revision: 0

TITLE: SURFACE SOIL SAMPLING

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the methods used for obtaining surface soil samples for physical and chemical analyses. This SOP also describes the procedures for using the various types of sampling equipment, which include shovels, trowels, and hand augers. The equipment may be constructed of special materials (for example, stainless steel or inert plastics) according to specific project requirements outlined in the project sampling plan.

2.0 RELATED DOCUMENTS

- American Society for Testing and Materials. ASTM D-1452-65 for soil investigations and sampling by auger borings. Annual Book of ASTM Standards.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Decontamination of sampling equipment. Number 501.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Sample chain-of-custody. Number 506.
- U. S. Environmental Protection Agency. 1982. Test Methods for evaluating solid waste physical/chemical methods SW-846. 2nd ed.

3.0 RESPONSIBILITIES

The project geologist/engineer or his designee will be responsible for the proper use of all types of equipment utilized for obtaining surface soil samples, and the collection, labeling, handling and storage of all samples until further chain-of-custody procedures are undertaken.

KEYSTONE ENVIRONMENTAL RESOURCES
STANDARD OPERATING PROCEDURE

TITLE: SURFACE SOIL SAMPLING

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4.0 REQUIRED MATERIALS

- Shovel - long or short-handled type. Used for penetrating the upper surface and or/obtaining soil samples directly.
- Trowel/scoop - the blade of a trowel is generally flat and 5 to 6 inches in length whereas a scoop's blade has curved edges.
- Hand auger - this tool consists basically of a short metal cyinder ranging in diameter from 1 to 5 inches with a spiral-bladed or some other design metal base attached to extensions and cross handles. Clockwise rotation of the cross handle initiates the cutting process. Most of the loose soil is discharged upward as the auger moves downwards. However, if the soil is cohesive some of it will stick to the auger flight providing a collectable sample at a measurable depth. Samples of surface soil can also be collected using a tube sampler which will be attached to the end of the auger rods and advanced into the soil to extract a sample.

5.0 SAFETY PRECAUTIONS

At a minimum, hard hat, eye protection, and safety shoes will be worn. Gloves will be worn during the sampling if needed to avoid skin contact with the samples.

6.0 PROCEDURE

Specific sampling equipment and methodology will be dictated by the characteristics of the soil to be sampled, the type of soil samples required by the project and the parameters to be measured. Soil samples obtained at the surface may be collected using a shovel, trowel or scoop. The type of analyses requested (e.g., grain-size distribution, physical, chemical) may require sp amounts or the use of specialized sampling equipment. Sampling to obtain uniform coverage within a specified area will require the use of an area grid. These considerations will be followed based upon specific project requirements defined in the project sampling plan.

A hand auger may be used to collect soil samples up to 10 feet below the surface. Representative samples will be collected directly from the auger flight as it is withdrawn from the ground, or from the tube sampler attached to the end of the rods which is advanced into the soil.

The location of sample points will be determined on a project specific basis.

6.1 Standard Procedure

1. Determine the specific sampling location in accordance with the project sampling plan. Construct a sampling grid if necessary. Remove all surface materials that are not to be included in the samples (i.e., rocks, twigs, leaves).

2. Select the type of sampler required to obtain the correct sample. At the surface, use a shovel, trowel or tube sampler; below the surface, use a hand auger or tube sampler.

3. Obtain a sufficient quantity of soil for the desired analyses.

4. When using the hand auger, auger the hole to the required depth, then slowly remove the auger and collect the soil sample from the auger flight itself at the point corresponding to the required depth. Reinsert and continue augering if deeper samples are required. In addition, a tube sampler can be attached to the auger rods after augering to the desired depth, inserted

into the open bore, and then advanced into the deposits at the base of the boring. If sampling is needed in sandy or non-cohesive soil, a shovel may be necessary to obtain samples.

7.0 QUALITY CONTROL

1. If the project sampling plan lists specific requirements for the type of sampling equipment to be utilized, be sure to follow these requirements.

2. Decontaminate the sampler between collection points (see SOP Number 501). Be sure to follow any special decontamination procedure outlined in the project sampling plan.

3. Label and cap the sample container properly. Seal the container if analyses for volatile chemical species are anticipated.

4. Follow chain-of-custody procedures outlined in the Sample Chain-of-Custody SOP (Number 506).

8.0 DOCUMENTATION

Various forms are required to ensure that the sample collection activities are adequately documented. These forms include:

- Field data sheets
- Field notebook
- Sample logs
- Chain-of-custody forms
- Shipping forms

TITLE: SURFACE SOIL SAMPLING

The field notebook will be maintained as an overall log of all samples collected throughout the study. These documents will be retained in the appropriate project files.

SOP#1

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
STANDARD OPERATING PROCEDURE

Page:	1 of 5
Date:	10/85
Number:	206
Revision:	0

TITLE: SURFACE-WATER SAMPLING TECHNIQUES

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) defines the basic techniques and general considerations to be followed for the collection of water quality samples from surface waters (e.g., streams, lakes, ponds). The specific details of actual sample collection are highly dependent upon local conditions as well as upon the purpose of the water quality study. Nevertheless, certain aspects of sample collection procedures are independent of project specific variations.

Two types of samples may be collected, grab or composite. Grab samples are collected at discrete locations and analyzed separately for the purpose of evaluating spatial differences in water quality (e.g., in a wastewater treatment pond it may be important to characterize water quality at inlet and outlet locations). Composite samples are generally made by combining two or more grab samples. The purpose of a composite sample is to obtain average water quality data. The types of samples to be collected and sample locations should be defined prior to going to the field.

2.0 RELATED DOCUMENTS

- U.S. Environmental Protection Agency. 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. 2nd ed. EPA-600/4-84-076.

3.0 RESPONSIBILITIES

The project engineer/scientist is responsible for ensuring that the sampling plan adequately defines methods for surface water sample collection. The sampling plan should identify the general sampling location(s), frequency, sample type (grab or composite), water-quality parameters and analytical procedures. The field team leader is responsible for familiarizing himself with the sampling program, ensuring that all field equipment is in good operating condition and that the appropriate sample containers and preservatives are available.

4.0 REQUIRED MATERIALS

- Site area maps (e.g., USGS 7-½ minute or 15 minutes quadrangle topographic maps)
- Sample bottles
- Insulated containers (e.g., coolers) for sample storage and shipment and an ample supply of ice
- Physical measurement equipment as specified in the sampling plan, corresponding manufacturer's manuals, and calibration standards where appropriate
- Surface-water sampling device as specified in the sampling plan
- Weighted tape measure or rigid gage
- Field data sheets and/or field notebook
- First aid kit

5.0 SAFETY PRECAUTIONS

The buddy system (at least two People) should be employed to collect all samples unless the surface water body is small, (e.g., several feet wide stream) then one person may be employed. In using boats to collect samples, safety equipment and procedures governing the water body should be employed. Good common sense should be used at all times.

6.0 PROCEDURE

Prior to field collection of samples, it is advisable that the site be visited or determine sample locations, collection methods, safety requirements and other data which may be useful in defining the sampling program.

6.1 Sample Location Selection

Sampling locations should be identified in the sampling plan as accurately as possible. Sampling locations where mixing is incomplete should be avoided if an average composition is required. Often areas of poor lateral or vertical mixing can be visually identified. For example, color or turbidity differences may be apparent immediately below the confluence of a tributary and the main river or at a wastewater discharge point.

6.2 Stream Sampling

1. In shallow streams (those which can be safely traversed on foot) the sample container can be filled directly with the flowing water. Unless otherwise specified in the project sampling plan, samples should be collected at mid-depth in the mid-section or deepest flow channel of the stream.

2. In deep streams/rivers, a boat or raft may be required. The sampling plan should identify the locations and types of samples to be collected. It is common practice to

sample large streams/rivers at three positions across the width of the river; i.e., 1/4 mid-channel, and 3/4 locations. If the river is more than 5 feet deep at any of these locations, collect a surface and a bottom sample. Also, if the river is more than 15 feet deep, then it may be appropriate to collect surface, bottom and mid-depth samples. It should be emphasized again that the sampling plan, prepared prior to field activities, should define these locations.

3. Measure depth using a depth sounder or by physical measurement with a heavily weighted flexible measuring tape or a rigid gage.

4. A sampling device specifically designed to collect samples at a specific depth in water column should be used (e.g., a Kemmerer sampler).

6.3 Lake and Pond Sampling

1. Refer to sampling plan for details on sampling locations and types of samples to be collected.

2. Water in lakes and ponds is generally poorly mixed and thermal stratification is common. Single samples can only represent the specific spot from which they were obtained. For many studies, samples taken at the inlet (s) and/or outlet(s) of the lake or pond are of the most interest. In other studies, a grid is established over the lake or pond and samples are collected at grid-line intersections or in some studies composite water samples may be appropriate. Composite samples may be obtained by mixing several grab samples taken at different locations.

3. As with deep rivers, a suitable sampler should be used for sample collection.

7.0 QUALITY CONTROL

Standard Operating Procedures which discuss procedures for sample labeling, preservation, shipment, chain-of-custody and sampling equipment decontamination should be used and referred to frequently.

8.0 DOCUMENTATION

A record must be kept of every sample collected and every bottle must be clearly marked, preferable with a waterproof label. Project specific data sheets or field notebooks may be used. The field record must provide positive sample identification as well as the name of the sample collector, the date, time and exact location of the sample collection point, and results of all field water quality measurements. Other information such as weather and stream flow conditions should also be noted. All documentation shall be retained in the appropriate project files. Chain-of-custody forms will be maintained.

KEYSTONE ENVIRONMENTAL RESOURCES
STANDARD OPERATING PROCEDURE

TITLE: SUBSURFACE SOIL SAMPLING		Page:	1 of 5
		Date:	10/85
		Number:	304
		Revision:	0

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the use of split spoons to obtain subsurface soil samples for chemical and physical analyses, grain-size distributions, and stratigraphic correlations. Subsurface soil samples are obtained in conjunction with soil boring and monitoring well installation programs and provide direct information as to the physical and chemical makeup of the subsurface environment.

2.0 RELATED DOCUMENTS

- "ASTM Method D2487-69 and D2488-69 for Unified Soil Classification System".
- "ASTM Standard Method D1586-67 (Reapproved 1974) for Penetration Test and Split-Barrel Sampling of Soils".
- Keystone Environmental Resources Standard Operating Procedure. 1986. Packaging and shipping of samples. Number 502.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Sample chain of custody. Number 506.

3.0 RESPONSIBILITIES

It is the responsibility of the contract driller to provide the necessary materials for obtaining subsurface soil samples. This includes the split-spoon sampler, related drilling equipment and sample containers as well as the appropriate boring logs. It is the contract driller's responsibility to maintain a complete set of boring logs for contract purposes. Equipment decontamination shall also be the responsibility of the driller, however the field team leader must ensure that proper decontamination procedures are conducted.

It shall be the responsibility of the field team leader or his designee to observe all activities pertaining to subsurface soil sampling to ensure that the standard procedures are followed, and to record all pertinent data on a boring log. It is also the field team leader's responsibility to indicate to the driller at what specific depths samples are to be collected.

4.0 REQUIRED MATERIALS

In addition to those materials provided by the contract driller, the following materials should be available:

- Sample bottles and labels
- Boring logs
- Field notebook
- Chain-of-Custody forms

5.0 SAFETY PRECAUTIONS

At a minimum, hard hat, eye protection, and safety shoes will be worn. Gloves will be worn during handling of the split spoon sampler and during the transfer of soil from the sampler to sampling jars, if needed to avoid skin contact.

6.0 PROCEDURE

6.1 General Procedure

The sampling depth interval should be identified in the project sampling plan but is typically one sample per every five vertical feet with additional samples taken, at the discretion of the field team leader, when significant textural, visual or odor changes are encountered.

The following are the standard procedures to be used in advancing casing and obtaining soil samples. Specific requirements described in the project's sampling plan may call for deviations in these standard procedures. Any deviation from specified procedures will be recorded on the boring log.

6.2 Standard Procedure - Advancing Casing

1. Advance the casing to the required depth. All loose material within the casing should be removed prior to sampling. The casing will be advanced according to project requirements. Borings are typically advanced by three methods, drive-and-wash casing, hollow-stem augering and mud-rotary drilling. The casing shall be of the flush joint or flush couple type and of suffcent size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid flight augers with casing may be used according to specific project requirements as described in the project sampling plan. If hollow-stem augers are to be used, the bit shall be equipped with a plug device to be removed at the required sampling depth.

2. For those borings which encounter obstructions, the casing will be advanced either past or through the obstruction by drilling, mechanically fracturing, or blasting (if required).

3. Do not use recirculated water when casing is being driven unless specified in the project work plan.

4. If recirculated water is used all loose materials within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care shall be taken to limit recirculation of the wash water to those times when the water supply is extremely limited or unavailable.

6.3 Standard Procedure - Soil Sampling

1. Obtain subsurface soil samples using a split-tube type sampler (split spoon). Split spoons come in a variety of sizes from 2.0 to 3.5 inch OD and in lengths of 12, 18, and 24 inches. Split spoons shall be equipped with a check valve at the top and a flap valve or basket-type retainer at the bottom.

2. Sampling depth shall be independently determined by the inspecting geologist, and any discrepancies shall be resolved prior to obtaining the sample.

3. Obtain samples using the standard penetration test (SPT), which allows for determination of resistance within the deposits. The sampler shall be driven using a 140-pound hammer with a vertical drop of 30 inches. The number of hammer blows shall be recorded on the boring log.

4. Open sampler immediately upon removal from the casing. The supervising geologist will determine if the recovery is adequate or if another attempt shall be made before drilling is continued.

5. Place soil sample in appropriate container, label container and store samples in a secure location. The boring log and the sample container/label should contain the following information for each sample: site name, boring location, depth, blow counts, recovery, sample number and collection date. The type of material shall be indicated in the boring logs and will be described using either the Unified Soil Classification System (ASTM:D2487-69 and D2488-69) or the Burmeister System.

7.0 QUALITY CONTROL

The sampler shall be cleaned with water between attempts in order to prevent cross-contamination. More elaborate decontamination procedures may be followed at the authorization of the supervising geologist. Proper procedures for delivery to the designated laboratory shall be initiated when all samples are collected. This includes packaging, shipping with sample logs, analysis request forms, and chain-of-custody forms (see SOPs Number 502 and Number 506).

8.0 DOCUMENTATION

The following records should be kept of soil sampling activities.

- Field notebook
- Boring logs
- Chain-of-Custody forms
- Shipping forms

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
STANDARD OPERATING PROCEDURE

		Page:	1 of 18
		Date:	06/86
TITLE:	QA/QC CONTROL FOR GROUNDWATER SAMPLING	Number:	504
		Revision:	0

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the quality assurance and quality control (QA/QC) procedures to be followed when collecting groundwater samples from monitoring wells. The scope of this SOP is limited to QA/QC measures involving field operations and protocol. Specific operations and protocol are outlined in other SOPs.

This SOP provides the QA/QC measures to be implemented in the collection of groundwater samples. These measures are designed to ensure the reliability and validity of field and analytical laboratory data gathered as part of the overall groundwater monitoring program, therefore these QA/QC measures will become a routine part of every sampling project.

2.0 RELATED DOCUMENTS

- Keystone Environmental Resources Standard Operating Procedure. 1986. Groundwater sampling collection from monitoring wells. Number 201.
- Keystone Environmental Resources Standard Operating Procedure. 1986. Packaging and shipping of samples. Number 502.
- Scalf, M. R., J. A. McNabb, W. J. Dunlap, R. L. Cosby and J. Fryberger. 1981. Manual of groundwater sampling procedures. U.S. EPA. Robert S. Kerr. Environmental Research Laboratory. Ada, OK: NWWA/WPA Series 1981.
- U.S. Environmental Protection Agency. 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. 2nd Ed. EPA 600/4-84-076.
- U.S. Environmental Protection Agency. 1985. RCRA groundwater monitoring technical enforcement guidance document. Draft.

3.0 RESPONSIBILITIES

The site coordinator (field team leader) or his/her designee is responsible for ensuring that the proper QA/QC procedures for groundwater sampling are followed in accordance with this SOP.

4.0 REQUIRED MATERIALS

The list below identifies typical pieces of equipment that may be used for a wide range of groundwater sampling applications. From this list, project specific equipment should be selected based upon project objectives, the depth to groundwater, purge volumes, analytical requirements and well construction.

- Purging/Sample Collection Equipment

  Bailers
  Centrifugal pump
  Submersible pump
  Peristaltic pump
  Bladder pump

- Related Sampling Equipment

  Thermometer
  pH meter
  Specific conductance meter
  Filtration apparatus (vacuum or pressure)
  Water-level measurement equipment

- General Materials

  Goggles or equivalent eye protection
  Distilled water and dispenser bottle
  Decontamination liquids
  Field data sheets and/or log book
  Sample preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First aid kit
  Key(s) for well locks
  Stopwatch

- Expendable Materials

  Pump tubing
  Bailer cord
  Gloves
  Filters
  Chemical-free paper towels
  Protective coveralls, e.g., Tyvek

5.0 SAFETY PRECAUTIONS

Creosote, PCP and CCA are three chemical constituents which are health and safety concerns when conducting groundwater sampling. To reduce the potential for skin contact with these constituents, it is advisable that polyvinyl or other similar gloves be worn when conducting sampling activities. Safety shoes, hard hat and safety glasses should also be worn.

6.0 PROCEDURE

6.1 Preparation

6.1.1 Sample Bottle Preparation

Three general types of analyses are performed on groundwater samples (i) conventional pollutants, (ii) metallic pollutants, and (iii) priority pollutants and Appendix VIII constituents. The protocols for preparing the bottles for each type of analyses are discussed below.

6.1.1.1 Conventional Pollutants

1. Use new bottles with screw-type lids.
2. Prelabel and prepreserve (where appropriate) all bottles prior to shipping sample bottles to field.
3. Place bottles in suitable shipping packages, for example, ice chests with adequate packing material to reduce bottle breakage (see SOP 502).

6.1.1.2 Metallic Pollutants

1. Use new polyethylene collapsible containers with plastic screw-type lids.

2. Clean new container:

   - Rinse with 1:1 nitric acid.
   - Rinse with tap water four times.
   - Rinse with distilled water four times.

3. Prelabel all containers prior to shipping sample bottles . Add preservative material at the job site.

4. Place container in suitable shipping package, for example, ice chests with adequate packing material to reduce bottle breakage.

6.1.1.3 Organics Other Than Volatiles

1. Use new bottles with screw-type lids. (For PAH, use new amber bottles with Teflon lids.)

2. Clean new bottles:

   - Wash with hot soapy water.
   - Rinse with tap water, three times.
   - Rinse with distilled water three times.
   - Wash with acetone.
   - Wash with hexanes (pesticide grade).
   - Dry with pure nitrogen.

3. Prelabel and prepreserve bottles.

4. Place in suitable shipping package.

6.1.1.4 Volatile Organic Aromatics (VOAs)

1. Use new bottles with screw-type lids.

2. Clean new bottles:

   - Wash with hot soapy water.
   - Rinse with tap water three times.
   - Rinse with distilled water three times.
   - Air dry.
   - Heat for approximately three hours at 100°C.
   - Soak septum for approximately three hours in methanol then heat at 100°C for 10-15 minutes.

6.1.2 Bailer Preparation

1. Clean stainless steel bailers for all sampling:

   - Wash with hot soapy water.
   - Rinse with tap water three times.
   - Rinse with 1:1 nitric acid.
   - Rinse with distilled water three times.
   - Wash with acetone (pesticide grade).
   - Wash with hexane (pesticide grade).

2. Dry bailer using pure nitrogen.

3. Heat for one hour at 1200°F.

4. Cool to room temperature.

5. Wrap bailer with aluminum foil (shiny side out).

6.1.3 Well Pump Preparation

1. When cleaning, the pump should be disassembled according to the manufacturer's manual.

2. The metal parts may be cleaned using a 1:1 nitric acid wash as the first step. Do not perform this step on the actual parts (i.e., pump head).

3. All parts are to be washed according to the procedure outlined in Section 6.1.1.2.

4. Reassemble pump and wrap with aluminum foil (shiny side out). Place pump in a plastic covering.

5. The line assembly should be cleaned using hot soapy water and rinsed using tap water then distilled water. Dry the tubing using very pure nitrogen. Place it on the spool and wrap in plastic.

6.2 Well Purging

Keystone Environmental Resources Standard Operating Procedure Number 201 will be used as a guideline when purging or sampling a well. In addition, the following QA/QC measures will be implemented into the sampling program:

1. New disposable vinyl gloves are to be used when purging and sampling a well. This is not only a safety requirement, but it also prevents equipment contamination. A new pair of gloves are to be worn for each well.

2. A slit is to be cut in one side of a plastic sheet (or garbage bag) and slipped over and around the well casing. This will create a clean surface onto which the sampling equipment can be placed. This clean work area should be a minimum of 8 square feet. Care should be taken to prevent any "foreign" material, i.e., dirt, grass, rocks, etc., from coming in contact with the sheet. A new plastic sheet is to be used for each well.

3. The wells are to be purged using specially prepared mechanical pumps or specially cleaned stainless steel bailers. A purging device will be dedicated to each well.

The pumps and bailers are prepared according to the procedures outlined in sections 6.1.3 and 6.1.2 of SOP Number 201.

After proper preparation the bailers are corked at one end. On the other end nylon cotton string is attached to lower and raise the bailer in the well. New corks and string are used for each well.

6.3 Sampling

When the required volume of sampling water is obtained the sample is either filtered in the field or left unfiltered. This decision is performed in accordance with the project specific sampling plan. Below are QA/QC measures that are to be implemented when filtering.

Composite the sample into a field bottle. The field bottle is to be washed according to the procedures outlined in Section 6.1.1. (The field bottle is to be cleaned the same as the most carefully cleaned parameter for that project). Place lid on jug between sample pourings to minimize possible contamination from the environment.

2. Transfer the field jug to the field lab.

3. At the lab the samples are poured into a funnel and filtered through the required caliber of filter paper.

7.0 QUALITY CONTROL

All sampling projects should have an efficient sampling and analysis plan. This plan will include a description of the type of work to be done and the equipment and procedures needed to successfully complete the project. Once this plan is developed it is up to the field personnel to abide by the outlined procedures. Project plan compliance will not only aid in the success of the project but it will also improve the QA/QC measures to be implemented. This will lead to data that accurately represents the conditions at the sampling site.

The proper equipment should be used for sampling the specific chemical constituents. In addition, the correct sampling procedures should be used to avoid altering the chemical composition of the samples, particularly in regard to the stripping of volatile organic compounds in samples.

Depending on the parameters to be analyzed for and the state and federal regulations, some samples may require filtration. When using a vacuum or pressure filtration apparatus, the pH and conductivity of the sample are measured before filtering. A clean funnel is used for each sample. The funnels are cleaned using the procedures outlined in Section 6.

An important aspect of QA/QC is the implementation of blanks. Blanks are used to verify that the sample collection and handling process has not affected the quality of the field samples. The sampling personnel should prepare both field and trip blanks and analyze them for all of the required monitoring parameters. The distilled water used for these blanks should be obtained from a single source at the same time. This step enhances the accuracy and validity of the QA/QC measures.

Trip Blank - Fill one of each type of sample bottles with distilled water, transport to site, and return to the laboratory for analysis. One trip blank set per sampling event is sufficient. This blank ensures that the sampling bottles have been effectively cleaned and preserved.

Field Blank - This blank serves to ensure that the cleaning of the sampling equipment is performed effectively. Fill the sampling device with distilled water or, if appropriate, pump distilled water through the device. Transfer the water to each type of sample bottle required for that project and return them to the laboratory for analysis. One field blank set should be taken each day groundwater monitoring wells are sampled.

Other quality control samples (standards, spikes, performance evaluation samples) should be prepared and analyzed as part of the laboratory operation. As with all QC samples, this data should be used as a measure of performance or as an indicator of potential sources of cross-contamination but should not be used to alter or correct analytical data. If contaminants are found in the blanks, the source of contamination should be identified and corrective action, including resampling, should be initiated.

All field equipment used by the sampling personnel should be calibrated prior to field use and recalibrated during the sampling project. A calibration sheet should accompany the samplers on each project. This sheet should be used to record all initial, final and periodical calibration checks. This information is an aid to the QA/QC program because it provides an updated record of meter performance and accuracy.

An adequate chain-of-custody program is another important part of a sampling project. The chain-of-custody form can be used to document the possession and handling of individual samples from the time of field collection through laboratory analysis. The original chain-of-custody form must be shipped with the samples and retained by the receiving laboratory. The field team leader shall retain a copy of the form and provide the project manager with a copy for central filing. A thorough chain-of-custody program should include the following.

- Sample Labels - To prevent misidentification of the samples.
- Evidence Tape - To seal outside of coolers to preserve integrity of sample from the time it is collected until it is opened at the receiving laboratory (can also use metal chain-of-custody tags to seal cooler).
- Field Logbook - To record pertinent information about each sample collection during the groundwater monitoring program.
- Chain-of-custody record - To provide the documentation necessary to trace sample possession from the time of collection to analysis.
- Sample analysis request sheets - To serve as official communication to the laboratory of the particular analysis required for each sample and provide further evidence that the chain-of-custody is complete.
- Laboratory logbook - To maintain all pertinent information about the sample.

The chain-of-custody form is the record of sample collection and the transference of custody. Information such as the sample collection date, sample identification and origination, and client or project name shall be entered on each chain-of-custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all groundwater samples which are known to be non-hazardous and to which U.S. Department

of Transportation and U.S. Post Office regulations do not apply. Such information is as follows.

- Sample collector's name, mailing address and telephone number.
- Analytical laboratory's name, mailing address and telephone number.
- Quantity of each sample.
- Date of shipment.
- Description of sample.

The chain-of-custody form provides a location for entry of the above listed information. A copy of this form is given in Section 8.0.

8.0 DOCUMENTATION

A number of different documents will be completed and maintained as part of the groundwater sampling. These documents will provide a summary of the sample collection procedures and conditions, shipment method, the analyses requested and the custody history. The list of documents is as follows.

- Sample Preservation Sheet
- EPA Recommended Holding Times
- Calibration Sheet
- Chain-of-custody Form
- Field Data Sheet
- Analyses Form
- Shipping Receipts

ANALYSIS PROCESS
EPA RECOMMENDED HOLDING TIMES
FROM DATE OF COLLECTION

Parameter		Holding Time, Days
pH	Odor	Immediately to 6 hours
Conductivity	Temperature	
Chlorine	D.O. Coliforms	
TOC (if BOD needed)	Chromium (Hexavalent)	2 days
BOD$_5$	Nitrate	
Color	Nitrite	
Settleable Solids	O-Phosphate	
Turbidity	SO$_4$ only if SO$_3$ is required	
SO$_3$		
Residue (evaporated, suspended, dissolved)		7 days
Sulfide		
Extractions for PAH (EPA-610), Phenols (EPA-604), PCP (Koppers)		
Total Organic Halogens (TOX)		
Cyanides	Alkalinity	14 days
Acidity		
Conductance (if not required at sampling time)		28 days
Mercury	SO$_4$ (if SO$_3$ not needed)	
Cl	COD	
F	TOC (if BOD not needed)	
NH$_3$-N	Oil	
NO$_3$ + NO$_2$	Phenols	
Si O$_2$	TKN	
T-PO$_4$		
PAH by EPA-610 (complete analysis)		40 days
Phenols by EPA-604 (complete analysis)		
Metals		6 months
Hardness		

SAMPLE PRESERVATION

UNPRESERVED

pH-100
Conductivity-250
Color-50
Turbidity-100
Acidity-100
Alkalinity-100
Solids(Residue)3 x 100

Nitrite-N(NO_2)-100
Bicarbonate-100
Carbonate-100
Chloride-100
Cr-Hex-200
F-100
SO_4-100
SO_3-100
BOD_5-500(min)
Hardness-100
Boron

PAH-1 Qt. [illegible]
3x (Replicate on 10% of Sample)

Chloro Phenols-1 Qt.

Petrolia GC-
R-THD-PSA-BMDSA
250

TOX-8 ozs.(Unfiltered)
Teflon Septum

Pest/Herb-1 Qt.(unfiltered)

Naphthalene-1 pt. or 1 Qt.

o-Phosphate-100(Unfiltered)

ACID($NaHSO_4$)

Total Phosphate-100
TOC-100
COD-100
Phenol-100-500
NH_3-N(Ammonia)-250
TKN(1 PT)
Nitrate-N(NO_3)-100

PETROLIA PHENOLS

1 Qt. with $CaCl_2$, at pH
approximately 7

ACID APPROXIMATELY 1 Qt.

Oil(Duplicate on 10% of Sample)
2x

HNO_3 at pH 2

Radiation-2 x 1 Qt.(Unfilterd)

NaOH

PCP-50
CN-T-100
CN-A-100
CN-Free-100
CN-Fixed-100
SCN-100

Zn-acetate

Sulfide-250

METALS(HNO_3)1Qt.

Sb
As
Ba
Be
Cd
Ca
Cr(total)
Cu
Fe
Pb
Mg
Mn
HG
Ni
K
Se
Ag
Na
Tl
Sn
Zn

rev/3/86
djr/547-0/01/860

CALIBRATION SHEET

pH METER

Project: ______________________________ Date: ______

Meter: ______________________________

	Meter Reading	Buffer Solutions 4	7	9	Standard 6.5	Operator Initials
Initial Calibration	unadjusted					
	adjusted					
Calibration Check	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
Final Calibration	unadjusted					
	adjusted					

Calibration checks should be made after every 10 readings using the pH 7 buffer solution (unadjusted reading). If readings are within .1 unit of the solution no calibration adjustment is made, if greater than .1 a complete calibration is necessary (adjusted reading), if greater than .2 do a complete calibration and increase the frequency of calibration checks.

Operator Signature: ____________________

CONDUCTIVITY METER

Project: ______________________________ Date: ______

Meter: ______________________________

Is meter temperature compensated, (if no, see temp. adjustment) ______ Yes ______ No

Temperature Adjustments:

25°C - If the temperature of the sample is below 25°C, add 2% of the reading per degree.

25°C - If the temperature is above 25°C, subtract 2% of the reading per degree.

Standard (umhos/cm)	Meter Reading	Disregard if meter is temperature compensated Sample Temp above or below 25°C (y or N)	If Y, add or subtract temp. adjustment to meter reading
1. 300	______	______	Make sure adjusted readings are recorded on field sheet
2. 300	______	______	
3. 300	______	______	

Operator Signature ____________________

CHAIN OF CUSTODY RECORD

PLANT CODE

PROJECT NAME

SAMPLERS *(Signature)*

STA. NO.	DATE	TIME	COMP.	GRAB	WELL	STATION LOCATION	NUMBER OF CONTAINERS						REMARKS OR OBSERVATIONS

Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received for Laboratory by: *(Signature)*	Date	Time	Remarks:	

DISTRIBUTION: Original accompanies shipment; Copy to Coordinator Field Files.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

FIELD DATA SHEET FOR GROUNDWATER SAMPLING

PLANT:

PROJECT:

DATE OF WELL LEVELS:

DATE OF SAMPLING:

SAMPLING METHOD:

SAMPLED BY:

WEATHER:

Site No.	Time	Well Dia. (in.)	Depth of Well (ft) (including stickup)	Depth to H_2O in Well (ft)	Depth of H_2O in Well (ft)	Number of Bails Removed	Dry at Number of Bails Removed	In-situ Measurements								
								pH (units)				Conductivity (umhos/cm)				Temp. (C°)

SITE NO.	OBSERVATIONS

Page____of____

ANALYTICAL REQUEST FORM

TO: D. M. Miller, MSTC
FROM: ____________________

REQUESTED
TURNAROUND TIME: ______________

PROJ. ENG./SCIENTIST: __________
COPY REPORTS TO: __________
PLANT/STUDY: __________
PLANT #: __________
PHASE #: __________
COST CODE #: __________

STUDY DESCRIPTION:		SAMPLE TYPE:		METHOD:	EXTRACTIONS:
Hydrostudy	Drinking Water	Soil	Surface Water	Composite	Total
RCRA Permitting	NPDES Permitting	Sludge	Process Water	Grab	EP-Toxicity
Characterization	RIFS	Residue		Bailer	TCLP
Treatability Study	Other: __________	Groundwater		Pump	ASTM

ANALYSES REQUIRED

PARAMETER	LIMS	PARAMETER	LIMS	PARAMETER	LIMS
1. pH (by EAL)	PH	26. SOLIDS		45. Arsenic(As)	AS
2. pH (FIELD)	PHF	Dissolved	TDS or	46. Barium(Ba)	BA
3. Conductivity	COND	(T-F-V)	DS	47. Beryllium(Be)	BE
(by EAL)		Evaporated	TDS or	48. Boron(B)	B
4. Conductivity	CONDF	(T-F-V)	ES	49. Cadmium (Cd)	CD
(FIELD)		Suspended	TSS or	50. Calcium (Ca)	CA
5. Acidity-(Total)	ACID	(T-F-V)	SS	51. Chromium (Cr)	
6. Alkalinity	ALK	27. Sulfate	SO4	Total	CR
7. Bicarbonate	HCO3	28. Sulfite	SO3	Hexavalent	CR6
8. Carbonate	CO3	29. Sulfide	S	52. Copper (Cu)	CU
9. Color	COLOR	30. Cyanide		53. Iron-Total(Fe)	FE
10. Chloride	CL	Total	CN	54. Ferrous Iron	FE2+
11. BOD-T	BOD5	Amenable	CNAM	55. Lead (Pb)	PB
12. BOD-S	BOD5S	Free	CNF	56. Magnesium(Mg)	MG
13. COD-T	COD	31. Thiocyanate	SCN	57. Manganese(Mn)	MN
14. COD-S	CODS	32. Oil & Grease	OILS	58. Mercury(Hg)	HG
15. Fluoride	F	ORGANICS		59. Molybdenum(Mo)	MO
16. Hardness	HARD	33. Carbon (TOC)	TOC	60. Nickel(Ni)	NI
17. Ammonia as N	NH3N	34. Halogens (TOX)	TOX	61. Potassium(k)	K
18. Nitrate as N	NO3N	35. Phenol	PHNOL	62. Selenium(Se)	SE
19. Nitrite as N	NO2N	36. PCP	PCP	63. Silver(Ag)	AG
20. Kjeldahl -	TKN	37. PCB	PCB	64. Solium(Na)	NA
Nitrogen		38. PAH	PAH	65. Thallium(Ti)	TL
21. Organic -	ORGN	39. Purgeable	PAR	66. Tin(Sn)	SN
Nitrogen		Aromatics		67. Titanium(Ti)	TI
22. Phosphorous -	PO4	40. Purgeable	PHAL	68. Zinc(Zn)	ZN
Total		Hydrocarbons		MISCELLANEOUS	
23. Phosphorous -	PO4O	41. Acid Extractable	AEP	69. Radiation	RAD
ortho		Phenolics(EPA 604)		70. Bacteria	COLI
24. Phosphorous -	PO4TD	42. Surfactants	MBAS	71. K-100	
Total Dissolved		METALS		72. Priority Pollutants	
25. Turbidity	TURB	43. Aluminum (Al)	AL	(VOA,BN,AE,Pest/Herb,	
		44. Antimony (Sb)	SB	Metals)	
				73. Other__________	

SPECIAL INSTRUCTIONS ______________________________
____
____
____

1138-Misc.#6

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
STANDARD OPERATING PROCEDURE

TITLE:	**QA/QC FOR CHARACTERIZATION STUDIES**	Page:	1 of 15
		Date:	06/86
		Number:	503
		Revision:	2

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) is concerned with the Quality Assurance/Quality Control (QA/QC) practices for characterization studies.

2.0 RELATED DOCUMENTS

- Keystone Environmental Resources Standard Operating Procedure. 1986. Groundwater sample collection from monitoring well. Number 201.
- Keystone Environmental Resources Standard Operating Procedure. 1985. Packaging and shipping of samples. Number 502.
- Keystone Environmental Resources Standard Operating Procedure. 1985. Sample chain of custody. Number 506.
- U.S. Environmental Protection Agency Office of Research and Development. 1986. RCRA groundwater monitoring technical enforcement guidance document.

3.0 RESPONSIBILITIES

The site coordinator (field team leader) or his/her designee shall be responsible for ensuring that proper QA/QC is followed in the field.

4.0 REQUIRED MATERIALS

- Cleaning Materials

  - decontamination liquids
  - distilled water
  - pure nitrogen gas
  - soap
  - brush
  - tap water
  - Teflon liners
  - aluminum foil
  - heating unit

- General Materials for Sampling
  - sample containers
  - distilled water
  - preservative
  - gloves
  - chain of custody forms and tags
  - soil sampling equipment
  - pH paper
  - bailer, cord, plastic bags

5.0 SAFETY PRECAUTIONS

These procedures do not require specific safety precautions, but normal laboratory and field care should be applied (i.e the wearing of safety glasses, safety shoes, rubber gloves, and other protective clothing when necessary).

6.0 PROCEDURE

6.1 Sample Bottle Preparation

Three general types of analyses are performed on groundwater samples (i) conventional pollutants, (ii) metallic pollutants, and (iii) priority pollutants and Appendix VIII constituents. The protocols for preparing the bottles for each type of analyses are discussed below.

6.1.1 Conventional Pollutants

1. Use new amber bottles with screw-type lids.

2. Label and preserve (when appropriate) all bottles prior to shipping them to a job site.

3. Place bottles in suitable shipping packages, for example, ice chests with adequate packing material to reduce bottle breakage (see Packaging and Shipping Samples SOP Number 502).

6.1.2 Metallic Pollutants

1. Use new polyethylene collapsible containers with plastic screw-type lids.

2. Clean new container.

   - Rinse with 1:1 nitric acid.
   - Rinse with distilled water two times.
   - Rinse with 1:1 hydrochloric acid.
   - Rinse with tap water at least four times.
   - Rinse with distilled water at least four times.

3. Label and preserve all containers prior to shipping sample bottles to field.

4. Place containers in suitable shipping packages, for example, ice chests with adequate packing material to reduce bottle breakage.

6.1.3 Priority Pollutants and Appendix VIII Parameters

1. Use new amber bottles with screw-type lids.

2. Clean new bottles:

   - Wash with hot soapy water.
   - Rinse with tap water.
   - Rinse with 1:1 nitric acid.
   - Rinse with distilled water two times.
   - Rinse with 1:1 Hydrochloric acid.
   - Rinse with tap water four times.
   - Rinse with distilled water four times.
   - Wash with acetone (pesticide grade).
   - Wash with hexane (pesticide grade).
   - Dry glassware and equipment with pure nitrogen.

3. Lids must have Teflon liners.

4. Label and preserve bottles.

6.2 Groundwater and Soil Sampling Equipment Preparation

Groundwater sampling from monitoring wells is generally accomplished by hand drawn, stainless steel bailers. For soil sampling, there are two types of equipment that can be used (i) trowel/scoop and (ii) hand auger. The protocol for preparing this equipment is discussed below.

- Wash with hot soapy water.
- Rinse with tap water.
- Rinse with .1 normal hydrochloric acid.
- Rinse with tap water four times.
- Rinse with distilled water four times.
- Wash with acetone (pesticide grade).
- Wash with hexane (pesticide grade).
- Dry with pure nitrogen.
- Burn bailers and funnels off in 550°C oven for two hours.
- Wrap equipment with aluminum foil (shiny side out).

6.3 Sampling

6.3.1 Water Sampling

The sample bottles are filled directly from the sample source and care should be taken not to overfill the bottles containing preservatives. Once the bottles are filled the lids are screwed on immediately. This will minimize possible contamination from the environment. Disposable vinyl gloves are worn during sampling. A new pair of gloves is worn for each sampling point.

6.3.2 Soil Sampling

A sufficient quantity of soil is taken from the specific sampling point and placed immediately into a sample container. The sample containers are prepared according to the procedure outline in 5.1.3. Disposable vinyl gloves are to be worn during samplings. A new pair of gloves is worn for each sampling point.

6.4 Blanks

Other quality control samples (standards, spikes, performance evaluation samples) should be prepared and analyzed as part of the laboratory operation. As with all QC samples, this data should be used as a measure of performance or as an indicator of potential sources of cross-contamination but should not be used to alter or correct analytical data. If contaminants are found in the blanks the source of contamination should be identified and corrective action including resampling should be initiated.

Trip blanks and field blanks are to be taken to verify that the sample collection and handling process has not affected the quality of the field samples. The blanks should be analyzed for all the required monitoring parameters and prepared the following way:

Trip Blank - Fill one of each type of sample bottle with deionized water, transport to the site, handle like a sample and return to the laboratory for analyses. One trip blank for each study is the minimum. VOC's require a trip blank with each shipping container.

Field Blank- Fill a bottle with deionized water, transfer it to the field (the general area where the sampling occurred), transfer to the sample bottle(s) and return to the laboratory for analysis. One field blank, each day sampling is occurring, is the minimum.

6.5 Field Equipment

All field equipment used by the sampling personnel should be calibrated prior to field use and recalibrated during the sampling project. A calibration sheet should accompany the samplers on each project. Use this sheet to record all initial, final and periodical calibration checks. This information is an aid to the QA/QC program because it provides an updated record of meter performance and accuracy.

6.6 Chain-Of-Custody

An adequate chain of custody program is another important part of a sampling project. The chain of custody form can be used to document the possession and handling of individual samples from the time of field collection through laboratory analysis. The original chain of custody form must be shipped with the samples and retained by the receiving laboratory. The field team leader shall retain a copy of the form and provide the project manager with a copy for central filing. A thorough chain of custody program should include:

- sample labels - prevents misidentification of sample;
- evidence tape - seal outside of coolers to preserve the integrity of the sample from the time it is collected until it is opened in the lab (also can use metal chain of custody tags to chain cooler);

- field logbook - to record pertinent information about each sample collection during the groundwater monitoring program;
- chain of custody form - provides the documentation necessary to trace sample possession from the time of collection to analysis;
- sample analysis request sheets serve as official communication to the laboratory of the particular analysis required for each sample and provide further evidence that the chain of custody is complete;
- laboratory logbook is maintained in the laboratory and contains all pertinent information about the sample.

7.0 DOCUMENTATION

The chain-of-custody form is the record of sample collection and the transference of custody of the collected samples. Information such as the sample collection date, sample identification and origination, and client or project name shall be entered on each chain-of-custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all groundwater samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply.

- Sample collector's name, mailing address and telephone number.
- Analytical laboratory's name, mailing address and telephone number.
- Quantity of each sample.
- Date of shipment.
- Description of sample.
- Identification of all parameters.

- Shipper's name.
- Chain-of-custody tag and cooler numbers.
- Internal temperature as recorded by receiving.

The chain-of-custody form provides a location for entry of the above listed information.

8.0 ATTACHED DOCUMENTS

- Sample Preservation Sheet
- EPA Recommended Holding Times
- Calibration Sheet
- Chain-of-Custody Form
- Field Data Sheet
- Analyses Form

SAMPLE PRESERVATION

UNPRESERVED

pH-100
Conductivity-250
Color-50
Turbidity-100
Acidity-100
Alkalinity-100
Solids(Residue)3 x 100

Nitrite-N(NO_2)-100
Bicarbonate-100
Carbonate-100
Chloride-100
Cr-Hex-200
F-100
SO_4-100
SO_3-100
BOD_5-500(min)
Hardness-100
Boron

PAH-1 Qt. [illegible]
3x (Replicate on 10% of Sample)

Chloro Phenols-1 Qt.

Petrolia GC-
R-THD-PSA-BMDSA
250

TOX-8 ozs.(Unfiltered)
Teflon Septum

Pest/Herb-1 Qt.(unfiltered)

Naphthalene-1 pt. or 1 Qt.

o-Phosphate-100(Unfiltered)

ACID($NaHSO_4$)

Total Phosphate-100
TOC-100
COD-100
Phenol-100-500
NH_3-N(Ammonia)-250
TKN(1 PT)
Nitrate-N(NO_3)-100

PETROLIA PHENOLS

1 Qt. with $CaCl_2$, at pH
approximately 7

ACID APPROXIMATELY 1 Qt.

Oil(Duplicate on 10% of Sample)
2x

HNO_3 at pH 2

Radiation-2 x 1 Qt.(Unfilterd)

NaOH

PCP-50
CN-T-100
CN-A-100
CN-Free-100
CN-Fixed-100
SCN-100

Zn-acetate

Sulfide-250

METALS(HNO_3)1Qt

Sb
As
Ba
Be
Cd
Ca
Cr(total)
Cu
Fe
Pb
Mg
Mn

HG
Ni
K
Se
Ag
Na
Tl
Sn
Zn

rev/3/86
djr/547-0/01/860

ANALYSIS PROCESS
EPA RECOMMENDED HOLDING TIMES
FROM DATE OF COLLECTION

Parameter		**Holding Time, Days**
pH	Odor	Immediately to 6 hours
Conductivity	Temperature	
Chlorine	D.O. Coliforms	
TOC (if BOD needed)	Chromium (Hexavalent)	2 days
BOD_5		
Color	Nitrite	
Settleable Solids	O-Phosphate	
Turbidity		
SO_3		
Residue (evaporated, suspended, dissolved)		7 days
Sulfide		
Extractions for PAH (EPA-610), Phenols (EPA-604), PCP (Koppers)		
Total Organic Halogens (TOX)		
Cyanides	Alkalinity	14 days
Acidity		
Conductance (if not required at sampling time)		28 days
Mercury	SO_4	
Cl	COD	
F	TOC (if BOD ot needed)	
NH_3-N	Oil	
$NO_3 + NO_2$	Phenols	
	TKN	
T-PO_4	Nitrate	
PAH by EPA-610 (complete analysis)		40 days
Phenols by EPA-604 (complete analysis)		
Metals		6 months
Hardness		

pap/779-0/1

CALIBRATION SHEET

pH METER

Project: ______________________________ Date: ______

Meter: ______________________________

	Meter Reading	Buffer Solutions			Standard 6.5	Operator Initials
		4	7	9		
Initial Calibration	unadjusted					
	adjusted					
Calibration Check	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
Final Calibration	unadjusted					
	adjusted					

Calibration checks should be made after every 10 readings using the pH 7 buffer solution (unadjusted reading). If readings are within .1 unit of the solution no calibration adjustment is made, if greater than .1 a complete calibration is necessary (adjusted reading), if greater than .2 do a complete calibration and increase the frequency of calibration checks.

Operator Signature: ______________________

CONDUCTIVITY METER

Project: ______________________________ Date: ______

Meter: ______________________________

Is meter temperature compensated, (if no, see temp. adjustment) ______ Yes ______ No

Temperature Adjustments:

25°C - If the temperature of the sample is below 25°C, add 2% of the reading per degree.

25°C - If the temperature is above 25°C, subtract 2% of the reading per degree.

Standard (umhos/cm)	Meter Reading	Disregard if meter is temperature compensated	
		Sample Temp above or below 25°C (y or N)	If Y, add or subtract temp. adjustment to meter reading
1. 300	______	______	Make sure adjusted readings are recorded on field sheet
2. 300	______	______	
3. 300	______	______	

Operator Signature ______________________

CHAIN-OF-CUSTODY RECORD

PLANT CODE	PROJECT NAME
SAMPLERS *(Signature)*	

STA. NO.	DATE	TIME	COMP.	GRAB	WELL	STATION LOCATION	NUMBER OF CONTAINERS							REMARKS OR OBSERVATIONS

Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received for Laboratory by: *(Signature)*	Date	Time	Remarks:	

DISTRIBUTION: Original accompanies shipment; Copy to Coordinator Field Files.

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FIELD DATA SHEET FOR GROUNDWATER SAMPLING

PLANT:	DATE:	SAMPLED BY:
PROJECT:	SAMPLING METHOD:	WEATHER:

Site No.	Time	Well Dia. (in.)	Depth of Well (ft) (including stickup)	Depth to H$_2$0 in Well (ft)	Depth of H$_2$O in Well (ft)	Number of Bails Removed	Dry at Number of Bails Removed	In-situ Measurements								
								pH (units)				Conductivity (umhos/cm)				Temp. (C°)

SITE NO.	OBSERVATIONS

ANALYTICAL REQUEST FORM

TO: D. M. Miller, MSTC
FROM: ____________________

REQUESTED TURNAROUND TIME: ________________

PROJ. ENG./SCIENTIST:
COPY REPORTS TO: __________
PLANT/STUDY: __________
PLANT #: __________
PHASE #: __________
COST CODE #: __________

STUDY DESCRIPTION:		SAMPLE TYPE:		METHOD:	EXTRACTIONS:
Hydrostudy	Drinking Water	Soil	Surface Water	Composite	Total
RCRA Permitting	NPDES Permitting	Sludge	Process Water	Grab	EP-Toxicity
Characterization	RIFS	Residue		Bailer	TCLP
Treatability Study	Other: __________	Groundwater		Pump	ASTM

ANALYSES REQUIRED

PARAMETER	LIMS
1. pH (by EAL)	PH
2. pH (FIELD)	PHF
3. Conductivity (by EAL)	COND
4. Conductivity (FIELD)	CONDF
5. Acidity-(Total)	ACID
6. Alkalinity	ALK
7. Bicarbonate	HCO3
8. Carbonate	CO3
9. Color	COLOR
10. Chloride	CL
11. BOD-T	BOD5
12. BOD-S	BOD5S
13. COD-T	COD
14. COD-S	CODS
15. Fluoride	F
16. Hardness	HARD
17. Ammonia as N	NH3N
18. Nitrate as N	NO3N
19. Nitrite as N	NO2N
20. Kjeldahl - Nitrogen	TKN
21. Organic - Nitrogen	ORGN
22. Phosphorous - Total	PO4
23. Phosphorous - ortho	PO4O
24. Phosphorous - Total Dissolved	PO4TD
25. Turbidity	TURB

PARAMETER	LIMS
26. SOLIDS	
Dissolved (T-F-V)	TDS or DS
Evaporated (T-F-V)	TDS or ES
Suspended (T-F-V)	TSS or SS
27. Sulfate	SO4
28. Sulfite	SO3
29. Sulfide	S
30. Cyanide	
Total	CN
Amenable	CNAM
Free	CNF
31. Thiocyanate	SCN
32. Oil & Grease	OILS
ORGANICS	
33. Carbon (TOC)	TOC
34. Halogens (TOX)	TOX
35. Phenol	PHNOL
36. PCP	PCP
37. PCB	PCB
38. PAH	PAH
39. Purgeable Aromatics	PAR
40. Purgeable Hydrocarbons	PHAL
41. Acid Extractable Phenolics(EPA 604)	AEP
42. Surfactants	MBAS
METALS	
43. Aluminum (Al)	AL
44. Antimony (Sb)	SB

PARAMETER	LIMS
45. Arsenic(As)	AS
46. Barium(Ba)	BA
47. Beryllium(Be)	BE
48. Boron(B)	B
49. Cadmium (Cd)	CD
50. Calcium (Ca)	CA
51. Chromium (Cr)	
Total	CR
Hexavalent	CR6
52. Copper (Cu)	CU
53. Iron-Total(Fe)	FE
54. Ferrous Iron	FE2+
55. Lead (Pb)	PB
56. Magnesium(Mg)	MG
57. Manganese(Mn)	MN
58. Mercury(Hg)	HG
59. Molybdenum(Mo)	MO
60. Nickel(Ni)	NI
61. Potassium(k)	K
62. Selenium(Se)	SE
63. Silver(Ag)	AG
64. Sodium(Na)	NA
65. Thallium(Tl)	TL
66. Tin(Sn)	SN
67. Titanium(Ti)	TI
68. Zinc(Zn)	ZN
MISCELLANEOUS	
69. Radiation	RAD
70. Bacteria	COLI
71. K-001	
72. Priority Pollutants (VOA,BN,AE,Pest Herb, Metals)	
73. Other__________	

SPECIAL INSTRUCTIONS

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the methods to be used for the decontamination of a variety of field sampling equipment used to collect soil samples (e.g., split spoons, trowels, shovels) and surface water and in-plant wastewater samples (e.g., dippers, buckets). It should be noted that SOP 201 defines decontamination procedures for bailers used to collect groundwater samples from wells.

Although this SOP defines decontamination procedures, it is highly recommended that 1) sufficient sampling implements are taken to the field so that decontamination is not necessary and 2) disposable sampling implements are used whenever possible. For example, in collecting soil samples, disposable scoops, wooden tongue depressors, etc., should be used. When collecting in-plant wastewater samples, glass sampling containers are used. Plastic and steel sampling containers should not be used for in-plant sampling. It is advisable that sufficient laboratory cleaned glassware be taken to the field so that decontamination of glassware is not needed. Also, if possible fill sample bottle directly and eliminate use of other sampling gear.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of the field personnel.

Decontamination is mainly achieved by washing and rinsing with liquids which include: soap and/or detergent solutions, tap water, distilled water, hexane, acetone, nitric acid and methylene chloride. Equipment should be allowed to air dry after being cleaned or it may be wiped dry with chemical-free paper towels if immediate reuse is needed.

2.0 RELATED DOCUMENTS

- U.S. Environmental Protection Agency. 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. 2nd ed. EPA-600/4-84-076.

3.0 RESPONSIBILITIES

It is the primary responsibility of the site coordinator to assure that the proper decontamination procedures are followed. It is the responsibility of the project safety officer or his designee to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

4.0 REQUIRED MATERIALS

- Distilled water
- Hexane - pesticide or HPLC grade
- Acetone - pesticide or HPLC grade
- Methylene chloride - HPLC grade
- Chemical-free paper towels
- Cleaning brushes
- Cleaning containers (e.g., buckets, pans)
- Cleaning agents (e.g., soaps, detergents)
- Squeeze bottles dedicated for all solvents above and distilled water.

5.0 SAFETY PRECAUTIONS

At a minimum, hard hat, eye protection, safety shoes, and gloves are to be worn. There are several types of gloves that may be worn, depending on equipment being cleaned, extent of equipment contamination, and potentially harmful con

Polyvinyl gloves may be worn when the equipment to be decontaminated is not heavily coated with constituents such as tars/oils. In cases where heavy accumulations of tars/oils are present on the equipment, a neoprene or similar glove is recommended.

6.0 PROCEDURE

The extent of known contamination will determine to what extent the equipment needs to be decontaminated. If the extent of contamination cannot be readily determined, cleaning should be performed according to the assumption that the equipment is highly contaminated until enough data is available to allow assessment of the actual level of contamination.

The decontamination procedures listed below can be considered as the procedure for full field decontamination. If different or more elaborate procedures are required for a specific project, they should be identified on the work request sheet. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

1. Remove gross contamination from sampling equipment by brushing and rinsing in tap water.
2. Wash in detergent solution.
3. Rinse with tap water.
4. Rinse with distilled water.
5. Rinse with methylene chloride.
6. Rinse in hexane.
7. Rinse in acetone.
8. Repeat entire procedure or any part of the procedure, if necessary.
9. Allow equipment to air dry or dry with nitrogen before use.

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7.0 QUALITY CONTROL

To assess the adequacy of decontamination procedures, field blanks for aqueous samples and replicates for soil samples are taken and analyzed by the laboratory. The specific number of field blanks and replicates shall be identified by the project engineer/scientist. In general, for aqueous samples, one field blank should be collected per sampling event and one per sampling equipment. If in-plant wastewaters and groundwater samples are being collected during the same sampling event, a field blank should be collected for each different piece of sampling equipment (e.g., field blank for bailer and field blank for bucket).

8.0 DOCUMENTATION

The decontamination procedures used for each piece of sampling equipment should be recorded in the field notebook/data sheet. The project engineer/scientist will maintain a record of the decontamination procedures. Field blanks and replicate samples will be properly labeled, Chain-of-Custody records completed, and other shipping information maintained.

APPENDIX B

HEALTH AND SAFETY PLAN FOR SITE INVESTIGATION

SAUNDERS SUPPLY
SUFFOLK VIRGINIA

PREPARED BY

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
MONROEVILLE, PENNSYLVANIA

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1.0 INTRODUCTION

1.1 Background

This Health and Safety Plan is intended to provide guidance for personnel working on-site during the Site Investigation at the Saunders Supply site in Suffolk, Virginia and other personnel or public in close proximity to the site investigation activities. This plan has also been developed to minimize, to the extent possible, the risk of injury or illness as a consequence of activities undertaken at this site.

A Site Investigation of the Saunders Supply site is being conducted to determine the need for corrective measures and to characterize the nature and extent of contamination of soils, groundwater and its threat to human health and the environment. The investigation activities may include:

- Monitoring Well Installation
- Soil Borings
- Falling Head Permeability Testing
- Groundwater Sampling (shallow and deep)
- Surficial Soil Sampling
- Subsurface Soil Sampling
- Surface Water Sampling
- Sediment Sampling

The information gathered in the will be used to formulate and implement corrective measures.

2.0 RESPONSIBILITY

A Site Health and Safety Officer (SHSO) will be designated. This person will be responsible for all health and safety activities, including subcontractor activities, air monitoring, overseeing the decontamination of equipment and materials leaving the contaminated area, providing and enforcing the use of personal protective equipment and clothing. Keystone's Health and Safety Manager or his designee will be responsible for the training of on-site personnel as described in Section 3.0.

The SHSO will have had experience in field operations with air monitoring equipment, personal protective equipment and clothing, decontamination procedures and emergency response procedures.

The SHSO will also work with health and safety personnel of subcontractors in the implementation of this site health and safety plan.

3.0 TRAINING

The Health and Safety Officer will conduct a training program designed to ensure that field personnel are aware of the hazards at the site and they perform their work in a manner that will minimize, as much as possible, risk to site personnel's health and safety. The health and safety training will include but not be limited to the following:

- A general overview of the project and site
- An explanation of exposure routes and potential effects of contaminants identified at the site
- Requirements for personnel protective equipment and clothing,respirator training, skin protection, etc.
- The "Buddy System"
- Decontamination and /or disposal procedures
- Personal hygiene requirements
- Action Levels and responses to high levels of air-borne contaminants

- Emergency response procedures (personal injury, accidents and other emergency procedures required).
- General site safety rules and procedures
- Responsibility of on-site supervision and management related to health and safety issues.

The site specific training program will involve at least 2 hours of instruction per employee. Also, job specific health and safety instructions will be reviewed before beginning each new phase of work.

Records of site personnel having completed the above training will be maintained by Keystone's Health and Safety Manager with copies maintained by the Site Health and Safety Officer.

Weekly and/or before a major change in operations the SHSO will conduct follow-up training related to the change in operations or any other training deemed necessary by the SHSO.

4.0 MEDICAL SURVEILLANCE PROGRAM

4.1 Purpose

The purpose of the worker medical surveillance program is to insure, to the extent possible, that all persons participating in field activities at the Saunders Supply site are in good health and capable of performing the field activities and verify that such work has not resulted in any health problems.

4.2 Protocol

All personnel, including subcontractors, subject to occupational exposure at the site will be required to have had a medical examination within the past year prior to the beginning of field operations at the Saunders Supply site. A written certification from the examining physician stating that the employee can work on the site before the employee begins work at the site. Protocols will be approved by the Health and Safety Manager. The medical examination as a minimum will consist of the following:

- Review and documentation of medical records
- General physical
- Pulmonary Function Test (FVC and FEV)
- SMA 24 blood chemistry
- Complete Blood Count (CBC)
- Chest X-Ray (if medically indicated)
- Heavy Metals Screen (urine analysis) only if medically indicated

Medical surveillance will include a judgment by the examining physician of the ability of the employee to use a negative or positive pressure respirator and a positive pressure breathing apparatus. Those individuals determined to have a medical condition which could directly or indirectly be aggravated by exposure to chemical substances within the site environment or the use of respiratory equipment will not be employed on this project.

The SHSO in consultation with Keystone's Health and Safety Manager and Koppers Corporate Medical Director or his designee will decide whether an employee is to undergo re-examination should an individual develop an illness or injury during the course of site activities. The physician examining the individual must certify that the individual is fit to return to work without restrictions before he/she can participate in site activities. In addition the Koppers Corporate Medical Director and/or Keystone's Health and Safety Manager can request additional medical testing if abnormal exposure occurs.

An exit examination of individuals exposed to hazardous site conditions throughout the length of the project will be scheduled upon completion of this project.

5.0 DECONTAMINATION

5.1 Purpose

Decontamination procedures will be implemented for equipment and personnel to ensure that suspected contaminants are adequately controlled and to avoid the transfer of contaminants off of the work site and to other personnel.

5.2 Equipment

All equipment will be decontaminated before it leaves the site. Decontamination may consist of scraping, water or solvent rinsing or steam cleaning. Verification that equipment leaving the site has been adequately decontaminated is the responsibility of the SHSO. Equipment that cannot be adequately decontaminated at the site will be effectively covered to prevent off-site contamination and transported to another area for eventual decontamination or disposal in accordance with all applicable regulations.

Heavy equipment decontamination (i.e. drill rigs, backhoe, auger flights, drilling tools and any other large item that needs to be decontaminated) will be done in area area specifically designated for this purpose.

5.3 Sample Container Decontamination

A sample decontamination station will be set up to decontaminate sample containers before they are prepared for shipment to the laboratory,moved inside to the on-site laboratory, preserved and/or if any samples are to screened on-site using a Photoionization Device or any other organic vapor analyzer.

The sample decontamination station may consist of a table specifically designated to decontaminate sample containers, water, detergent, spray bottles of solvent and dionized water.

5.4 Personnel and Protective Equipment

On-site personnel will be required to remove contaminated clothing and thoroughly wash hands and face prior to smoking, handling of any food or drink, using of the restroom facilities or leaving the site. On a daily basis, personnel shall scrub boots, hard hats (if contaminated), and gloves in a detergent and water type solution, rinse with clean water and allow to dry overnight. The inside surface of each must be inspected for contamination. Any contamination must be removed, the item cleaned or washed (as above) or discarded. Respirators will be cleaned daily with commercially available respirator cleaner-sanitizer if they are worn.

Any personnel protective equipment to be thrown away will be placed in an appropriate container and disposed of in accordance with all applicable local, state and federal regulations.

When exiting the work area for breaks,use of the restroom, or going to lunch, personnel will remove contaminated protective clothing in the appropriate area then, wash his/her face, hands, neck, and arms before moving into the break area or leaving the site.

When a minor first-aid emergency requires worker to leave the work site, site personnel will follow these amendments:

- The worker will remove gross contamination, remove outer garments in the area, if possible, and receive first-aid at that time or further information concerning the emergency.

- If the accident/injury is not serious, the worker, after being treated, will redress and return to the work area.

- If the accident/injury is serious, the worker will be immediately transported to the hospital. During the wait for an emergency vehicle the injured will be decontaminated as much as possible.If more elaborate personnel protective equipment clothing is required, decontamination procedures will be modified to be consistent with the increased level of protection.

6.0 HEALTH AND SAFETY PROCEDURES

6.1 General

The following general policies/procedures will be in effect at the Saunders Supply site:

- the Site Health and Safety Officer will be notified before anyone enters the site area,
- personnel must wash hands, arms, neck and face before smoking, eating, drinking using restroom facilities, or leaving the site,
- all personal protective equipment will be decontaminated or properly disposed of before leaving the site,
- all changing of clothes and personal protective equipment will take place in a designated change area,
- contact lenses will not be worn on-site,
- personnel violating safety procedures will be removed from the job,
- all activities will comply with all applicable local, state and federal laws,

- work zones will be honored,

- each sample must be treated as though it were toxic and hazardous,

- persons with beards or other facial hair that interferes with respirator fit are not permitted within the site boundaries when conditions require respiratory protection,

- all personnel should avoid all unnecessary contact with contaminated soil and water,

- all personnel should avoid any contact between their hands and mouths until they are thoroughly decontaminated,

- horseplay on the site is prohibited,

- use of, or under the visible influence of alcohol, narcotics, or controlled substances while working will not be permitted, and

- firearms, ammunition, fireworks and explosives are prohibited.

6.2 Site Control

The purpose of site control is to minimize potential contamination of workers, protect the public from the site's hazards. All workers will enter the site through one site entry point. The site work zones will be established by using red, orange and green flagging.

6.3 Hazard Analysis

A preliminary hazard analysis has been conducted to ensure that site activities, personal protection and emergency response are consistent with the specific contaminants expected to be encountered. (See Table 6-0). The analysis forms the foundation for this Health and Safety Plan.

The contaminants of concern that may be present at the site include benzene, copper, chromium, arsenic, naphthalene,polychlorinated dibenzo-p-dioxins(PCDD) and dibenzofurans(PCDFs),pentachlorophenol and various volatile to practically non-volatile polynuclear aromatic hydrocarbons[3] including acenaphthene, chrysene[1], fluorene, phenanthrene, anthracene, 2-methyl-naphthalene, pyrene, benzo(a)anthracene, benzo(g,h,i)pyrene, 2-methylphenol,fluoranthene 2,4-dimethylphenol, 4-methylphenol, 2-chlorophenol, benzo(a)pyrene[1] and acenaphthylene which properly or improperly by the term "coal tar pitch volatiles, as benzene soluble portion. PCPs,PCDDs, and PCDFs are associated with the pentachlorophenol treatment process which at one time was used at the site." The applicable OSHA PELs from 29 CFR 1910.1000, TLV-TWAs and TLV-STELs from the American Conference of Governmental Industrial Hygienist(ACGIH) are listed below, where available. Additional data on occupational health effects of these compounds is included as Appendix I.

TLV-TWA represents the time-weighted average concentration for an eight hour workday and a forty hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The TLV-STEL is defined as a fifteen minute time-weighted average exposure which should not be exceeded at any time during a work day even if the eight-hour time-weighted average is within the Threshold Limit Value(TLV). The OSHA Permissible Exposure Limits (PELs) are those TLV-TWAs which have been adopted by OSHA under 29 CFR 1910.1000.

The primary exposure pathways of concern for these compounds are skin absorption/contact and inhalation. Pentachlorophenol and naphthalene are the most volatile of these compounds and exposure to naphthalene could possibly occur in the vapor state as well as with contaminant particulates. With the rest of the chemicals the major concern is with airborne exposure from dust contaminated with these compounds. Open areas of wood preservative seeps and highly contaminated soils probably represent the greatest hazard through skin contact.

Since past investigations indicate a lack of airborne contamination, airborne exposure to contaminants prior to site drilling operations should be slight. Potential exposure to workers may occur during site drilling , any well installations and boring activities.

6.4 Air Monitoring

Air quality monitoring is a very important part of the Health and Safety Plan. Data collected serve to form decisions as to what worker protective clothing and equipment, site work procedures and emergency procedures will be formulated and implemented for this site. The air quality monitoring plan for this site is defined in the following Table (6-1) :

- Continuous, real-time measurement of total organic vapor concentrations.

- Initial ambient air monitoring program

Portable instruments are used to provide real-time, semi-quantitative data on total organic vapor concentrations in and around the breathing zone of workers and downwind of site activities.

During all drilling,boring and sampling activities on-site, portable photoionization detectors (PIDs) or equivalent will be used for monitoring organic vapor concentrations in the breathing zone. These detectors will be calibrated daily and organic vapor concentration will be monitored during site activities. Action levels for employee protection and emergency actions will be instituted based on observations related to airborne concentrations of contaminants measured during site air quality monitoring of the work area. The operation and calibration procedures are included in Appendix III.

There may be an occasion that airborne particulate monitoring will be done, if necessary.

The Health and Safety Officer or his/her designee will document the air quality measurements daily, including corresponding meteorological data.

6.5 Personnel Protective Equipment

Personnel protective equipment specific to each task areas are outlined in table 6-2 through 6-4. Drilling work will be done at a modified Level C,which means all protective equipment that is worn at Level C will be used except for respirators. A contingency has been set up so that if monitoring readings exceed action levels full Level C attire will be worn.

Within the work area, organic vapor measurements at the breathing zone will be used as an indication of airborne contaminate levels. Action levels have been established for organic vapor readings. Responses to these action levels have been devised and general actions are defined once observed sustained organic vapor concentrations above background are realized. "Sustained" indicates elevated concentrations of organic vapors in the breathing zone for longer than 15 minutes. The basic responses to air concentrations observed during area monitoring are as follows:

- Level 1 -	OV concentration of less than .045ppm (.5mg/m^3) above background : Respirators not required
- Level 2 -	OV concentration of .045ppm(.5mg/m^3)-.23ppm (2.5mg/m^3) above background: Requires MSHA/NIOSH approved respirators with organic vapor cartridges and hepa filters. Also they will be worn if a "dust cloud" has been generated and the workers must continue to work within the dust cloud.
- Level 3 -	OV concentrations exceed 2.3 ppm (25mg/m^3) above background. Workers will be advised to wear full faced respirators with organic vapor cartridges

and hepa filters, a supplied-air respirator with a full facepiece, helmet, or hood.

- Level 4 - If OV concentrations exceed 6.8ppm (75mg/m^3) all activity in the area will be suspended until air quality is reduced to acceptable levels . If organic vapors remain equal to or greater than 6.8ppm, other actions will be considered, including upgrading to a higher level of protection.

The .05mg/m^3 (.23ppm) response level for the use of respirators is based on the TLV-TWA for Pentachlorophenol, the most volatile of the contaminants of concern. The 6.8 ppm response level for suspension of operations is within the bounds of the effective range of the MSHA/NIOSH approved respirators. Employees will be informed of the need for a change in the level of protection required via word of month. Upgrading the level of protection will be performed in the decontamination area.

During the course of this investigation personal monitoring for airborne particulate matter will be conducted.

If a particular job function appears to result consistently in high employee exposure, addition employee training for improved work habits, and /or other administrative action will be taken to reduce acute and/or chronic exposure potential.

6.6 Health and Safety Plan - General Population

For the purpose of this investigation, the "general population" will be defined as those individuals not associated with the field activities of this investigation but could be in proximity to these activities.

The Health and Safety Plan for these groups consist of:

1. Limiting the potential interaction with these groups and

2. Instituting a system of "Perimeter Action Levels" based on air monitoring of the specific field activity, whereby organic vapor or airborne particulate concentrations at the perimeter of work area are closely monitored to dictate health and safety actions.

6.6.1 Limiting Interactions

Visitors to the site will be required to report to the field headquarters and sign a visitors log book prior to entering the site. Depending on the purpose of the visit and the areas of the site to be visited, the Health and Safety Officer or his/her designee will determine what personal protective equipment is required to be worn by the visitor.

7.0 EMERGENCY PROCEDURES

7.1 Responsibility

The following personnel are responsible for on-site coordination of emergency procedures :

Project Manager -	(to be assigned prior to the site investigation)
Site Health and - Safety Officer	(to be assigned prior to the site investigation)

These people will be responsible for initiating emergency response procedures and allocating resources to conduct spill containment or other emergency operations.

7.2 General Injury

Since the location of the investigation activities are within a Koppers operating facility, Keystone's SHSO will review with the Koppers facility Safety Director proposed activities of the site investigation. In the event of a medical emergency, Koppers Safety personnel will be promptly notified for assistance.

7.3 First Aid

7.3.1 General

1. Give first-aid as is appropriate and necessary
2. Contact plant Safety Director to arrange for off-site assistance and/or medical help, if necessary (see Table 7-1)
3. Notify Project Manager and Health and Safety Manager

7.3.2 Specific Treatments

- Eye Exposure
Immediately flush exposed eye with copious amounts of water, using emergency eye wash station

- Skin Exposure
Wash contaminated area with mild soap and water immediately

- Inhalation
Remove person to clean air. Perform artificial respiration and/or CPR, if appropriate.

- Swallowing
Contact nearest hospital or poison control center for instructions.

- Burns

Immediately treat acid, caustic and thermal burns by rinsing in cold water then report promptly to SHSO or his/her designee.

* Movement of an injured person/s should be avoided unless the injured person/s is in immediate danger.

7.4 Occupational Injuries and Illnesses

All recordable occupational injuries and illnesses as required by the regulations issued under the Occupational Safety and Health Act shall be recorded on the appropriate form (OSHA LOG 200). Occupational injuries and illnesses shall be recorded within 48 hours of the recordable case as required by law.

7.5 Fire

- Notify appropriate plant personnel

- localized (controlled)

use fire extinguisher and/or fire blanket to extinguish.

- Uncontrolled

follow established plant fire procedures.

7.6 Emergency Site Evacuation Procedures

7.6.1 Evacuation Plan

In the event that an emergency does arise,(i.e., including but not limited to fire, explosion or substantial toxic gas release into the atmosphere, a air horn will be activated. The horn will be activated continuously for approximately 15 seconds, all personnel will evacuate the site and assemble at a location to be named later . Necessary instructions concerning the evacuation will be given at that time. After the emergency has been declared over, the site project manager or the health and safety officer will indicate that work can once again begin.

The Site Health and Safety Officer has the authority to initiate proper action in the case of an on-site emergency. In his/her absence the on-site Project Manager is delegated this responsibility.

During a site emergency visitors will not be allowed to enter the emergency area once an alarm has been sounded. Visitors or other persons present in the area of the emergency shall be instructed to evacuate the area.

All project personnel will be instructed on proper emergency procedures.It will be the on-site project managers responsibility to insure that the phone located in the office is manned in case emergency phone calls need to be made or received.

Front-end loaders, drill rigs or other combustion apparatus shall be shut down once an alarm has been sounded. Operators and other support personnel will then proceed to the site assembly location immediately for further instructions.

7.7 Communications

If communication between the office and the work site is necessary, it may be done via 2-way radio communications. Verbal communication at the site can be impacted by the on-site background noise and the use of personal protective equipment. For effective communications, commands can be prearranged and additional audio or visual cues will help convey the messages.

At the site, personnel could use one of the following means of communication:

DEVICE	TYPE OF COMMUNICATIONS	SIGNAL
2-Way Radio	To each other	Assigned radio No.
	To field HQ/	Assigned radio No.

	nonemergency	
	To field HQ/ emergency	Code Red/assigned No.
Compressed Air Horn	To field/ nonemergency To field/ emergency	One long, one short blast Three long blasts
	Evacuation	Continuous blast. (15 seconds)
Visual	To each other distress/need help	Hands on top
	Break, lunch, end of day	Two hands together break apart
	Contaminated air/	Hands clutching throat
strong odor		
	To field/ evacuate area	Grip partners wrist or place both hands around waist
	Thumbs up	I'm ok, I understand
	Thumbs down	No, negative
	Clenched fist held up	Stop equipment or work

TABLE 6-0

THRESHOLD LIMIT VALUES

	TLV-TWA	TVL-STEL	PEL
Arsenic as AS	0.2 mg/m^3	N/A	0.2 mg/m^3
Benzene	10 ppm	30 ppm	1 ppm
Chromium (VI)[2]	0.05 mg/m^3	N/A	0.1 mg/m^3
Copper (Dust & Mist)	1 mg/m^3	N/A	1 mg/m^3
Polycylic Aromatic Hydrocarbons (Coal Tar Pitch Volatiles(1))	0.2 mg/m^3	N/A	0.2 mg/m^3
Naphthalene	10 ppm	N/A	10 ppm
Pentachlorophenol-skin	0.5mg/m^3	N/A	0.5mg/m3

Exposure limits for most of the specific PAH compounds listed above have not been set by OSHA or ACGIH.

1.- Not specifically titled "Coal Tar Pitch Volatiles" in IARC or by NTP 82-300 under the subject title "Soots, Tars and Minerals Oils." ACGIH assigns coal tar pitch volatiles to their category "Ala - Human Carcinogens."

2.- There is sufficient evidence for the carcinogenicity of chromium and certain chromium compounds both in humans and experimental animals (IARC, and NTP 82-330) certain water insoluable compounds (ACGIH TLVs 1987-88). Specific compounds not identified.

TABLE 6-1

AIR QUALITY MONITORING PROGRAM SUMMARY

TYPE OF MONITORING	FREQUENCY	LOCATION AND NUMBER	EQUIPMENT USED	PURPOSE
Work Area	During sampling operations	Active work areas (e.g., each sampling location)	Foxboro Flame-ionization Organic Analyzer or PID instrument	Real-time, semi-quantitative data on total organic vapors for operational and health and safety decision making
Boring, well installations	30-60 minute intervals during operations or as necessary	at (1) ground surface and (2) breathing level	Foxboro Flame-ionization Organic Analyzer or PID instrument	Documentation of organic vapor levels and determination of need to change protection action levels
Personal	As necessary	personal monitor	MSA Model G Pump	Documentation of airborne particulate matter

TABLE 6-2

PERSONNEL PROTECTIVE EQUIPMENT FOR MONITORING WELL INSTALLATION AND BORINGS

REQUIRED

- Work Coveralls
- Safety Glasses or Goggles
- PVC Undergloves
- Neoprene Overgloves
- Steel Toe and Shank Footwear
- Hard Hat

CONTINGENCY

- Sun Screen
- At least one respirator (MSHA/NIOSH approved) for each person at the drill site, with OV/AG/Hepa cartridge filter.
- Tyvek disposable coveralls
- First Aid Kit
- Portable eyewash station
- Fire extinguisher and blanket
- Disposable overboots
- Ear protection (if needed)

---

*Note: Glove (protective clothing) material selection are based on best judgment, considering all potential solvent contacts, BUT, no one glove (protective clothing) material is resistant to permeation and degradation by all solvents. Thus, care must be taken to examine the gloves (protective clothing) while being worn and when removed for physical condition (tears, holes, split seams, etc.) and signs of liquid permeation/degradation.

TABLE 6-3

PERSONNEL PROTECTIVE EQUIPMENT FOR SOIL SAMPLING, GROUNDWATER SAMPLING AND PERMEABILITY TESTING

REQUIRED

- Work coverall
- Safety glasses or goggles
- PVC Undergloves
- Neoprene Overgloves
- Steel toe and shank footwear
- Hard hat

CONTINGENCY

- Sun screen
- At least one respirator (MSHA/NIOSH approved) for each person at the site with OV/AG/Hepa cartridges
- Tyvek disposable coveralls
- First aid kit
- Portable eyewash station
- Fire extinguisher and blanket
- Disposable overboots

---

*Note: Glove (protective clothing) material selection are based on best judgment, considering all potential solvent contacts, BUT, no one glove (protective clothing) material is resistant to permeation and degradation by all solvents. Thus, care must be taken to examine the gloves (protective clothing) while being worn and when removed for physical condition (tears, holes, split seams, etc.) and signs of liquid permeation/degradation.

TABLE 6-4

PERSONNEL PROTECTIVE EQUIPMENT FOR SURFACE WATER AND SEDIMENT SAMPLING

REQUIRED

- Work coveralls
- Safety glasses or goggles
- Rubber boots
- PVC undergloves
- Rubber boots
- Neoprene Overgloves
- Life Vest (when in boat)

CONTINGENCY

- Sun screen
- At least one respirator (MSHA/NIOSH approved) for each person at the site with OV/AG/Hepa cartridges
- Portable eye wash station
- First aid kit

---

*Note: Glove (protective clothing) material selection are based on best judgment, considering all potential solvent contacts, BUT, no one glove (protective clothing) material is resistant to permeation and degradation by all solvents. Thus, care must be taken to examine the gloves (protective clothing) while being worn and when removed for physical condition (tears, holes, split seams, etc.) and signs of liquid permeation/degradation.

TABLE 7-1

EMERGENCY INFORMATION

In the event of a fire, uncontrollable chemical spill, explosion, or any occurrence that might be harmful to personnel or adjacent property, immediately notify the proper emergency services will be required. The proper emergency service is determined by the nature of the emergency.

EMERGENCY NOTIFICATION NUMBERS

Suffolk Fire Department	(804) 539-3131
City of Suffolk Police	(804) 255-4676
Louise Obici Hospital Emergency Room	(804) 934-4803

ROUTE TO HOSPITAL: Turn right out of Saunders Supply onto Route 10 (East). Go approximately 7 miles to the intersection of Route 460. Turn left onto Route 460 and go approximately 1/4 mile and the Hospital is on the left.

PROCEDURES FOR REPORTING INCIDENTS

Immediately Call:

Keystone's Contacts

John C. Mitsak	(301) 547-7922
Michael J.Dvorsky	(412) 733-9519
James M. Thomas, II	(412) 733-9473

Saunders Supply Contact

Samuel Howell	(804) 255-4531

APPENDIX I

MATERIAL SAFETY DATA SHEETS/HEALTH DATA

ANTU

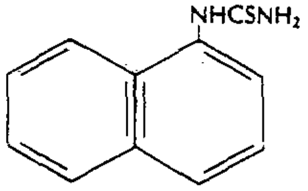
alpha-Naphthyl-thiourea

$H_{10}N_2S$

Skin

TLV, 0.3 mg/m³

STEL, 0.9 mg/m³



ANTU is an odorless gray powder. Its molecular weight is 202.27 and the melting point is 198° C with decomposition occuring upon boiling. Insoluble in water and only very slightly soluble in most organic solvents.

The principle use of ANTU is as an rodenticide.

McClosky *et al*[1] reported that the acute oral toxicity of ANTU varies greatly among different species, rats and dogs being the most susceptible (LD_{50}, 30-50 mg/kg) and rabbits the least (1000 mg/kg). Later studies showed an acute oral LD_{50} for monkeys of 4,250 mg/kg. The acute toxicity of ANTU for man is believed to lie somewhere between these extremes. A dietary level of 50 ppm for two years (approximately 2.5 mg/kg per day, equivalent to 170 mg/man/day) produced tissue damage in rats.[2]

Evaluation of the toxicity data for a threshold limit recommendation is further complicated by the cumulative action of ANTU on the endocrine systems (thyroids and adrenals) leading to hypothyroidism upon repeated exposure, whereas a tolerance to certain of the acute effects of ANTU (pulmonary effusion) likewise occurs.[3]

A case of contact eczema due to handling a rat poison containing ANTU as a base has been reported.[4] Tests performed on workers handling thiourea products showed ready penetration through the skin, leading to destructive changes in the thyroid glands.[5]

ANTU has been implicated[6] as a causative agent in occupational bladder tumors because of its content of beta naphthylamine as an impurity in alpha naphthylamine from which ANTU is made. At the TLV of 0.3 mg/m³ it is believed that the amount of beta naphthylamine exposure would pose no carcinogenic risk provided skin contact is avoided. Other adverse effects of ANTU are believed to be protected against by the recommended TLV and the STEL of 0.9 mg/m³.

References:

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ARSENIC AND COMPOUNDS

As

Soluble Compounds, as As

TLV, 0.2 mg/m³

Arsenic, an element with atomic number 33, atomic weight 74.92, is in Group VA of the periodic table. The most common form of the element is a gray brittle crystalline solid with a specific gravity of 5.72, which sublimes at 613° C. It also exists in amorphous forms: black, specific gravity of 4.7 and yellow, specific gravity of 2.0, which is relatively volatile. Yellow arsenic is soluble in carbon disulfide; the other forms are insoluble in water or solvents, but dissolved by oxidizing acids.

Elemental or metallic arsenic is employed as an alloying agent for heavy metals, in special solders, and as a doping agent in silicon and germanium solid state products.

In addition to arsenic compounds discussed separately (As_2O_3, AsH_3 and lead arsenate, q.v.) many others find commercial application. The arsenites are important herbicides, calcium and other arsenates are insecticides; sulfides are pigments, rodenticides and used in pyrotechnics; gallium arsenide is in semiconductors; arsenic trichloride, a liquid with a boiling point of 130.5 C, is employed in chemical synthesis; the gaseous tri- and pentafluorides apparently have no important commercial uses. Many organic arsenic compounds, however, have been employed in medicine, or as war gases.

As with other metallic poisons, the toxicities, especially the acute toxicities, of arsenic compounds are related to their solubility in water. Thus most arsenates and arsenites are acute poisons, while the sulfides are probably less toxic in an acute sense, but may be equally hazardous on prolonged exposure. Elemental arsenic is also less acutely toxic than its oxides, except for the rare yellow arsenic which is highly toxic, possibly similar to yellow phosphorus in some of its properties.

Systemic arsenic poisoning is rarely seen in industry, and still more rarely is it severe in character. According to Hardy,[1] it is hard to explain the difference between industrial and nonindustrial arsenic poisoning, but such variation is recorded in all industrialized countries. The usual effects on workers are local, on skin and mucous membranes, etc. A hoarse voice is characteristic of an arsenic worker, and a perforated nasal septum is a common result of prolonged inhalation of white arsenic dust or fume. A few documented cases of cirrhosis of the liver, however, due to occupational exposure to arsenic, have been recorded.[1]

Although the epidemiologic evidence is not complete arsenic is considered by some to be a of the skin, and perhaps of the bronchi.[2,3] Cancers from exposure to arsenic have followed: 1) the internal use of Fowler's Solution, an aromatic solution of potassium arsenite;[4] 2) inhalation and skin contact with sheep-dust, a mixture of sodium arsenite and sulfur;[5] 3) the combined inhalation of As_2O_3, SO_2 and other particulates from the smelting of ores containing arsenic (see documentation, arsenic trioxide production). Experimental cancers in animals have not been produced from As_2O_3 despite several attempts[6-8] and the conclusion of Vallee *et al*[8] was that *"it is improbable that arsenic (per se) plays asignificant role in the generation of cancer."* The belief that other occupational factors are necessary for the development of cancer, in addition to arsenic exposure, has been expressed by others.[9]

A search of the world literature reveals no reports of industrial or experimental exposures solely to arsenic compounds which contain both environmental and toxicological criteria from which a TLV can be unequivocally based. Watrous and McCaughey[10] found concentrations of arsenic in a pharmaceutical plant averaging about 0.2 mg/m³, with no definite evidence of intoxication. Pinto and McGill studied a group of smelter employees and found an average urinary arsenic excretion of 0.8 mg/L.[11] The chief manifestation of toxic exposure was dermatitis, with perforation of the nasal septum, pharyngitis and conjunctivitis noted less frequently. A reasonable interpretation of the urinary arsenic levels would indicate an average exposure of about 0.2 mg/m³ of arsenic in air. Since individual concentrations as high as 4 mg/L of urine were found, it is probable that many workers were exposed at higher concentrations.

In its criteria document for inorganic arsenic, NIOSH in 1973[12] recommended 0.05 mg As/m³ (as a TWA) as a workplace air standard. This was changed in 1975 to 0.002 mg/m³ as a 15 minute ceiling.

The first limit was based primarily on reports of cancer among workers exposed to arsenic, as well as non-occupational cancer resulting from arsenic medications. The only pertinent environmental data cited not already noted consist of an average concentration of 0.56 mg/m³ computed from the paper by Perry *et al*[13] on an English sheep dip factory study, and a study by Lee and Fraumeni[14] in a smelting plant. Concentrations of 1.47, 1.56 and 1.50 mg/m³ were reported in "medium and high exposure areas" and 0.65, 0.17 and 0.002 mg/m³ in "light exposure areas". In both plants an increased incidence of cancer was reportedly found.

The Committee is not aware of any published explanation of the reasons for the reduction of the NIOSH 1973 recommendation of a TWA of 0.05 mg/m³ as a standard, to a ceiling of 0.002 mg/m³ in 1975.

Normal values of arsenic in urine, as recorded in the literature, vary from 0.013 to 0.046 mg/L,[1] to 0.13,[11] to 0.25.[15] The urinary excretion, in mg/liter, of elements that are freely eliminated by this route, such as fluorine, mercury and arsenic, is at most 2.5 to 5 times the occupational exposure in mg/cubic meter of air.[16] It is apparent th[illegible] biological monitoring for arsenic by urinalysis would b[illegible] limited value in determining whether or not the NIOSH recommended standard was being met or exceeded.

According to the 1977 compilation of occupational exposure limits of the International Labour Office, the following countries had adopted the previous TLV of 0.5 mg/m³: Australia, Finland, Japan, Holland, Switzerland and Yugoslavia. Czechoslovakia, East Germany, Hungary and Poland specified the USSR MAC of 0.3 mg/m³; Romania 0.2 and Sweden 0.05 mg/m³. Only three of 18 countries (West Germany, Italy and Sweden) designated arsenic and compounds as carcinogens, although Belgium and the Netherlands so characterized arsenic trioxide.

It is possible that some arsenic compounds, the trichloride for example, might produce certain toxic effects at concentrations below 0.2 mg/m³ of arsenic. Data to substantiate this speculation are lacking. The contrary situation, that some compounds, or the metal itself, are chronically less toxic than As_2O_3, the form for which most information is available, seems more probable in the light of present knowledge. Therefore, a TLV of 0.2 mg As/m³ for soluble compounds of arsenic is recommended.

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440 COLLEGE PARK DR
MONROEVILLE PA 15146

DATE: 07/02/87
CUST # 3C1183 P.O. # 14-7-80783

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

PRODUCT # 15462-8 NAME: BENZENE, 99+%, SPECTRCPHOTOMETRIC GRADE
CAS # 71-43-2

TOXICITY HAZARDS

RTECS # CY1400000
BENZENE

IRRITATION DATA

SKN-RBT 15 MG/24H OPEN MLD	AIHAAP 23,95,62
SKN-RBT 500 MG/24H MCD	28ZPAK -,23,72
EYE-RBT 88 MG MOD	AMIHAB 14,387,56
EYE-RBT 2 MG/24H SEV	28ZPAK -,23,72

TOXICITY DATA

IHL-HMN LCLO:2 PPH/5M	TABIA2 3,231,33
ORL-MAN LDLO:50 MG/KG	YAKUD5 22,883,80
IHL-HMN LCLO:2000 PPM/5M	YAKUD5 31,883,80
IHL-HMN LCLO:65 MG/M3/5Y	ARGEAR 44,145,74
UNR-MAN LDLO:194 MG/KG	85DCAI 2,73,70
ORL-RAT LD50:3306 MG/KG	TXAPA9 19,699,71
IHL-RAT LC50:10000 PPM/7H	28ZRAQ -,113,60
IPR-RAT LD50:2890 UG/KG	36YFAG -,302,77
ORL-MUS LD50:4700 MG/KG	HYSAAV 32,349,67
IHL-MUS LC50:9980 PPM	JIHTAB 25,366,43
SKN-MUS LD50:48 MG/KG	NPIRI* 1,5,74
IPR-MUS LD50:990 UG/KG	AGGHAR 18,109,60

REVIEWS, STANDARDS, AND REGULATIONS
CARCINOGENIC REVIEW:HUMAN SUSPECTED IMEMDT 7,203,74
CARCINOGENIC REVIEW:ANIMAL SUSPECTED IMEMDT 29,93,82
CARCINOGENIC REVIEW:HUMAN POSITIVE IMEMDT 29,93,82
CARCINOGENIC REVIEW:ANIMAL INDEFINITE IMEMDT 7,203,74
ACGIH TLV-SUSPECTED CARCINOGEN 85INA8 5,50,86
ACGIH TLV-TWA 10 PPM 85INA8 5,50,86
MSHA STANDARD:AIR-CL 25 PPM (80 MG/M3) (SKIN) DTLVS* 3,22,71
OSHA STANDARD-AIR:TWA 10 PPM;CL 25 PPM;PK 50 PPM/10M/8H FEREAC 39, 23540,74
NIOSH REL TO BENZENE-AIR:CL 1 PPM/60M MMWR** 34(1S),8S,85
EPA GENETOX PROGRAM 1986, POSITIVE: CARCINOGENICITY-MOUSE/RAT
EPA GENETOX PROGRAM 1986, POSITIVE: IN VITRO CYTOGENETICS-HUMAN LYMPHOCYTE
EPA GENETOX PROGRAM 1986, POSITIVE: IN VIVO CYTOGENETICS-HUMAN LYMPHOCYTE
EPA GENETOX PROGRAM 1986, POSITIVE: MAMMALIAN MICRONUCLEUS: SPERM MORPHOLOGY-MOUSE
EPA GENETOX PROGRAM 1986, POSITIVE/DCSE RESPCNSE: PLANT GENE MUTATION
EPA GENETOX PROGRAM 1986, NEGATIVE: CELL TRANSFORM.-SA7/SHE: IN VITRO SCE-HUMAN LYMPHOCYTES
EPA GENETOX PROGRAM 1986, NEGATIVE: IN VITRO SCE-HUMAN
EPA TSCA CHEMICAL INVENTCRY, 1986
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0680-0345;8EHQ-1277-0027: 8EHQ-0378-0112
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0978-0244;8EHQ-0379-0277
EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0378-0112
EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, DECEMBER 1986
NIOSH ANALYTICAL METHCDS: SEE HYDROCARBONS, AROMATIC, 1501: HYDROCARBONS, BP 36-126 C, 1500
NTP CARCINOGENESIS STUDIES (GAVAGE);CLEAR EVIDENCE:MOUSE NTP-TR-289,86
NTP FOURTH ANNUAL REPCRT ON CARCINOGENS, 1984
MEETS CRITERIA FOR PROPOSED OSHA MEDICAL RECCRDS RULE FE

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MATERIAL SAFETY DATA SHEET

PAGE:

CATALOG # 15462-8 NAME: BENZENE, 99+%, SPECTROPHOTOMETRIC GRADE

82

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR COMPLETE INFORMATIO

------------------ HEALTH HAZARD DATA ------------------

ACUTE EFFECTS
DANGER
CANCER-SUSPECT AGENT.
OSHA-REGULATED CARCINOGEN. SEE CFR TITLE 29 PART 1910.
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.
VAPOR OR MIST IS IRRITATING TO THE EYES, MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
CAUSES SKIN IRRITATION.
EXPOSURE CAN CAUSE:
NAUSEA, DIZZINESS AND HEADACHE
NARCOTIC EFFECT.
CHRONIC EFFECTS
CARCINOGEN.
MAY ALTER GENETIC MATERIAL.
BLOOD EFFECTS
FIRST AID
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
CALL A PHYSICIAN.
REMOVE AND WASH CONTAMINATED CLOTHING PROMPTLY.

--------------------PHYSICAL DATA --------------------

MELTING POINT: 5.5 C
BOILING POINT: 80.2 C
SPECIFIC GRAVITY: 0.874
VAPOR DENSITY: 2.77
VAPOR PRESSURE: 166.0 MM @ 37.7 C

------------ FIRE AND EXPLOSION HAZARD DATA ------------

LOWER EXPLOSION LEVEL: 1.4%
UPPER EXPLOSION LEVEL: 8.0%
FLASH POINT: 12 F
EXTINGUISHING MEDIA
CARBON DIOXIDE, DRY CHEMICAL POWDER, ALCOHOL OR POLYMER FOAM.
WATER MAY BE EFFECTIVE FOR COOLING, BUT MAY NOT EFFECT EXTINGUISHMENT.
SPECIAL FIRE FIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.
USE WATER SPRAY TO COOL FIRE-EXPOSED CONTAINERS.
UNUSUAL FIRE AND EXPLOSION HAZARDS
DANGER
EXTREMELY FLAMMABLE.
VAPOR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND FLASH BACK.
CONTAINER EXPLOSION MAY OCCUR UNDER FIRE CONDITIONS.

------------------ REACTIVITY DATA ------------------

INCOMPATIBILITIES
OXIDIZING AGENTS

MATERIAL SAFETY DATA SHEET

CATALOG # 15462-8 NAME: BENZENE, 99+%, SPECTROPHOTOMETRIC GRADE

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
TOXIC FUMES OF:
CARBON MONOXIDE, CARBON DIOXIDE

--------------- SPILL OR LEAK PROCEDURES --------------

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
EVACUATE AREA.
SHUT OFF ALL SOURCES OF IGNITION.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY RUBBER GLOVES.
COVER WITH AN ACTIVATED CARBON ADSORBENT, TAKE UP AND PLACE IN CLOSED CONTAINERS. TRANSPORT OUTDOORS.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.
WASTE DISPOSAL METHOD
BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER BUT EXERT EXTRA CARE IN IGNITING AS THIS MATERIAL IS HIGHLY FLAMMABLE.

OBSERVE ALL FEDERAL, STATE & LOCAL LAWS.

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ----

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
SAFETY SHOWER AND EYE BATH.
USE ONLY IN A CHEMICAL FUME HOOD.
USE NONSPARKING TOOLS.
DO NOT BREATHE VAPOR.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
FOR PROTECTION AND HANDLING REQUIREMENTS CONSULT CFR TITLE 29 PART 1910.
CANCER-SUSPECT AGENT.
IRRITANT.
MUTAGEN.
KEEP TIGHTLY CLOSED.
KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.
STORE IN A COOL DRY PLACE.

---------- ADDITIONAL PRECAUTIONS AND COMMENTS ---------

NOT APPLICABLE

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. ALDRICH SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

Occupational Health Guideline for Chromium Metal and Insoluble Chromium Salts*

INTRODUCTION

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

APPLICABILITY

The general guidelines contained in this document apply to all chromium metal and insoluble chromium salts. Physical and chemical properties of some specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Metallic chromium

- Formula: Cr
- Synonyms: None
- Appearance and odor: Shiny, odorless metal.

Copper chromite

- Formula: $Cu_2Cr_2O_4$
- Synonyms: Cuprous chromite
- Appearance and odor: Greenish-blue, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chromium metal or insoluble chromium salts is 1 milligram of chromium metal or insoluble chromium salts per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. Certain forms of chromium (VI) have been found to cause increased respiratory cancer among workers. Certain other forms of chromium (VI) are currently believed to be non-carcinogenic. The non-carcinogenic forms are the monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium (VI) oxide (chromium acid anhydride). NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than 6. NIOSH recommends that the permissible exposure limit for carcinogenic chromium (VI) compounds be reduced to 0.001 Cr (VI) mg/m^3 and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for non-carcinogenic chromium (VI) be reduced to 0.025 Cr (VI) mg/m^3 averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 0.05 Cr (VI) mg/m^3 averaged over a 15-minute period. It is further recommended that chromium (VI) in the workplace be considered carcinogenic, unless it has been demonstrated that only the non-carcinogenic chromium (VI) compounds mentioned above are present. The NIOSH Criteria Documents for Chromic Acid and Chromium (VI) should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Chromium metal or insoluble chromium salts can affect the body if they are inhaled. They can also affect the body if they are swallowed.

- **Effects of overexposure**

Ferro chrome alloys have been associated with lung changes in workers exposed to these alloys. Chromite dust exposure may cause minor lung changes.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to chromium metal or insoluble chromium salts.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to chromium metal or insoluble chromium salts at potentially hazardous levels:

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

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

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

September 1978

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system should be stressed.

—14" x 17" chest roentgenogram: Chromium and its insoluble salts may cause human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Insoluble chromium salts are reported to cause decreased pulmonary function. Periodic surveillance is indicated.

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

- **Summary of toxicology**

The dusts of chromium metal and its insoluble salts, chiefly the chromites, are usually reported to be relatively nontoxic; this is debatable, since exposures associated with toxic effects are usually mixed exposures involving several hexavalent chromium compounds. Ferrochrome alloys have been associated with pulmonary disease in humans. Four workers engaged in the production of ferrochrome alloys developed a nodular type of pulmonary disease with impairment of pulmonary function; air concentrations of chromium in this study averaged 0.26 mg/m^3, although other fumes and dusts were also present. This pulmonary problem may be one of hypersensitivity and thus reversible. Other reports state that chest roentgenograms have revealed only "exaggerated pulmonic markings" in workers exposed to chromite dust. The lungs of groups of workers exposed to chromite dust have been shown to be the seat of pneumoconiotic changes consisting of slight thickening of interstitial tissue and interalveolar septa, with histologic fibrosis and hyalinization. Chromite ore roast mixed with sheep fat implanted intrapleurally in rats produced squamous cell carcinomata coexisting with sarcomata of the lungs; the same material implanted in the thighs of rats produced fibrosarcomata. A refractory plant using chromite ore to make chromite brick had no excess of lung cancer deaths over a 14-year period, and it was concluded that chromite alone probably is not carcinogenic.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data—Metallic chromium**

1. Molecular weight: 52
2. Boiling point (760 mm Hg): 2640 C (4784 F)
3. Specific gravity (water = 1): 7.2
4. Vapor density (air = 1 at boiling point of metallic chromium): Not applicable
5. Melting point: 1900 C (3452 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Copper chromite**

1. Molecular weight: 295.1
2. Boiling point (760 mm Hg): Data not available
3. Specific gravity (water = 1): 5.24
4. Vapor density (air = 1 at boiling point of copper chromite): Not applicable
5. Melting point: Data not available
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Basic potassium zinc chromate**

1. Molecular weight: 873.8
2. Boiling point (760 mm Hg): Decomposes at red heat
3. Specific gravity (water = 1): 3.47
4. Vapor density (air = 1 at boiling point of basic potassium zinc chromate): Not applicable
5. Melting point: Loses water slowly above 100 C (212 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Chromium metal in contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: None listed.
4. Special precautions: None listed.

- **Flammability**

1. Flash point: Not applicable
2. Minimum ignition temperature (metal): 400 C (752 F) (layer); 580 C (1076 F) (cloud)
3. Minimum explosive dust concentration (metal): 230 $grams/m^3$
4. Extinguishant: Dry sand, dry dolomite, dry graphite

- **Warning properties**

Chromium metal and insoluble salts are not known to be eye irritants.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

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

- **Ceiling Evaluation**

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

- Method

Sampling and analyses may be performed by collection of chromium metal or insoluble chromium salts on a filter, followed by treatment with acid and atomic absorption spectrophotometric analysis. An analytical method for chromium metal and insoluble chromium salts is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 6, 1980, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00369-6).

RESPIRATORS

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

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solids or liquids containing insoluble chromium salts.
- Clothing contaminated with insoluble chromium salts should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of insoluble chromium salts from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the insoluble chromium salts, the person performing the operation should be informed of insoluble chromium salts's hazardous properties.
- Non-impervious clothing which becomes contaminated with insoluble chromium salts should be removed promptly and not reworn until the insoluble chromium salts are removed from the clothing.
- Employees should be provided with and required to use dust- and splashproof safety goggles where solids or liquids containing insoluble chromium salts may contact the eyes.

SANITATION

- Skin that becomes contaminated with insoluble chromium salts should be promptly washed or showered with soap or mild detergent and water to remove any insoluble chromium salts.
- Eating and smoking should not be permitted in areas where solids or liquids containing insoluble chromium salts are handled, processed, or stored.
- Employees who handle solids or liquids containing insoluble chromium salts should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to chromium metal or insoluble chromium salts may occur and control methods which may be effective in each case:

Operation	Controls
Use in fabrication of alloys	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in preparation of alloy steels to enhance corrosion- and heat-resistance	Local exhaust ventilation; general dilution ventilation
Use in fabrication of plated products for decoration or increased wear-resistance	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in production of non-ferrous alloys to impart special qualities to the alloys	Local exhaust ventilation; general dilution ventilation
Use in production and processing of insoluble salts	Local exhaust ventilation; general dilution ventilation; personal protective

Operation	Controls
Use as chemical intermediates; use in textile industry in dyeing, silk treating, printing, and moth-proofing wool	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in leather industry in tanning; use in photograhic fixing baths	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as catalysts for halogenation, alkylation, and catalytic cracking of hydrocarbons	Local exhaust ventilation; general dilution ventilation
Use as fuel additives and propellant additives; in photogaphic fixing baths and in ceramics	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

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

- **Eye Exposure**

If chromium metal or solids or liquids containing insoluble chromium salts get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

- **Skin Exposure**

If solids or liquids containing insoluble chromium salts get on the skin, wash the contaminated skin using soap or mild detergent and water. If solids or liquids containing insoluble chromium salts penetrate through the clothing, remove the clothing and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**

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

- **Swallowing**

When solids or liquids containing insoluble chromium salts have been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

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

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If chromium metal or insoluble chromium salts are spilled, the following steps should be taken:

1. Remove all ignition sources where metallic chromium has been spilled.
2. Ventilate area of spill.
3. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing chromium metal or insoluble chromium salts should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Chromium metal or insoluble chromium salts may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

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- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
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Workers," *Industrial Medicine and Surgery*, 20:358-363, 1951.

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- National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: *Criteria for a Recommended Standard . . . . Occupational Exposure to Chromium (VI).* HEW Publication No. (NIOSH) 76-129, GPO No. 017-033-00125-1, U.S. Government Printing Office, Washington, D.C., 1975.
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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on these chemicals and has concluded that they cause cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 2, 1973, and Volume 23, 1980.

• Method

Sampling and analyses may be performed by collection of chromium metal or insoluble chromium salts on a filter, followed by treatment with acid and atomic

MATERIAL
SAFETY
DATA
SHEET

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SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: ELECTRODE,AROMATIC,BINDER,TARGET,CORE & COAL TAR PITCH

SYNONYM: COAL TAR PITCH

CHEMICAL FAMILY: POLYNUCLEAR AROMATIC HYDROCARBONS

FORMULA: COMPLEX MIXTURE OF HYDROCARBONS

CAS NUMBER: 65996-93-2

DOT PROPER SHIPPING NAME: NONE

DOT HAZARD CLASS: NONE

UN/NA NUMBER: NONE

SECTION II - HEALTH/SAFETY ALERT

CHRONIC OVEREXPOSURE (AS DEFINED BY OSHA RECOMMENDED STANDARDS)
MAY CAUSE CANCER
WARNING
HARMFUL TO THE SKIN, OR IF INHALED OR SWALLOWED
CAUSES EYE AND SKIN IRRITATION
AVOID PROLONGED AND/OR REPEATED CONTACT
OBSERVE GOOD HYGIENE AND SAFETY PRACTICES WHEN HANDLING THIS PRODUCT
DO NOT USE THIS PRODUCT UNTIL MSDS HAS BEEN READ AND UNDERSTOOD

SECTION III - HEALTH HAZARD INFORMATION

EYE: OVEREXPOSURE TO VAPOR CAN RESULT IN IRRITATION AND/OR CORNEAL CHANGES. DIRECT EYE CONTACT MAY CAUSE IRRITATION. CONTACT WITH HEATED MATERIAL MAY CAUSE THERMAL BURNS.

SKIN: CONTACT WITH SKIN CAN RESULT IN IRRITATION WHICH WHEN ACCENTUATED BY SUNLIGHT MAY RESULT IN A PHOTOTOXIC SKIN REACTION. REPEATED AND/OR PROLONGED CONTACT MAY CAUSE MORE SERIOUS SKIN DISORDERS INCLUDING CANCER. CONTACT WITH HEATED MATERIAL MAY CAUSE THERMAL BURNS.

INHALATION: OVEREXPOSURE TO VAPOR MAY RESULT IN RESPIRATORY TRACT IRRITATION. REPEATED AND/OR PROLONGED CONTACT TO HIGH CONCENTRATIONS OF VAPOR MAY RESULT IN RESPIRATORY DIFFICULTIES, CENTRAL NERVOUS SYSTEM (CNS) EFFECTS AND POSSIBLE CARDIOVASCULAR COLLAPSE.

INGESTION: INGESTION OF MATERIAL MAY CAUSE GASTROINTESTINAL DISTURBANCES INCLUDING IRRITATION, NAUSEA, VOMITING, ABDOMINAL PAIN AND IN EXTREME CASES CARDIOVASCULAR INVOLVEMENT.

OTHER: SEE SECTION XII (COMMENTS) FOR ADDITIONAL INFORMATION ON

SECTION IV - EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: IMMEDIATELY FLUSH WITH LARGE AMOUNTS OF WATER FOR 15 MINUTES. IMMEDIATELY SEEK MEDICAL AID.

SKIN CONTACT: WASH THOROUGHLY WITH WATERLESS HAND CLEANER. FOR CONTACT WITH MOLTEN PRODUCT, DO NOT REMOVE CONTAMINATED CLOTHING. FLUSH SKIN IMMEDIATELY WITH LARGE AMOUNTS OF COLD WATER. IF POSSIBLE, SUBMERGE AREA IN COLD WATER. PACK WITH ICE. SEEK MEDICAL AID.

INHALATION: REMOVE FROM EXPOSURE. IF BREATHING HAS STOPPED OR IS DIFFICULT, ADMINISTER ARTIFICIAL RESPIRATION OR OXYGEN AS INDICATED. SEEK MEDICAL AID.

SECTION V - FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT & METHOD: >150 C (>302 F) COC AUTOIGNITION TEMP: NA

FLAMMABLE LIMITS (% BY VOLUME/AIR): LOWER: NA UPPER: NA

EXTINGUISHING MEDIA: USE DRY CHEMICAL, CARBON DIOXIDE, FOAM OR WATER SPRAY. WATER OR FOAM MAY CAUSE FROTHING.

FIRE-FIGHTING PROCEDURES: WEAR COMPLETE FIRE SERVICE PROTECTIVE EQUIPMENT, INCLUDING FULL-FACE MSHA/NIOSH APPROVED SELF-CONTAINED BREATHING APPARATUS. USE WATER TO COOL FIRE-EXPOSED CONTAINERS/STRUCTURES/PROTECT PERSONNEL TOXIC VAPORS MAY BE GIVEN OFF IN A FIRE.

FIRE AND EXPLOSION HAZARDS: WHEN HEATED (FIRE CONDITIONS), VAPORS/DECOMPOSITION PRODUCTS MAY BE RELEASED FORMING FLAMMABLE/EXPLOSIVE MIXTURES IN AIR. CLOSED CONTAINERS MAY EXPLODE WHEN EXPOSED TO EXTREME HEAT(FIRE). DUST MAY FORM EXPLOSIVE MIXTURE WITH AIR. COMBUSTIBLE AT HIGH TEMPERATURES.

SECTION VI - SPILL, LEAK AND DISPOSAL INFORMATION

SPILL OR LEAK PROCEDURES: SOLIDIFIED SPILLS: SHOVEL INTO DRY CONTAINERS AND COVER. FLUSH AREA WITH WATER. CONTAIN RUNOFF FROM FIRE CONTROL AND DILUTION WATER. RELEASE OR SPILLAGE OF SOLID CAN BE TREATED AS A COAL SPILLAGE AND RECOVERY MADE AVOIDING SKIN AND EYE IRRITATION. IF HOT LIQUID IS SPILLED, CONTAIN WITH SAND, ASHES, ETC. ALLOW TO COOL, SCRAPE UP AND DISPOSE. AVOID CONTACT WITH HOT LIQUID AND FUMES.

WASTE DISPOSAL: THIS PRODUCT IS NOT DEFINED AS A US EPA HAZARDOUS WASTE, BUT SHOULD BE DISPOSE OF AS A HAZARDOUS WASTE IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL REGULATIONS. PLACE IN TIGHTLY SEALED LABELED CONTAINERS.

SECTION VII - RECOMMENDED EXPOSURE LIMIT/HAZARDOUS INGREDIENTS

EXPOSURE LIMIT (PRODUCT): *FOR COAL TAR PITCH VOLATILES, OSHA-PEL IS 0.2 MG/M3 AVERAGED OVER AN 8 HOUR WORK SHIFT, BENZENE SOLUBLE FRACTION. THE ACGIH-TLV IS 0. MG/M3.

HAZARDOUS INGREDIENTS	CAS NUMBER	PERCENT	EXPOSURE LIMIT (PPM;MG/M3
COAL TAR PITCH			*

SECTION VIII - PERSONAL PROTECTION INFORMATION

EYE PROTECTION: INDUSTRIAL SAFETY GLASSES, MINIMUM. AS NECESSARY TO COMPLY WITH 29 CFR 1910.133 AND WORK AREA CONDITIONS; USE SIDE SHIELDS, GOGGLES OR FACE SHIELD TO COMPLY WITH ANSI STANDARD Z87.1. CHEMICAL GOGGLES; FACE SHIELD (IF HANDLING MOLTEN MATERIAL).

SKIN PROTECTION: AS REQUIRED, INDUSTRIAL GRADE FABRIC-TYPE GLOVES, FOR SOLID PITCH. HEAT RESISTANT IF MOLTEN. WEAR INDUSTRIAL-TYPE WORK CLOTHING AND SAFETY FOOTWEAR. DEPENDING ON WORKING CONDITIONS, I.E., CONTACT POTENTIAL, WEAR PROTECTIVE GARMENTS SUCH AS HEAD/NECK COVER, APRONS, JACKETS, PANTS, COVERALLS, BOOTS, ETC.

RESPIRATORY PROTECTION: IF VENTILATION DOES NOT MAINTAIN INHALATION EXPOSURES BELOW TLV(PEL), USE MSNA/NIOSH APPROVED UNITS AS PER CURRENT 29CFR1910.134 AND MANUFACTURERS' "INSTRUCTIONS" AND "WARNINGS". COMBINATION FILTER/ORGANIC VAPOR CARTRIDGES OR CANISTERS MAY BE USED. FULL-FACE PIECE RESPIRATORY PROTECTIVE UNITS REQUIRED.

VENTILATION: PROVIDE SUFFICIENT GENERAL AREA/LOCAL EXHAUST VENT. IN PATTERN/VOLUME TO CONTROL INHALATION EXPOSURES BELOW CURRENT EXPOSURE LIMITS AND AREAS BELOW FLAMMABLE VAPOR/EXPLOSIVE DUST CONCENTRATIONS.

SECTION IX - PERSONAL HANDLING INSTRUCTIONS

HANDLING: AVOID PROLONGED OR REPEATED CONTACT WITH SKIN OR BREATHING OF DUSTS. OBSERVE GOOD PERSONAL HYGIENE PRACTICES AND RECOMMENDED PROCEDURES. APPLICATION OF CERTAIN PROTECTIVE CREAMS (SUN SCREENS FOR COAL TAR PRODUCTS) BEFORE WORKING/SEVERAL TIMES DURING WORK MAY BE BENEFICIAL.

STORAGE: KEEP IN A CLOSED, LABELED CONTAINER WITHIN A COOL (WELL SHADED), DRY -VENTILATED AREA. PROTECT FROM PHYSICAL DAMAGE. MAINTAIN GOOD HOUSEKEEPING.

OTHER: NOT FOR USE OR STORAGE IN OR AROUND THE HOME. DO NOT TAKE INTERNALLY. DO NOT USE UNTIL MANUFACTURER'S PRECAUTIONS HAVE BEEN READ/UNDERSTOOD. WASH EXPOSED AREAS PROMPTLY AND THOROUGHLY AFTER SKIN CONTACT AND BEFORE EATING, DRINKING, USING TOBACCO PRODUCTS OR REST ROOMS.

SECTION X - REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY: NONE KNOWN

INCOMPATABILITY: NONE KNOWN

HAZARDOUS REACTIONS/DECOMPOSITION PRODUCTS: MAY EMIT TOXIC FUMES UPON DECOMPOSITION

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION: NONE

SECTION XI - PHYSICAL DATA

BOILING POINT: >260 C (>500 F)IBP SPECIFIC GRAVITY: >1.22

MELTING POINT: ND % VOLATILE BY VOL: NEGLIGIB

VAPOR PRESSURE: <1 MM HG EVAPORATION RATE(ETHER=1): <1BUTYL ACETATE=1

VAPOR DENSITY(AIR=1):>1 VISCOSITY: NA

SOLUBILITY: NEGLIGIBLE PH: NA

APPEARANCE/ODOR: BLACK SOLID WITH NO ODOR AT 21 C; AROMATIC ODOR AFTER MELTING

SECTION XII - COMMENTS

THIS PRODUCT CONTAINS COAL TAR PITCH. VOLUME 35 OF THE IARC MONOGRAPHS STATE THAT THERE IS SUFFICIENT EVIDENCE THAT COAL TAR PITCHES ARE CARCINOGENI IN HUMANS. ADDITIONALLY, THERE IS SUFFICIENT EVIDENCE THAT OCCUPATIONAL EXPOSURE TO COAL TARS AS IT OCCURS DURING THE DESTRUCTIVE DISTILLATION OF COAL IS CAUSALLY ASSOCIATED WITH THE OCCURRENCE OF SKIN CANCERS IN HUMANS.

PERSONS WITH A HISTORY OF LIVER, KIDNEY, SKIN OR RESPIRATORY DISEASE OR EXPOSURE TO MATERIALS HARMFUL TO THESE SYSTEMS ARE AT A GREATER THAN NORMAL RISK OF DEVELOPING ADVERSE HEALTH EFFECTS WHEN WORKING WITH THIS PRODUCT.

DO NOT WEAR CONTACT LENS WITHOUT PROPER EYE PROTECTION WHEN USING THIS PRODUCT.

Occupational Health Guideline for Copper Dusts and Mists

INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- Formulas of example compounds: $CuSO_4 \cdot 5H_2O$; CuCl
- Example compounds: Copper sulfate dust or mist; cuprous chloride dust
- Appearance and odor: Odorless solids

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for copper dusts or mists is 1 milligram of copper dusts or mists per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Copper dusts or mists can affect the body if they are inhaled or if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

- **Effects of overexposure**

1. Short-term Exposure: Powdered copper or dusts or mists of copper salts may cause a feeling of illness similar to the common cold with sensations of chills and stuffiness of the head. Small copper particles may enter the eye and cause irritation, discoloration, and damage.

2. Long-term Exposure: Repeated or prolonged exposure to copper dusts or mists may cause skin irritation or discoloration of the skin or hair.

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

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to copper dusts and mists at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from copper dusts and mists exposure.

—Chronic respiratory disease: Copper dusts or mists cause respiratory irritation in animals. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of copper dusts or mists might cause exacerbation of symptoms due to their irritant properties.

—Liver disease: Copper dusts or mists cause liver damage in animals. Persons with pre-existing liver disease may be more susceptible to the effects of these agents.

—Kidney disease: Copper dusts or mists cause kidney damage in animals. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Skin disease: Skin sensitization in human subjects has occurred. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

—Hematopoietic disorders: Anemia has occurred in animals given copper salts orally. Persons with pre-existing blood disorders may be more susceptible to the effects of these agents.

—Wilson's disease: Persons with pre-existing Wilson's disease may be more susceptible to the effects of these agents.

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

- **Summary of toxicology**

Inhalation of dusts and mists of copper and copper salts results in irritation of the upper respiratory tract, with occasional ulceration and perforation of the nasal septum. Inhalation of copper and its compounds by animals caused injury to the lungs and liver with

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

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Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

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

September 1978

hemochromatosis. Access of sheep to salt licks containing 5 to 9% copper sulfate caused the sudden onset of hemolytic anemia, icterus, and hemoglobinuria followed by death in a day or two; at necropsy, the liver, kidneys, and spleen showed severe degenerative changes. Workers exposed to copper dust in concentrations of 0.075 to 0.120 mg/m^3 complained of mild nasal discomfort. Exposure to the dust of copper acetate produced sneezing, coughing, digestive disorders, and fever. Metal workers exposed to complex copper salts in dust form complained of metallic taste with irritation of nasal and oral mucosa; atrophic changes in the mucous membranes were noted in subjects exposed for long periods of time. On ingestion, copper salts act as irritants and cause nausea, vomiting, abdominal pain, hemorrhagic gastritis, and diarrhea. Copper salts splashed in the eye cause conjunctivitis, corneal ulceration, and turbidity, and may produce palpebral edema. Copper particles embedded in the eye result in pronounced foreign-body reaction with characteristic discoloration of ocular tissue. Allergic contact dermatitis due to copper exposure, although rare, has been reported. Greenish discoloration of the skin and hair of some copper workers has been observed. Although copper is an essential element for health, excessive amounts can produce harmful effects.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: $CuSO_4$: 249.7; $CuCl_2$: 99
2. Boiling point (760 mm Hg): Not applicable
3. Specific gravity (water = 1): Greater than 1
4. Vapor density (air = 1 at boiling point of copper dusts or mists): Not applicable
5. Melting point: Higher than 100 C (212 F). For example, copper sulfate = 150 C (302 F); cuprous chloride = 430 C (806 F)
6. Vapor pressure at 20 C (68 F): Not applicable
7. Solubility in water, g/100 g water at 20 C (68 F): Ranges from very low (e.g. cuprous chloride = 0.006) to high (e.g. copper sulfate = 35)
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Extreme heat
2. Incompatibilities: Copper dusts or mists may react with acetylene gas to form copper acetylides, which are solids that are sensitive to shock. Some copper mists may react with magnesium metal to form flammable hydrogen gas.
3. Hazardous decomposition products: None
4. Special precautions: None

- **Flammability**

1. Ignition temperature: Copper dusts = 700 C (1292 F)

- **Warning properties**

According to Grant, copper acetoarsenite, copper chloride, copper sulfate, copper carbonate and oxide, and copper metal all produce local irritant effects when in contact with the eye. The *Documentation of TLV's* also notes that copper salts on the eye may cause "conjunctivitis or even ulceration and turbidity of the cornea." Concentrations producing these effects are not given.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

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

- **Method**

Sampling and analyses may be performed by collection of copper dusts or mists on a cellulose ester membrane filter, followed by treatment with nitric acid, solution in hydrochloric acid, and atomic absorption spectrophotometric analysis. An analytical method for copper dusts or mists is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

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

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, f minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with copper salts or liquids containing copper salts.

- If employees' clothing may have become contaminated with powdered copper, copper salts, or liquids containing copper salts, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing contaminated with copper salts should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of copper salts from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the copper salts, the person performing the operation should be informed of copper salts's hazardous properties.
- Non-impervious clothing which becomes contaminated with copper salts should be removed promptly and not reworn until the copper salts are removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where powdered copper or dusts, mists, or liquids containing copper salts may contact the eyes.

SANITATION

- Skin that becomes contaminated with copper salts should be promptly washed or showered with soap or mild detergent and water to remove any copper salts.
- Eating and smoking should not be permitted in areas where powdered copper, copper salts, or liquids containing copper salts are handled, processed, or stored.
- Employees who handle powdered copper, copper salts, or liquids containing copper salts should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Liberation during mining, extracting, and refining copper ore; during fabrication and manufacture of copper rod, wire, piping, and tubing for use in electrical, plumbing, and building industries; during manufacture of domestic utensils; during manufacture of alloys	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Liberation from production and application of fungicides, insecticides, and germicides for soil, feed, grain, textile, water and sewage treatments; during use of copper salts for paint pigments and coloring agents, electroplating baths, wood preservation, automotive emission controls, textile treatment, and organic synthesis	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

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

- **Eye Exposure**

If copper dusts or mists get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

- **Skin Exposure**

If copper salts or liquids containing copper salts get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If copper salts or liquids containing copper salts penetrate through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**

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

- **Swallowing**

When powdered copper, copper salts, or liquids containing copper salts have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

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

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of release until cleanup has been completed.
- If copper dusts or mists are spilled or released, the following steps should be taken:

1. Ventilate area of release.
2. Collect spilled material in the most convenient and safe manner for reclamation, or for disposal in a secured sanitary landfill. Liquid containing copper should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Copper dusts or mists and copper compounds may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

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0998V

Material Safety/Health Data Sheet

W-6438-A 3-85

DATE December 85

I. MATERIAL IDENTITY

MANUFACTURER'S NAME & ADDRESS
LTV Steel Company, Inc.

INFORMATION SUPPLIED
Manager Environmental Health

AREA CODE & PHONE NO
(216) 622-5242

AREA CODE & EMERG NO
(216) 622-5

PRODUCT NAME
Napthalene

CHEMICAL NAME & SYNONYMS
Camphor Tar, White Tar, Moth Balls

RECOMMENDED USE

II. GENERIC INGREDIENTS

INGREDIENT	CAS#	% WT	EXPOSURE LIMITS
Napthalene	90203	--	10 ppm

III. PHYSICAL DATA

1. BOILING POINT—(°F)	218
2. VAPOR PRESSURE—(mm Hg 68°F)	1
3. VAPOR DENSITY—(Air = 1)	4.42
4. SOLUBILITY IN WATER—	Insoluble
5. SPECIFIC GRAVITY—(H_2O = 1)	1.16
6. % VOLATILE BY VOLUME—	N.D.
7. EVAPORATION RATE—(Ethyl Ether = 1)	<1
8. AUTO IGNITION TEMP.—(°F)	1053
9. PHYSICAL STATE—	Solid
10. pH—(as shipped)	N.A.
11. APPEARANCE & ODOR	White crystals, Moth ball odor

IV. EMERGENCY MEDICAL PROCEDURES

1. FIRST AID

a. Inhalation	Remove from exposure, provide artificial respiration.
b. Skin Contact	Wash skin with water.
c. Eye Contact	Immediately flush eyes with copious amounts of water.
d. Ingestion	Induce vomiting, have patient drink water.
e. Other	

2. NOTES TO PHYSICIAN

Periodic medical exams and exposure monitoring is recommended. If swallowed, use gastric lavage followed by saline catharsis. Blood transfusions if necessary.

(X) MAJOR EXPOSURE HAZARD

☒ INHALATION ☐ SKIN CONTACT ☒ SKIN ABSORPTION ☐ EYE CONTACT ☐ INGESTION

Product Name Napthalene

Effects of Overexposure —

Acute	May cause nausea, headache, vomiting, convulsions, fever, coma and death. May produce anemia and liver damage through inhalation or skin absorption. May cause conjunctivitis or optic neuritis. Skin contact may produce a dermatitis.
Chronic	May produce anemia, jaundice, albuminuria, enlargement of the liver or spleen, abdominal pains, and diarrhea. Skin and eyes may become irritated with lenticular opacities in peripheral portions.

NOTE

Selection of personal Protective Equipment (PPE) should be based on exposure. Therefore, PPE will vary according to application. The PPE recommended below is generally applicable for most industrial applications. (x) as applicable.

Product Name
Napthalene

VI. PERSONAL PROTECTION INFORMATION

1. RESPIRATORY PROTECTION

b) Air Supplied:
- ____ SCBA
- ____ Supplied Air
- ____ Comb: Supplied & SCBA

b) Air Purifying:
- __X__ Particulate
- __X__ Gas & Vapor
- ____ Power Air Purifying
- ____ Full Face
- __X__ Half Mask
- ____ Qtr. Mask
- ____ Other (specify)

2. PROTECTIVE CLOTHING

- ____ Full Body Coverall
- __X__ Long Sleeves
- ____ Chem. Apron
- __X__ Boots
- ____ Flame Resistant Clothing
- ____ Other (specify)

3. GLOVES

- ____ Neoprene (N-1)
- ____ Rubber Latex (R-4)
- ____ Rubber Synthetic (R-5)
- __X__ Vinyl Coated (V-1)
- ____ Other (specify)

4. EYE PROTECTION

- ____ Glasses
- __X__ Goggles
- ____ Faceshield
- ____ Other (specify)

5. VENTILATION REQUIREMENTS

- ____ Natural ventilation is normally sufficient
- __X__ Local exhaust ventilation is generally required
- ____ Other (specify)

6. OTHER

Ventilation is recommended when working in confined spaces and when concentration exceeds permissible limits.

VII. FIRE & EXPLOSION HAZARD DATA

1. FLASH POINT	CLEVELAND OPEN CUP ONLY - ASTM D-92-52 (°F)	190
2. LOWER EXPLOSIVE		.9%
3. UPPER EXPLOSIVE LIMIT		6%
4. EXTINGUISHING MEDIA	Foam, CO_2, Dry Chemical	

5. SPECIAL FIRE FIGHTING PROCEDURES

Use SCBA, Direct water streams should be avoided.

May cause foaming.

VIII. REACTIVITY DATA

(x) AS APPLICABLE

☒ STABLE ☐ UNSTABLE ☐ HAZARDOUS POLYMERIZATION ☐ CORROSIVE

INCOMPATIBILITY

☐ NONE ☐ WATER ☒ ACID ☐ BASE ☒ OXIDATION MATERIAL ☐ OTHER

PRODUCTS OF DECOMPOSITION

1. Carbon Monoxide
2.
3.
4.
5.

IX. SPILL/LEAK PROCED.

1. CLEAN UP Large spills should be allowed to solidify. Mix with sand or other absorbent material.

Boots should be worn if necessary.

2. WASTE DISPOSAL

- ____ Contain, seal, label, dispose in approved landfill
- ____ Dispose in approved incinerator
- ____ Dispose in approved deep well injection
- __X__ Dispose in approved landfill
- ____ Dispose in approved recycle operation
- ____ Dispose in approved storage
- ____ Other ____

Product Name Napthalene

X. SPECIAL PRECAUTIONS

1. HANDLING & STORAGE Store in cool place. Keep away from heat and sources of ignition.

2. WELDING & CUTTING Prevent overheating. Do not burn or weld unless steps to prevent ignition are initiated.

3. COATINGS N.A.

4. OTHER PRECAUTIONS Oxidizing agents will react with material. Material is flammable. Vapor and dust are explosive.

XI. PRODUCT USAGE

Plant	Dept.	Est. Usage	Units	Plant	Dept.	Est. Usage	Units

NOTE: PLEASE COMPLETE ALL INFORMATION REGARDING YOUR PRODUCT AS ACCURATELY AS POSSIBLE. THIS INFORMATION WILL BE USED TO DETERMINE WHETHER ANY SAFE HANDLING OR STORAGE PROCEDURES ARE REQUIRED. PROMPT RETURN OF THIS COMPLETED FORM WILL HELP AVOID ANY DELAYS IN THE PURCHASE OF YOUR PRODUCT

ALSO: PLEASE ATTACH ALL LITERATURE REGARDING THE RECOMMENDED USE PROCEDURE FOR THIS PRODUCT

FOLLOWING SECTION FOR LTY USE ONLY

☐ Approved mill trial ______

☐ Approved continued purchase ______

☐ Rejected ______

☐ Confidentiality agreement required

☐ Confidentiality agreement initiated ______

☐ Confidentiality agreement executed ______

Occupational Health Guideline for Pentachlorophenol

INTRODUCTION

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

SUBSTANCE IDENTIFICATION

- Formula: C_6Cl_5OH
- Synonyms: PCP; penta
- Appearance and odor: Light brown solid with a pungent odor when hot.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for pentachlorophenol is 0.5 milligram of pentachlorophenol per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Pentachlorophenol can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

Exposure to pentachlorophenol may cause irritation of the eyes and respiratory tract. Bronchitis has been reported to occur. Systemic effects from either a large exposure or repeated smaller exposures include weakness, loss of appetite, nausea, vomiting, shortness of breath, chest pain, excessive sweating, headache, and dizziness. In fatal cases the temperature is often very high and death may occur as early as three hours after the onset of symptoms. The risk of serious intoxication is greater in hot weather. Persons with decreased liver or kidney functions are more susceptible to poisoning from this chemical. Repeated exposure to pentachlorophenol may cause an acne-like skin rash and liver damage. Commercial pentachlorophenol may be contaminated with dioxin compounds which are much more toxic than pentachlorophenol.

- **Reporting signs and symptoms:**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to pentachlorophenol.

- **Recommended medical surveillance**

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

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the cardiovascular system, eyes, upper respiratory tract, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders. Analysis of the urine for pentachlorophenol may be helpful in estimating the extent of absorption.

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

- **Summary of toxicology**

Pentachlorophenol dust and mist cause irritation of the eyes and upper respiratory tract; absorption results in an increase in metabolic rate and hyperpyrexia; prolonged skin exposure causes an acneform dermatitis. Human exposure to dust or mist concentrations greater than 1 mg/m^3 causes pain in the nose and throat, violent sneezing, and cough; 0.3 mg/m^3 may cause some nose irritation; persons acclimated to pentachlorophenol can tolerate concentrations up to 2.4 mg/m^3. Pentachlorophenol readily penetrates the skin; systemic intoxication is cumulative and has been fatal. Intoxication is characterized by weakness, anorexia, weight loss, and profuse sweating; there also may be headache, dizziness, nausea, vomiting, dyspnea, and chest pain. In fatal cases, the body temperature is frequently extremely high and

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

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

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death has occurred as early as 3 hours after the onset of symptoms. The risk of serious intoxication is increased during hot weather; persons with impaired liver or kidney function are more susceptible to the effects of pentachlorophenol. The dust, mist, and vapor cause eye irritation. Prolonged exposure of workers has caused an acneform dermatitis; 10 workers engaged in production of pentachlorophenol for 5 to 10 months developed a widely disseminated skin eruption characterized by small and large furuncles, brown pigmentation, and some cicatrization; 7 workers also developed severe bronchitis; all but 1 worker still showed signs of extensive acne more than a year after cessation of exposure, and 4 still complained of bronchitis. On the skin, solutions of pentachlorophenol as dilute as 1% may cause irritation if contact is repeated or prolonged.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 266.3
2. Boiling point (760 mm Hg): 311 C (592 F) (decomposes)
3. Specific gravity (water = 1): 2.0
4. Vapor density (air = 1 at boiling point of pentachlorophenol): Not applicable
5. Melting point: 182 – 190 C (360 – 374 F)
6. Vapor pressure at 20 C (68 F): 0.00017 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.002
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, chlorinated phenols, and carbon monoxide) may be released when pentachlorophenol decomposes.
4. Special precautions: None.

- **Flammability**

1. Not combustible

- **Warning properties**

1. Odor Threshold: The AIHA *Hygienic Guide* states that pentachlorophenol has a characteristic odor. No quantitative information is available, however, concerning the odor threshold of this substance.

2. Irritation Levels: The *Documentation of TLV's* states that "dusts are particularly irritating to the eyes and nose, in concentrations appreciably greater than 1 mg/m³, but some irritation of the nose may occur at 0.3 mg/m³. Hardened workers can tolerate up to 2.4 mg/m³." .22 ppm

0.092 ppm

.027 ppm

3. Evaluation of Warning Properties: Through its irritant effects, pentachlorophenol can be detected within three times of the permissible exposure limit. For the purposes of this guideline, therefore, pentachlorophenol is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

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

- **Method**

An analytical method for pentachlorophenol is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

- Gleason, M. N., Gosselin, R. E., Hodge, H. C., and Smith, R. P.: *Clinical Toxicology of Commercial Products* (3rd ed.), Williams and Wilkins, Baltimore, 1969.

RESPIRATORS

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

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with pentachlorophenol or liquids containing pentachlorophenol.
- If employees' clothing has had any possibility of being contaminated with pentachlorophenol or liquids containing pentachlorophenol, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing which has had any possibility of being contaminated with pentachlorophenol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of pentachlorophenol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the pentachlorophenol, the person performing the operation should be informed of pentachlorophenol's hazardous properties.
- Where there is any possibility of exposure of an employee's body to pentachlorophenol or liquids containing pentachlorophenol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with pentachlorophenol should be removed immediately and not reworn until the pentachlorophenol is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of pentachlorophenol or liquids containing pentachlorophenol contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to pentachlorophenol or liquids containing pentachlorophenol, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with pentachlorophenol should be immediately washed or showered with soap or mild detergent and water to remove any pentachlorophenol.
- Workers subject to skin contact with pentachlorophenol or liquids containing pentachlorophenol should wash with soap or mild detergent and water any areas of the body which may have contacted pentachlorophenol at the end of each work day.
- Eating and smoking should not be permitted in areas where pentachlorophenol or liquids containing pentachlorophenol are handled, processed, or stored.
- Employees who handle pentachlorophenol or liquids containing pentachlorophenol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	*Controls*
Formulation of preservatives, pesticides, and fungicides	Process enclosure; local exhaust ventilation; personal protective equipment
Application as a preservative for wood, starch, paint, adhesives, leather, latex, and oils; use in slime-algae control; use as a pesticide, herbicide, and snail control agent	Personal protective equipment
Manufacture of pentachlorophenol	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

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

- **Eye Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If pentachlorophenol or liquids containing pentachlorophenol penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

- **Breathing**

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

- **Swallowing**

When pentachlorophenol or liquids containing pentachlorophenol have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

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

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If pentachlorophenol is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and depost in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing pentachlorophenol should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Pentachlorophenol may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Pentachlorophenol," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Pentachlorophenol and Sodium Pentachlorophenate," *Hygienic GuideSeries*, Detroit, Michigan, 1970.
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- Spector, W. S. (Vols. I, II), Negherbon, W. O. (Vol. III), Grebe, R. M. (Vol. IV), and Dittmer, D. S. (Vol. V) (eds.): *Handbook of Toxicology*, Saunders, Philadelphia, 1956-1959.
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APPENDIX II

DECONTAMINATION PROCEDURES

DECONTAMINATION PROCEDURES

MODIFIED LEVEL C

1.	Equipment Drop	Deposit equipment used on-site (tools,monitoring instruments) on plastic drop cloths.Segregation at the drop reduces the probability of cross contamination.
2.	Outer Garment,Boots, and Gloves Wash and Rinse	Scrub outer boots,outer gloves and splash suit(if worn) with decon.solution or detergent wash water. Rinse off using large amounts of water.
3.	Outer Boots and Glove Removal	Remove outer boots and gloves. Deposit desposables in a container with plastic liner.
4.	Outer Garment Removal	Tyvek Coverall,inner gloves are removed and deposited in a plastic lined container.
5.	Field Wash	Hands,arms and face are to be thoroughly washed. Shower as soon as possible.

Level C Decontamination

1.	Equipment Drop	Equipment used on-site place on plastic drop cloths. Separation at the drop reduces the probability of cross contamination.
2.	Outer Garment,Boots, and Gloves Wash and Rinse	Scrub outer boots,outer gloves and splash suit(if worn)with decon solution or detergent water. Rinse off with large amounts of water.
3.	Outer Boots,Glove Removal	Remove outer boots and gloves. Deposit desposables in container with plastic liner

4.	Cartrige/Canister or Mask Change	If worker leaves work zone to change cartridge/canister or mask, this is last step in the decon procedure. Worker's cartridges/canister is exchange, outer gloves and boots are donned, joints taped and worker returns to work zone.
5.	Boots,Gloves and Outer Garment Removal	Boots,chemical splash suit(if worn),tyvek suits,inner gloves removed and deposited in separate containers lined in plastic.
6.	Respirator Removal	Respirator is removed. Avoid touching face with fingers. Respirators should be placed plastic bags and cleaned
7.	Field Wash	Hands,arms and face are to be thoroughly washed. Shower as soon as possible.

PROTECTION FOR DECONTAMINATION WORKERS

The Level of Protection worn by decontamination workers is determined by:

- Expected or visible contamination on workers.
- Type of contaminant and associated respiratory and skin hazards.
- Total vapor/gas concentrations in the contamination reduction corridor.
- Particulates and specific inorganic or organic vapors in the CRC.
- Results of swipe tests.

A. Level C Use

Level C includes a full-face, canister-type air-purifying respirator, hard hat with face shield (if splash is a problem), chemical-resistant boots and gloves, and protective clothing. The body covering recommended is chemical-resistant overalls with an apron, or chemical-resistant overalls and jacket.

A face shield is recommended to protect against splashes because respirators alone may not provide this protection. The respirator should have a canister approved for filtering any specific known contaminants such as ammonia, organic vapors, acid gases, and particulates.

B. Level B Use

In situations where site workers may be contaminated with unknowns, highly volatile liquids, or highly toxic materials, decontamination workers should wear Level B protection.
Level B protection includes SCBA, hard hat with face shield, chemical-resistant gloves, and protective covering. The clothing suggested is chemical-resistant overalls, jacket, and a rubber apron. The rubber apron protects the SCBA harness assembly and regulator from becoming contaminated.

DECONTAMINATION OF EQUIPMENT

Insofar as possible, measures should be taken to prevent contamination of sampling and monitoring equipment. Sampling devices become contaminated, but monitoring instruments, unless they are splashed, usually do not. Once contaminated, instruments are difficult to clean without damaging them. Any delicate instrument which cannot be easily decontaminated should be protected while it is being used. It should be placed in a clear plastic bag, and the bag taped and secured around the instrument. Openings are made in the bag for sample intake.

A. Decontamination Procedures

1. Sampling devices

Sampling devices require special cleaning. The EPA Regional Laboratories can provide information on proper decontamination methods.

2. Tools

Wooden tools are difficult to decontaminate because they absorb chemicals. They should be kept on site and handled only by protected workers. At the end of the response, wooden tools should be discarded. For decontaminating other tools, Regional Laboratories should be consulted.

3. Respirators

Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Regulators must be maintained according to manufacturer's recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance.

4. Heavy Equipment

Bulldozers, trucks, back-hoes, bulking chambers, and other heavy equipment are difficult to decontaminate. The method generally used is to wash them with water under high pressure and/or to scrub accessible parts with detergent/water solution under pressure, if possible. In some cases, shovels, scoops, and lifts have been sand blasted or steam cleaned. Particular care must be given to those components in direct contact with contaminants such as tires and scoops. Swipe tests should be utilized to measure effectiveness.

B. Sanitizing of Personnel Protective Equipment

Respirators, reusable protective clothing, and other personal articles not only must be decontaminated before being reused, but also sanitized. The inside of masks and clothing becomes soiled due to exhalation, body oils, and perspiration. The manufacturer's instructions should be used to sanitize the respirator mask. If practical, protective clothing should be machine washed after a thorough decontamination; otherwise it must be cleaned by hand.

APPENDIX III

OPERATION AND FIELD MANUALS FOR THE HNU PID AND THE FOXBORO OVA

STANDARD OPERATING PROCEDURES

Title: Operation/Calibration HNU Photoionization Analyzer

1.0 GENERAL APPLICABILITY

This SOP describes the operation and techniques used for the Model: PI 101 Photoionization Analyzer, manufactured by HNU Systems, Inc. This instrument has been adjusted to measure organic vapor levels. There are three direct reading ranges: 0-2 ppm, 0-20 ppm, 0-200 ppm at a minimum gain. The detection limit is 0.1 ppm. The response is less than 5 seconds to 90% of full scale. The PI 101 is capable of operating either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger.

2.0 RESPONSIBILITIES

2.1 The Health and Safety Officer or his/her designee will be responsible for the calibration, operation and maintenance of the instrument.

2.2 The Health and Safety Officer or his/her designee will be responsible for the documentation which applies to the various procedures performed with the instrument.

3.0 SUPPORTING MATERIALS

3.1 Traceable span gas cylinder

3.1.1 n-Hexane
3.1.2 1,3 Butadiene
3.2 Tedlar Bags

3.3 Tubing used for gas transferred from cylinder to bag.

3.4 AC Battery Charger

STANDARD OPERATING PROCEDURES

Title: Operation/Calibration HNU Photoionization Analyzer

4.0 METHODS OR PROTOCOL FOR USE

4.1 Standard Procedure

4.1.1 Operation and calibration of the instrument should be done in a controlled environment; i.e., in the office, interior of a vehicle, etc. This is done in order to control working temperature and to protect from vehicle exhaust, etc.

4.1.2 The probe nozzle, electrode case handle and cable are stored within the instrument cover. To assemble, the handle must be screwed to the opposite end of the electrode casing. The 12 pin connector at the end of the cable must then be attached to the rest of the unit by twisting it downwards until a distinct snap and lock is felt. The unit is now ready to be used.

4.1.3 Prior to calibration or use of the instrument, the unit should be allowed to warm up. In this time, check to see if the UV light source is working. DO NOT LOOK DIRECTLY AT THE LIGHT SOURCE. Also, check to see if the intake is working properly. It is within the electrode casing and will give off a distinct hum when the unit is turned on.

4.1.4 Check to make sure the level of charge is high enough to ensure accurate readings. When the instrument is switched to the Battery Check position, the needle should deflect upscale to well within the green area (battery level) on the face of the meter. If not, the unit should be charged using the AC charger. A 3-hour charge will bring the unit up to 90% full charge. With continuous use, (e.g., unit left on a full day), the unit should be recharged overnight for 10-14 hours.

4.2 Calibration and Maintenance

4.2.1 Calibration should be done at the beginning of each day the instrument is used, to ensure accurate readings over the full range of scale that is to be needed (One cylinder containing n-Hexane or 1,3-Butadiene of a known concentration of calibration gas).

4.2.2 The instrument should be zero'd before and after each calibration. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment knob until the meter reads zero (wait for a stable response and then adjust the zero adjustment knob until a zero reading is obtained).

4.2.3 Actual calibration is done by first filling an evacuated Tedlar Bag with n-Hexane or 1,3-Butadiene calibration gas. This is done by connecting to the outlet side of the regulator on the calibration gas cylinder a flexible hose and the other side connected to the inlet valve of the Tedlar bag. Fill bag. Be absolutely sure the Tedlar bag has been evacuated before filling it with gas. Otherwise the calibration gas will be diluted and its concentration will not be know.

4.2.4 The appropriate analyzer scale (0-20) shall be used on the known concentration of n-Hexane or 1,3-Butadiene calibration gas. Attach the probe nozzle to the Tedlar bag and allow it to sample the gas until a stable, unchanging reading is reported by the analyzer. Adjust the span control knobs so that the instrument reading agrees exactly with the concentration of the calibration gas. Whenever the span setting is changed, the zeroing procedure (section 4.2.2) should be repeated.

4.2.5 All calibration checks must be documented on appropriate forms.

4.3 Standard Operation

4.3.1 After the instrument is fully calibrated it is ready to be used. To obtain the most accurate reading, use the 0 - 20 scale. To analyze a sample, the probe nozzle should be placed at the (1) breathing zone and (2) the ground zone (about knee high) taking care not to contaminate the probe with any materials.

4.3.2 All reading should be documented on the appropriate forms.

4.3.3 Meter calibration should be checked by methods in 4.2 at the end of the day and any appropriate changes made and documented. This check should be done periodically.

STANDARD OPERATING PROCEDURES

Title: Operation/Calibration HNU Photoionization Analyzer

5.0 DOCUMENTATION

5.1 Field/Lab Equipment Status Forms

5.2 HNU PI 101 Recalibration Form Rev. 1

5.3 All documentation shall be retained in project files.

6.0 REFERENCES

Instruction Manual for PI 101 Photoionization Analyzer, printed by HNU Systems, Inc. 1975.

Standard Operating Procedure, Title: Operation/Calibration HNU Photoionization Analyzer, Date: 1st Qtr. 1984, Number: 7315, Revision 1.

STANDARD OPERATING PROCEDURES

Title: Operation/Calibration HNU Photoionization Analyzer

HNU PI 101 RECALIBRATION FORM
SN:__________

Project Name/No.________________ Recalibration Date ___/___/___

Time____________________

By Whom____________________

Calibration Gases:	Cylinder ID Number	Concentration
1.		ppm
2.		ppm

Where Recalibrated:______________________________
(Office, Field Lab)

Battery Check: (Y,N) ______ Recharge Time:____________hrs

Zero Adjust: (Y,N) ______

First Calibration: Designated Reading__________ppm
Observed Reading__________ppm

Span Setting: Initial _______
Final _______

Post Span Observed Reading________________ppm

Post Calibration Zero Adjust: (Y,N) _______

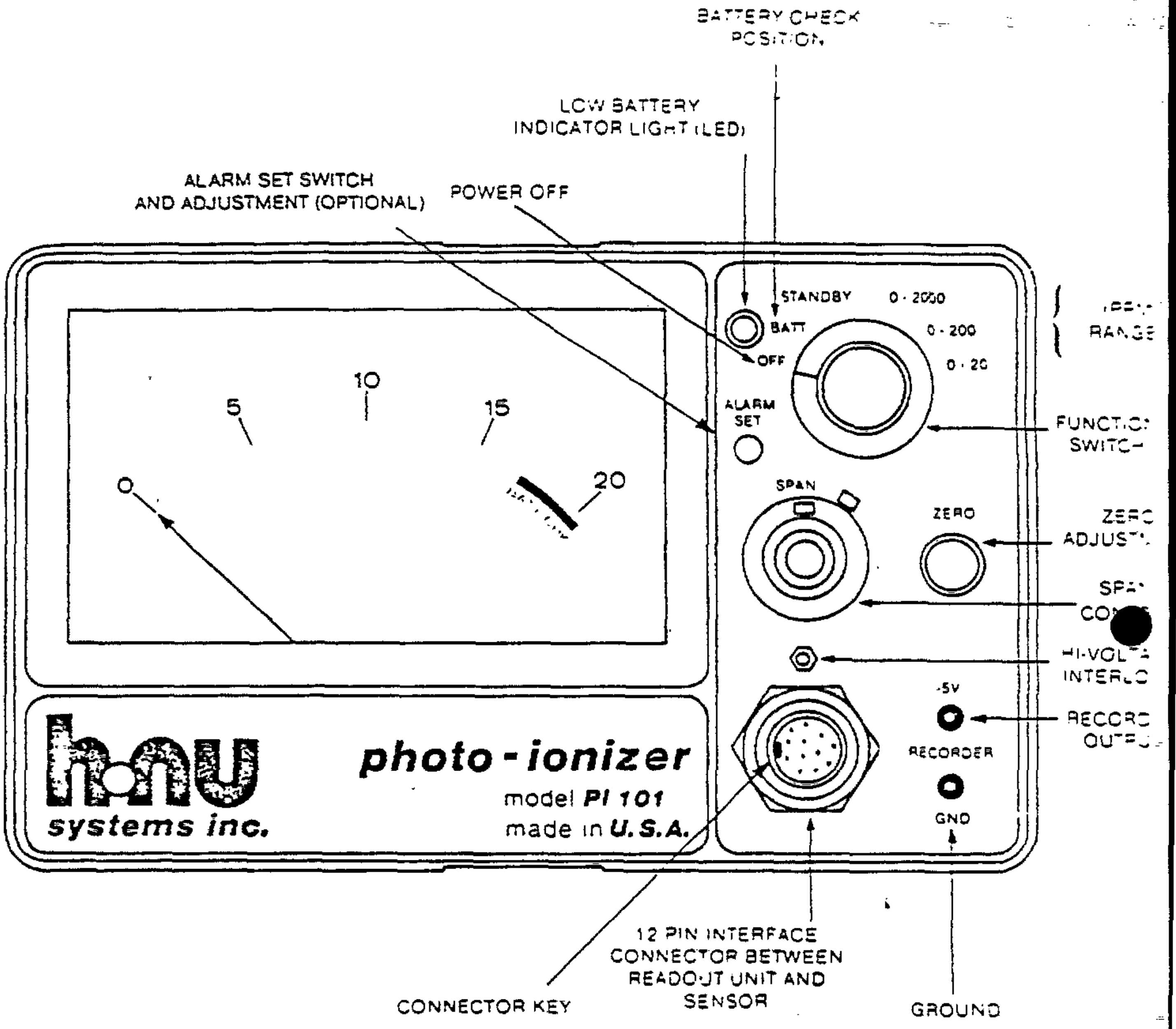


FIGURE 2-1
CONTROLS AND INDICATORS

FIELD/LAB EQUIPMENT STATUS FORM

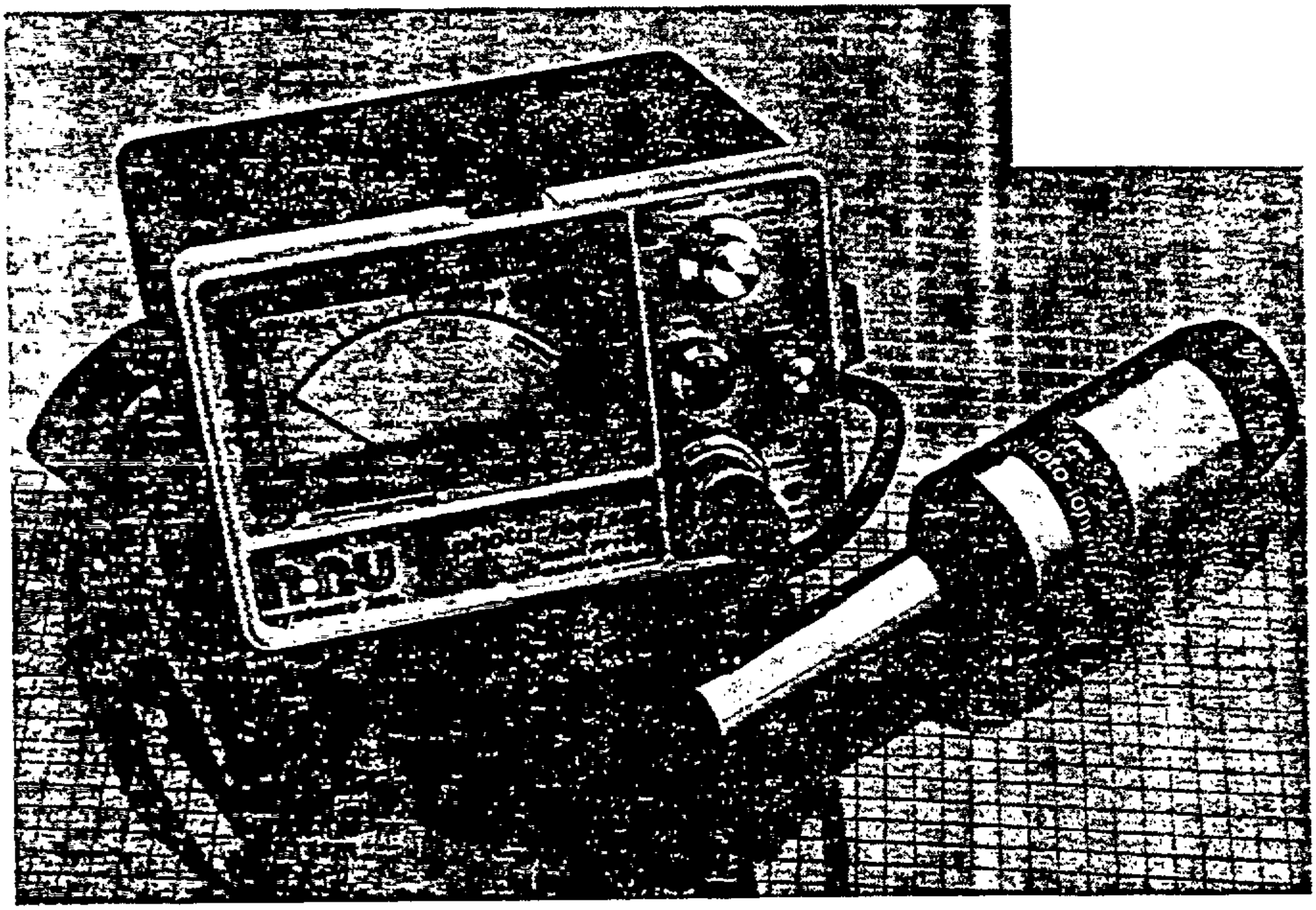
Type of Equipment ____________________

Equipment No. ____________ Mfr. ____________

			Adjustments Made				
Date	Calibration/ Maintenance (C, M)	Agent Used	What Type	Initial	Final	Status (OK, Hold)	Initial
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Additional Comments:

INSTRUCTION MANUAL



MODEL PI 101

Portable Photoionization Analyzer

INSTRUCTION MANUAL

TRACE GAS ANALYZER

HNU MODEL PI 101

HNU Systems, Inc.
160 Charlemont St.
Newton, MA 02161

December 1985

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SECTION PAGE

LIST OF ILLUSTRATIONS

SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This manual describes the operation, maintenance and parts list for the Trace Gas Analyzer, Model PI 101, HNU Systems Inc.

1.2 EQUIPMENT DESCRIPTION

The Trace Gas Analyzer (see Figure 1-1), is a portable instrument used to detect, measure, and provide a direct reading of the concentration of a variety of trace gases in many industrial or plant atmospheres. The analyzer employs the principle of photoionization. This process involves the absorption of ultra-violet light (a photon) by a gas molecule leading to ionization:

$$RH + hv \longrightarrow RH^{+} + e^{-}$$

in which

RH = Trace gas
hv = Photon with an energy level equal to or greater than the ionization potential of RH.

The sensor consists of a sealed ultraviolet (UV) light source that emits photons with an energy level high enough to ionize many trace species, particularly organics, but not high enough to ionize the major components of air, O_2, N_2, CO, CO_2 or H_2O.

A chamber exposed to the light source contains a pair of electrodes, one a bias electrode and the second a collector electrode. When a positive potential is applied to the bias electode a field is created in the chamber. Ions formed by the absorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter directly in parts per million (ppm).

To minimize absorption or decomposition of sample gases, a rapid flow of sample gas is maintained thru the ion chamber, which is small, made of inert material and located at the sampling point.

The analyzer consists of a probe, a readout assembly, and a battery charger. The probe contains the sensing and amplifying circuitry; the readout assembly contains the meter, controls, power supply and rechargeable battery. The analyzer will operate from the battery for more than 10 hours or continuously when connected to the battery charger.

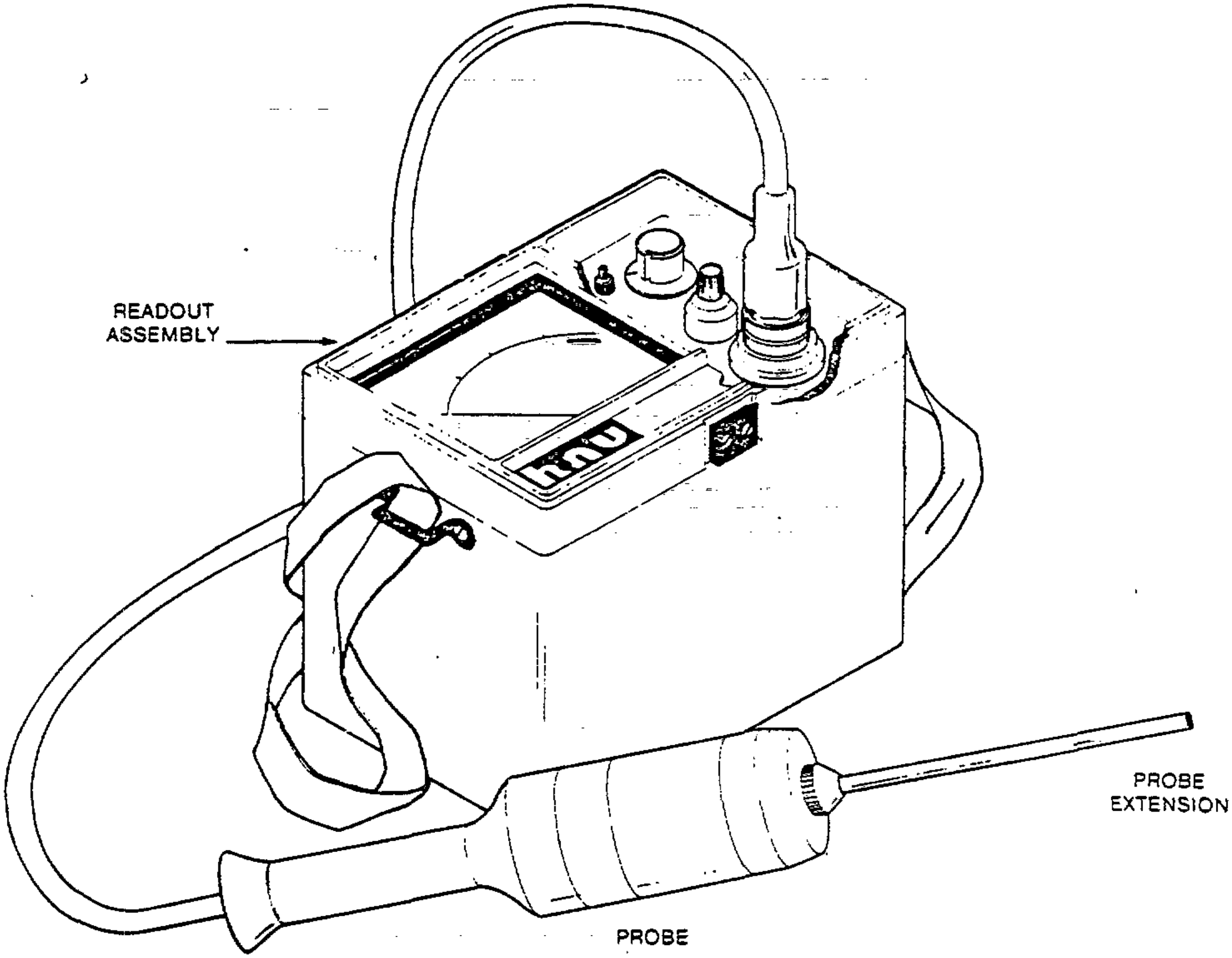


FIGURE 1-1
TRACE GAS ANALYZER
OPERATING CONDITION

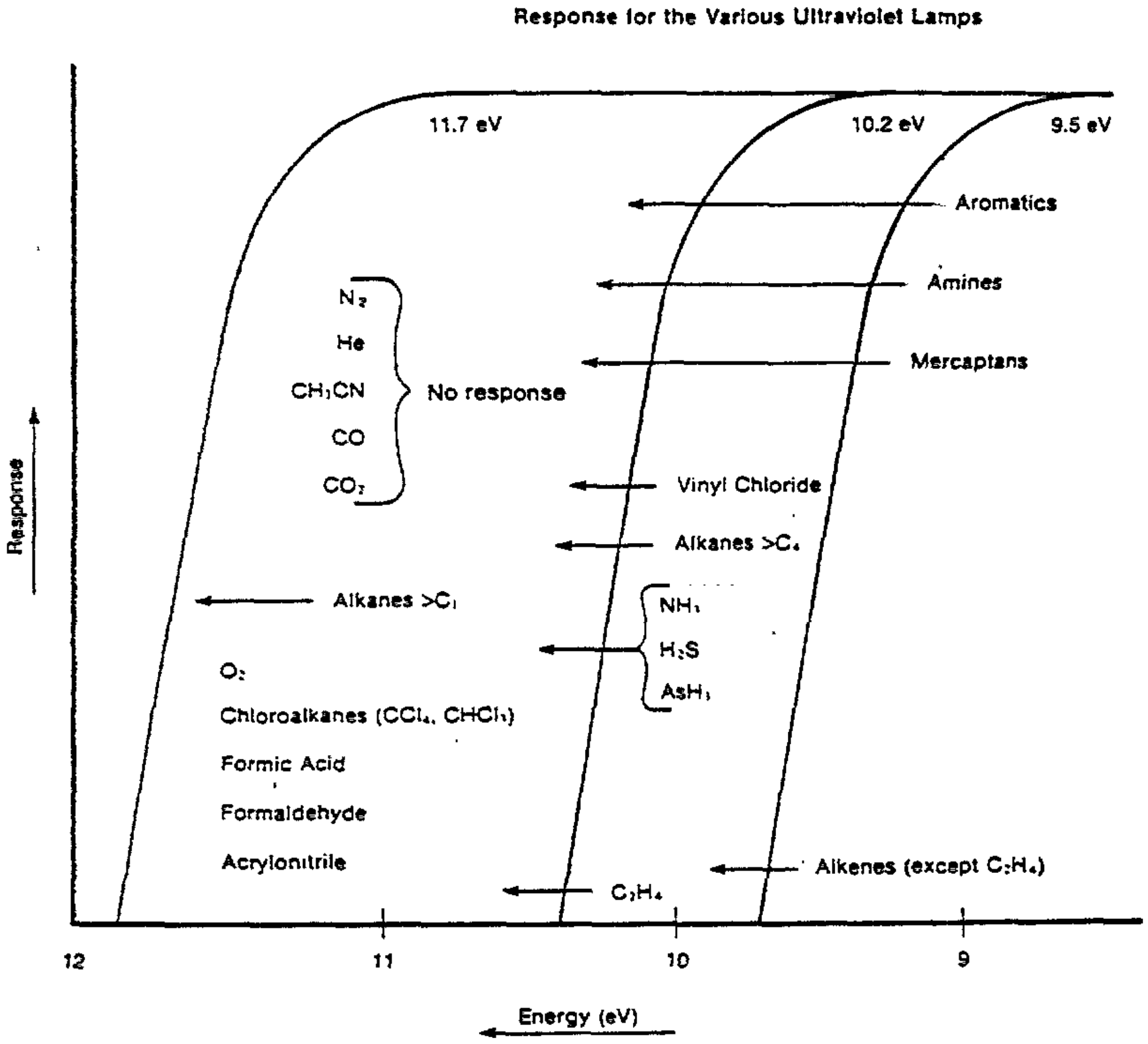


FIGURE 1-2
RESPONSE TO VARIOUS COMPOUNDS
FOR EACH ULTRAVIOLET LAMP

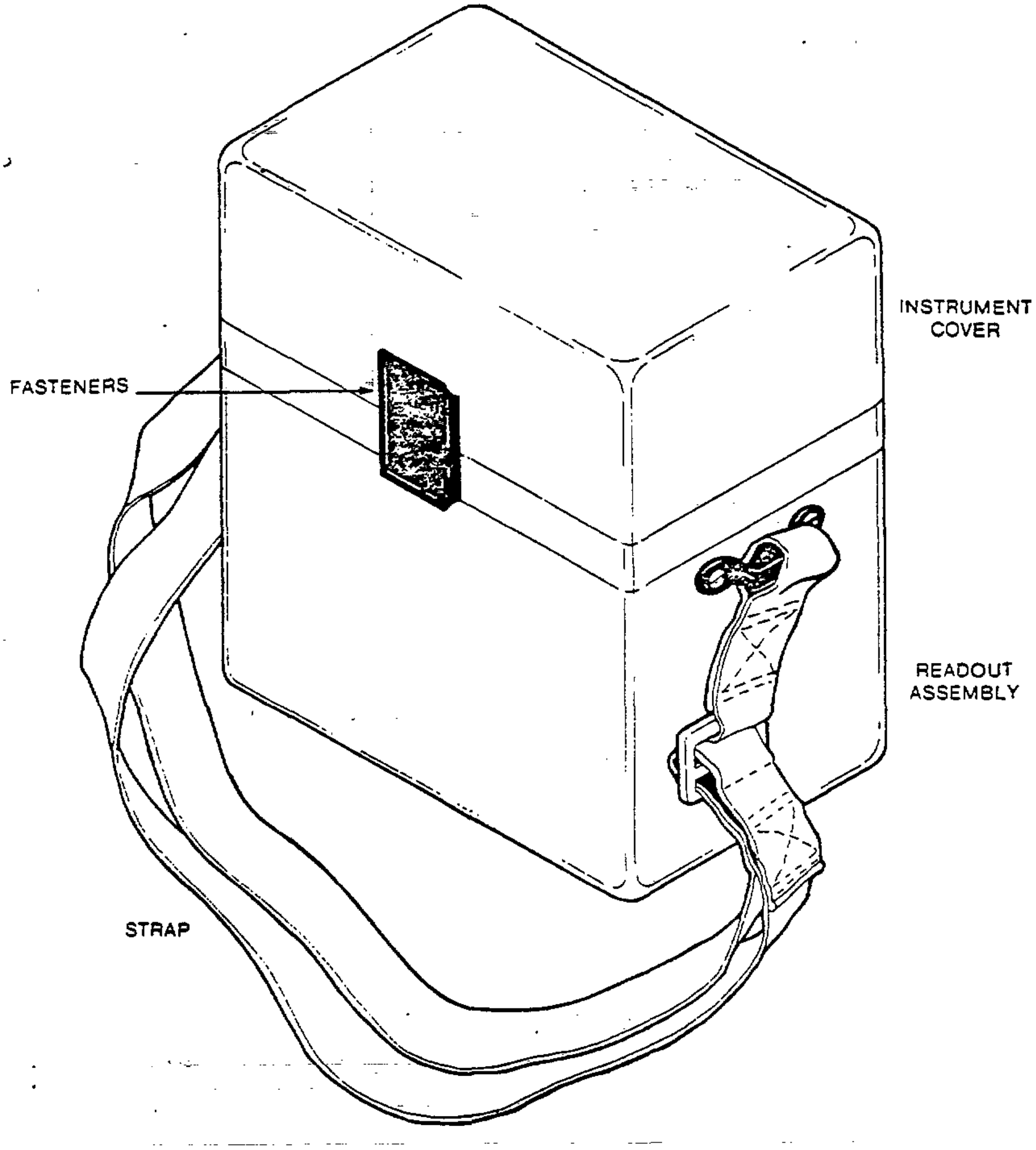


FIGURE 1-4
TRACE GAS ANALYZER
STORED CONDITION

TABLE 1-1 cont.

Recharge time from full discharge	Full recharge - 12 to 14 hours
Recharge current	Max 0.4 amps at 15 V DC
Battery Charger Power	120 V AC, single phase, 50-60 cycle, 1.5 Amps

NOTE: * When equipped with 10.2 eV Probe with SPAN set at 9.8 and measuring benzene. Values will vary for other compounds and conditions.

SECTION 2

OPERATION

2.1 INTRODUCTION/UNPACKING

Unpack the instrument carefully. The carton will contain the housing, straps, battery charger, additional probes, regulator and cylinder if ordered, spare parts, supplies and a manual. Be sure all items are removed before discarding the carton.

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

2.2 CONTROLS AND INDICATORS

The controls and indicators are located on the front panel of the readout assembly (see Figure 2-1) and are listed and described in Tables 2-1 and 2-2.

2.3 OPERATING PROCEDURES

The following procedures are to be used in operating the analyzer:

a. Unclamp the cover from the main readout assembly.

b. Remove the inner lid from the cover by pulling out the two fasteners.

c. Remove the probe, handle and cable from the cover. Attach the handle to the front part of the probe.

d. Connect the probe cable plug to the 12 pin keyed socket on the readout assembly panel. Carefully match the alignment slot in the plug to the key in the connector. Screw down the probe connector until a distinct snap and lock is felt.

e. Screw the probe extension into the probe end cap. The probe may be used without the extension if desired.

f. Set the SPAN control for the probe being used (10.2, 9.5, or 11.7 eV) as specified by the initial factory calibration or by subsequent calibrations.

TABLE 2-1

CONTROLS

Name	Position	Function
Function Switch	---	Controls the operation of the analyzer
	OFF	All operations OFF
	BATT (battery check)	Checks the condition of the battery. If the meter needle is in the green arc, the battery is charged. If not the battery should be recharged. Charging can be done in any position, best in OFF; see directions on charger.
	STANDBY	All electronics ON, ultraviolet (UV) light source OFF. This position conserves power and extends battery life. This position is used to set the analyzer zero position. (i.e. no UV light, no signal)
	0-2000	Sets range of meter at 0-2000 ppm.
	0-200	Sets range of meter at 0-200 ppm.
	0-20	Sets range of meter at 0-20 ppm.
ZERO	---	With the function switch in STANDBY position, this potentiometer is used to adjust the reading to zero.

NOTE: See Figure 2-1 for locations.

TABLE 2-2

INDICATORS AND DISPLAYS

Name	Function
Low Battery Indicator Light (red light) (see NOTE)	Illuminates when battery is discharged, indicates need for recharge. Do not use unit when this light is ON. Readings may be taken while battery is being recharged.
Meter (see NOTE)	Indicates concentration of measured gas.
Recorder (optional) (see Figures 2-1 And 8-3)	Provides a record of readings while analyzer operates unattended. Recorder inputs 0 to -5 V DC.

NOTE: See Figure 2-1 for locations.

n. The analyzer is now operational.

o. Hold the probe so that the extension is at the point where the measurement is to be made. The instrument measures the concentration by drawing the gas in at the end of the extension, through the ionization chamber, and out the handle end of the probe.

WARNING

The instrument measures gases in the vicinity of the operator and a high reading when measuring toxic or explosive gases should be cause for action for operator safety.

p. Take the reading or readings as desired taking into account that air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings. Change the ranges as required.

q. Check battery condition as required. If the Low Battery Indicator comes on, turn analyzer off and recharge.

CAUTION

Use only in an emergency with a low battery when on battery charge.

SECTION 3

CALIBRATION

3.1 INTRODUCTION

The PI 101 Analyzer is designed for trace gas analysis in ambient air and is calibrated at HNU with certified standards of benzene, vinyl chloride and isobutylene. Other optional calibrations are available (e.g., ammonia, ethylene oxide, H2S, etc.). Calibration data is given in the data sheet. If a special calibration has been done, the data is given in the Application Data Sheet, which notes the sample source, type of calibration (see Section 8, Appendix), and other pertinent information.

Good instrumentation practice calls for calibration on the species to be measured in the concentration range to be used. This procedure assures the operator that the analyzer is operating properly and will generate reliable data.

Some general points to consider when calibrating the PI 101 are that the analyzer is designed for operation ambient conditions and therefore the gas standards used for calibration should be delivered to the analyzer at ambient temperatures and pressure and at the proper flow rates.

WARNING:

The PI 101 is a non-destructive analyzer; calibrations using toxic or hazardous gases must be done in a hood.

The frequency of calibration should be dictated by the usage of the analyzer and the toxicity of the species measured. If the analyzer has been serviced or repaired, calibration should be done to verify operation and performance. It is recommended that calibration be checked frequently at first (daily or every other day) and then regularly based on the confidence level developed.

The normal meter scaleplate is 0 to 20. If the scaleplate is different, refer to the Application Data Sheet. If there are questions, consult the HNU representative before proceeding with calibration check.

An accurate and reliable method of calibration check is to use an analyzed gas cylinder in a test setup as shown in Figure 3-1 and described below. Additional material on calibration is given in Section 8, Appendix.

3.2 ANALYZED GAS CYLINDER

a. Concentration - The calibration gas cylinder is to contain the species of interest made up in an air matrix at or near the concentration to be analyzed. If the component is unstable in air, another matrix is to be used. The final calibration mixture should be similar to the sample the PI 101 will analyze. If the expected concentration is not known then a concentration should be chosen that will cause a scale displacement of 50 to 80% on the X10 range. Calibration on X10 range will provide accurate values on the X1 range as w

This insures that the PI 101 sees the calibration gas at atmospheric pressure and ambient temperature.

d. Usage - Generally, a gas cylinder should not be used below 200-300 psi as pressure effects could cause concentration variations. The cylinder should not be used past the recommended age of the contents as indicated by the manufacturer. In case of difficulty, verify the contents and concentration of the gas cylinder.

e. Alternate means of calibration are possible. For more information, contact the HNU Service Department.

3.3 PROBE

a. Identify the probe by the lamp label. If a question exists, disassemble the probe and inspect the lamp. The energy of the lamp is etched into the glass envelope.

b. Connect the probe to the readout assembly, making sure the red interlock switch is depressed by the ring on the connector.

c. Set the SPAN pot to the proper value for the probe being calibrated. Refer to the calibration memo accompanying the probe.

d. Check the Ionization Potential (IP) of the calibration gas to be used. The IP of the calibration gas must be at or below the IP of the lamp.

e. Proceed with the calibration as described in Section 3.4. Check the calibration memo for specific data. If any questions develop, call the HNU representative.

f. NOTE: The 11.7eV lamp has a special cleaning compound. Do not use water or any other cleaning compound with the 11.7 eV lamp. Do not interchange ion chambers, amplifier boards or lamps between probes. (See Section 5.2).

3.4 PROCEDURE

a. Battery check - Turn the function switch to BATT. The needle should be in the green region. If not, recharge the battery.

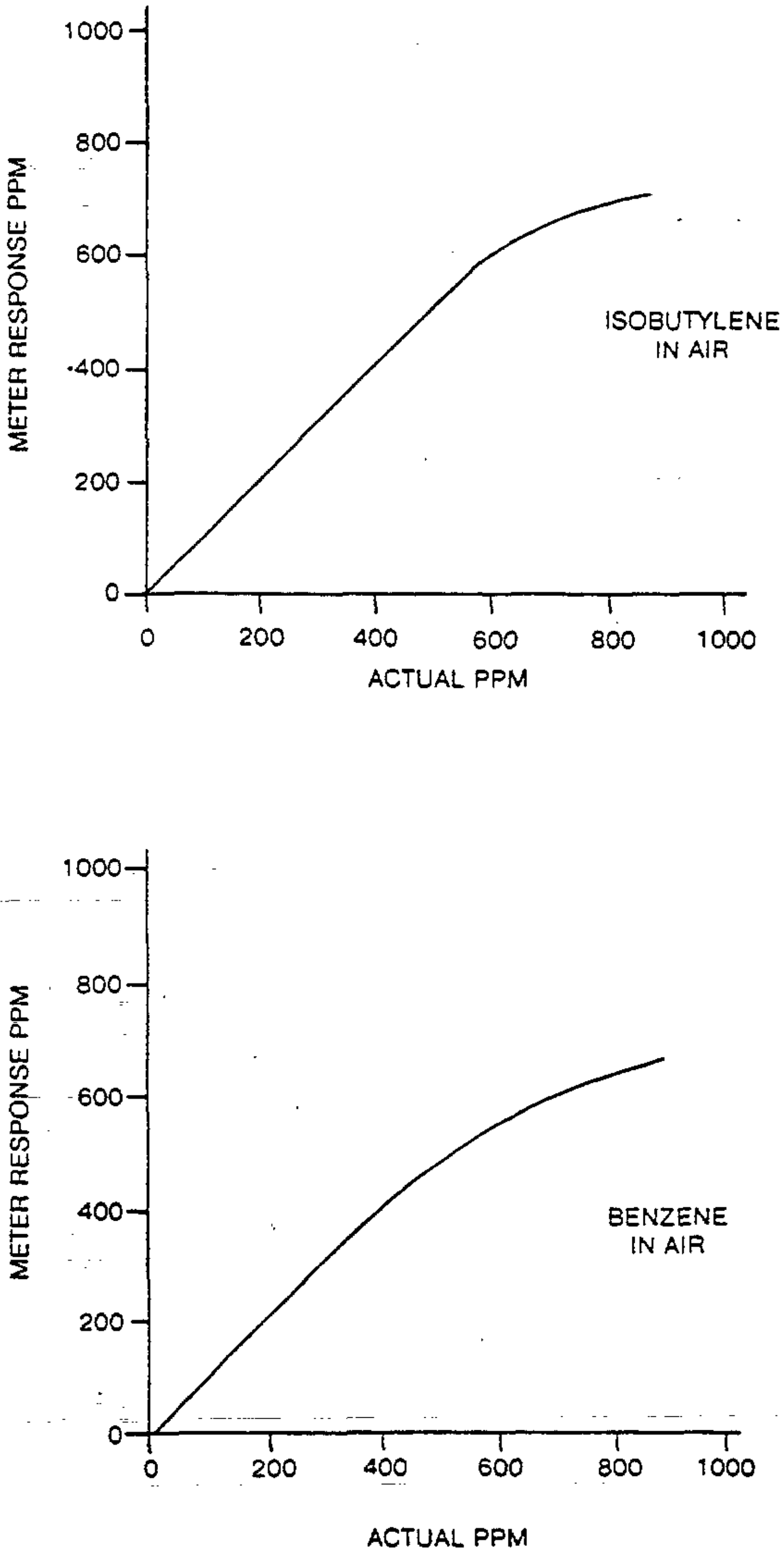


FIGURE 3-2
TYPICAL CALIBRATION CURVES (10.2 eV)

The species with the higher values are more sensitive to the 10.2 eV photons than are those with lower values. For example, referring to data in Table 9-14, an analyzer calibrated for benzene, when measuring a sample containing 10 ppm of benzene, will read 10.0 and when measuring a sample containing 10 ppm of vinyl chloride will read 5.0. This shows the lower sensitivity of the vinyl chloride. Similar conditions are the case for the 9.5 and 11.7 eV lamps.

4.4 CALIBRATED PROBES AND SELECTIVITY

The standard probe provided with the analyzer contains a 10.2 eV lamp. Optional probes containing lamps of 9.5 and 11.7 eV permit selective determination or exclusion of species.

The probe with the 9.5 eV lamp permits measurement of species having IP values lower than 9.5 eV in the presence of interfering species with IP values above 9.5 eV.

The probe with the 11.7 eV lamp permits measurement of species with IP values above 10.2 up to aproximately 11.7 eV.

The probes with different lamps are interchangeable in use within individual readout assemblies for different applications. The amplifier and ion chamber in the probe are selected for the specific eV lamp. Lamps of different eV ratings cannot be interchanged between probes. Examples of selective application of these probes is given in Table 4-2. Additional applications of the use of the probes are described in the sections that follow and illustrated in Figure 4-2. Further examples are given (without discussion) in Table 4-3. Re-zeroing is performed after each probe interchange.

4.5 10.2 eV PROBE

The 10.2 eV probe is the standard probe used with the Trace Gas Analyzer. The approximate span settings for a 10.2 eV probe that would give direct readings of the amounts of trace gas of a particular species in a sample is given in Table 9-14. for example, when the span control is set at 4.3 the analyzer will read 10 ppm when measuring a sample containing 10 ppm of vinyl chloride. These span settings will vary with the condition of the lamp. Application of the 10.2 eV probe is illustrated in examples "a", "b", and "c" in Figure 4-2. In each case the trace gas (or gases) is contained in a standard atmosphere.

Example "a" shows the use of the 10.2 eV probe to measure Vinyl Chloride (IP=9.995) by itself.

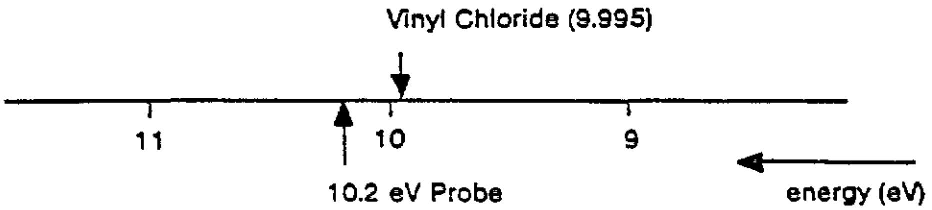
Example "b" shows the use of the 10.2 eV probe to measure Vinyl Chloride (IP=9.995) in the presence of a second gas, Acetylene (IP=11.4). The acetylene is not ionized and the probe gives a direct reading of the Vinyl Chloride above.

Example "c" shows the use of the 10.2 eV probe to measure Isoprene (IP=9.08) by itself. A 9.5 eV probe may also be used but is less sensitive. the 10.2 eV probe is recommended.

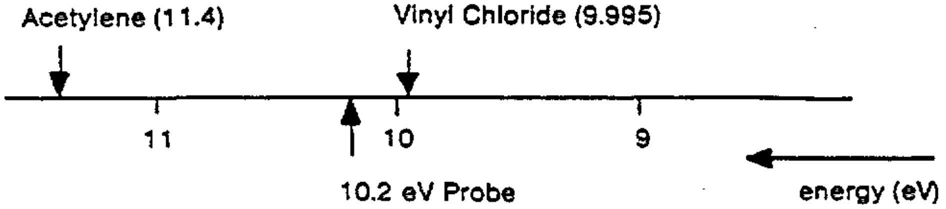
RELATIVE PHOTOIONIZATION SENSITIVITIES FOR GASES

Chemical Grouping	Relative Sensitivity (see NOTE)	Examples
Aromatic	10	Benzene, Toluene, Styrene
Aliphatic Amine	10	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	7-9	MEK, MiBK, Acetone, Cyclohexanone
Unsaturated	3-5	Arolein, Propylene, Cyclohexanone, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C5-C7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	
Paraffin (C1-C4)	0	Methane, Ethane

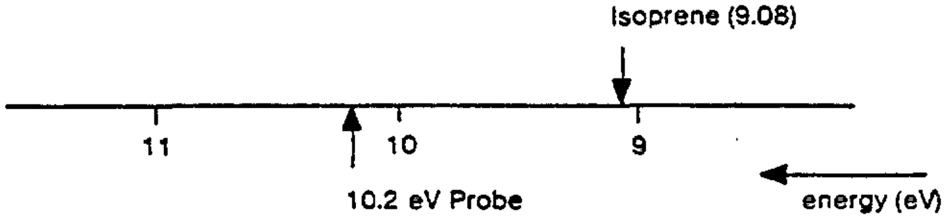
NOTE: Relative sensitivity = meter reading when measuring 10 ppm of the listed gas with instrument with 10.2 eV probe calibrated for 10 ppm of benzene, span pot setting = 9.8 for direct reading of benzene.



a. 10.2 eV-probe measures Vinyl Chloride (IP = 9.995)

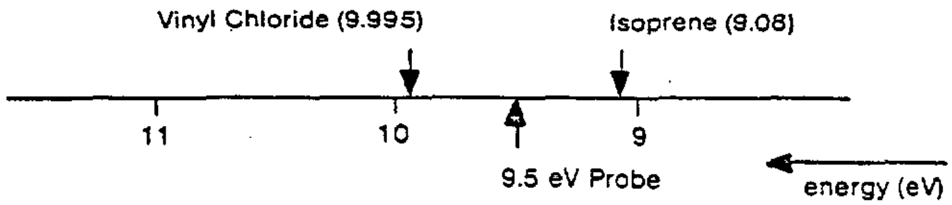


b. 10.2 eV Probe measures Vinyl Chloride (IP = 9.995)
but not Acetylene (IP = 11.4)

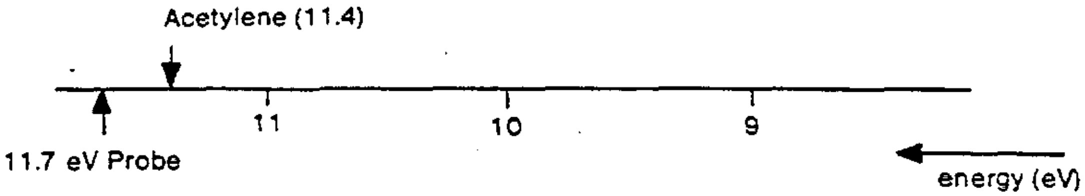


c. 10.2 eV Probe measures Isoprene (IP = 9.08)

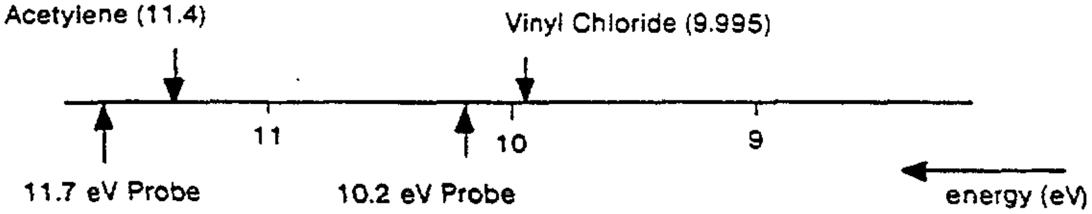
FIGURE 4-2
APPLICATION OF PROBES



d. 9.5 eV Probe measures Isoprene (IP = 9.08) but not Vinyl Chloride (IP = 9.995)



e. 11.7 eV Probe measures Acetylene (P = 11.4)



f. 11.7 eV Probe measures both Acetylene (IP = 11.4) and Vinyl Chloride (IP = 9.995)

10.2 eV Probe measures Vinyl Chloride but not Acetylene

Difference between the two readings is the measure of Acetylene

FIGURE 4-2
APPLICATION OF PROBES CONTINUED

TABLE 4-3

PROBE APPLICATION EXAMPLES

Application	Recommended Probe
Styrene (IP = 8.47) Alone	10.2
Hexane (IP = 10.48) Alone	10.2
Formaldehyde (IP = 10.87) Alone	11.7
Styrene/Hexane Together	10.2 and 9.5 Use 10.2 to measure total, 9.5 to measure Styrene, difference will be the concentration of Hexane.
Formaldehyde/Styrene Together	10.2 and 11.7 Use 11.7 to measure total, 10.2 to measure Styrene, difference will be the contentration of Formaldehyde

4.6 9.5 eV PROBE

The 9.5 eV probe is used to measure gases with IP<9.5 when it is necessary to exclude gases that may be present having IP>9.5 eV and <10.2 eV. This is illustrated by example "d" in Figure 4-2. Here a 9.5 eV probe is used to measure Isoprene (IP=9.08) in the presence of Vinyl Chloride (IP=9.995).

Gain settings for a 9.5 eV probe to give direct readings for various species are given in Table 8-15.

4.7 11.7 eV PROBE

The 11.7 eV Probe is used to measure trace gases with IP>10.2 eV but less than 11.7 eV. The use of this probe by itself is illustrated in example "e". Here the 11.7 eV probe is used to measure Acetylene (IP=11.4 eV). The use of this probe in conjunction with a 10.2 eV probe is illustrated in example "f". In this case, two gases are present, Acetylene (IP=11.4) and Vinyl Chloride (IP=9.995). The objective is to obtain a measurement of the Acetylene alone.

The 11.7 eV probe measures the total presence of both Acetylene and Vinyl Chloride together. The 10.2 eV probe measures just the Vinyl Chloride, excluding the Acetylene. The difference between the two readings is the measure of the Acetylene.

Gain settings for the 11.7 eV probe to give direct readings for various species are given in Table 8-15.

4.8 EQUIPMENT DESCRIPTION

The components of the analyzer are located in the probe and the readout assembly (see Figures 4-3 and 4-4). The ion chamber, UV light source, amplifier board, and fan are located in the probe assembly. The battery, the power supply board, and the meter are located in the readout assembly. The probe and the readout assembly are connected by an 300 cm (32") cable.

The fan draws gas in through the probe and ion chamber. The flow rate is approximately 100 cubic centimeters per minute. Small variations in the flow rate do not affect the measurement. A major obstruction to the flow, however, will prevent proper operation and lengthen response time. The fan cannot draw a sample from any distance or across a pressure drop.

The output from the ion chamber is amplified and read out on the meter.

Voltage for the light source, ion chamber, amplifier and fan is provided from a DC converter on the power supply board. The battery provides the source of power for the converter. The positive side of the battery is grounded.

The input signal from the ion chamber enters at connector P1/J1 (see schematic Figure 4-5), goes to transistor Q1 and amplifier A1. The zero adjustment setting on the control panel enters thru pins 3 and C on P2/J2, thence to the transistor Q1.

Power for the amplifier enters on pins D and F respectively. Span control adjustment from the control panel enters at pin B, signal output at pin E, and ground connector at pin J.

The output signal from the amplifier goes thru pin E in the cable connector P3/J3 to pad 11 on the power supply board, to the resistor network R39 thru R49, including the adjustable pot R48. From there it goes to the meter through the function switch on the control panel.

Connections from the resistor network through the function switch serve to set the operating range of the meter. Input to the span control potentiometer comes from this same network through the function switch. The output of the span control pot provides feedback control to the amplifier through pin H on the cable, pin B on the amplifier board, and feedback resistor R5 to the amplifier input.

Power for the UV lamp, D1, is provided by rectifier networks containing CR4-9 operating from the red and white terminals of transformer T1. Voltage for the lamp (pad 22 on the power supply board or J3 pin D, Figure 4-6) will be as follows for the several different conditions that may exist.

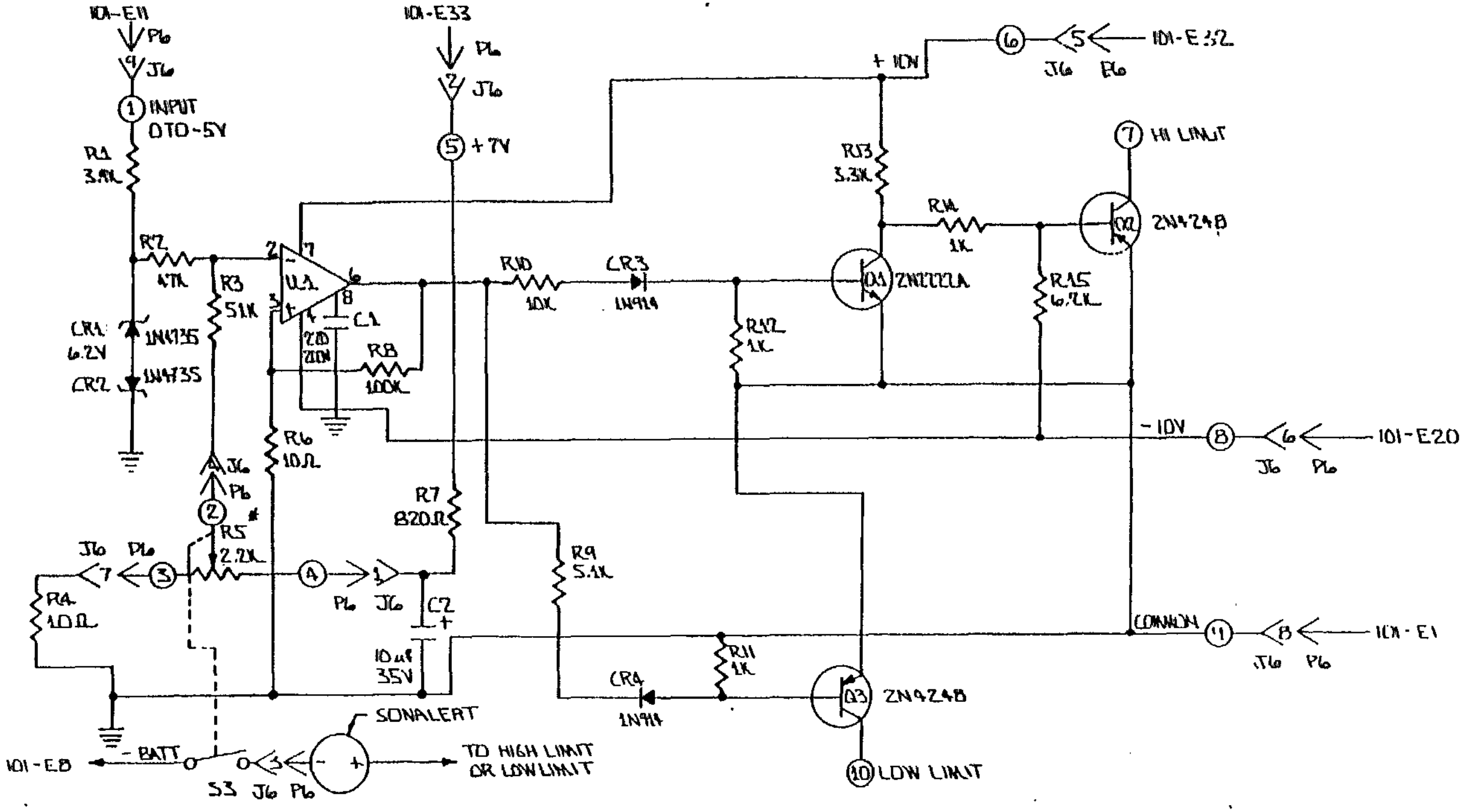
Condition	Voltage, V DC
Probe connected, lamp operating properly	-350 to -450
Probe connected, lamp not operating properly	-1100 to -1200
Probe not connected, high voltage switch not depressed	0 to -300
Probe not connected, high voltage switch depressed manually	-1100 to -1200

Power for the ion chamber is provided by rectifier network CR2 and 3 operating from terminals 6 and 7 of T1 and voltage regulator Z1. Power for the amplifier is provided by rectifier networks CR13-16 operating from terminals 4,5 and 8 of T1. Power for the fan motor is provided by rectifier network CR18-21 operating from terminals 1, 2 and 3 of transformer T1. Conversion of the DC from the battery for input power to T1 is accomplished by Z2. Power for a recorder is available at connector J7.

D3 provides indication if the battery voltage falls below the prescribed level of 11.23 V DC. J5 provides for connection of the battery charger. The six bank switch, S1, is the function switch. Microswitch S2 disables the high voltage power to the cable connector when disconnected.

The alarm board (optional) is connected to the power supply board by the cable containing connector P6/J6. The amplifier output signal, pin 9 on P6/J6 (see schematic Figure 4-6), goes to one input of amplifier U1 (see schematic Figure 4-5).

The output from the alarm set control on the front panel, pin 4 on P6/J6, goes to the second input of U1. The output from U1 operates the audible alarm through Q3 or Q2. Only one of these is connected at the factory to give low alarm or high alarm, respectively, as requested by the user. The alarm will operate when the signal falls or rises above this threshold. Reference power for the alarm setting enters the board at pin 2 and power for the amplifier and transistors Q1 thru Q3 enters at pin 5. The battery charger provides 15.0 V DC for recharging.



NOTE:

1) ALL RESISTORS ARE 1/4W C.C. OR C.F. ±5%.
2) FOR BOARDMASTER SEE HNU DWG. DB100584.
3) FOR P.C. MASTER SEE HNU DWG. MB100583.
4) FOR SILKSCREEN SEE HNU DWG. MB100585.
5) * R5, S1 MOUNTED ON FRONT PANEL.

FIGURE 4-5
SCHEMATIC DIAGRAM, ALARM BOARD

NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTORS ARE CARBON COMPOSITION ¼ W 5%.
2. RESISTORS MARKED WITH ASTERISK (*) ARE METAL FILM ¼ W 1% RN55D.
3. TRANSFORMER (T1) CASE IS CONNECTED TO GROUND.
4. R31 & R47 VALUES TO BE SELECTED AT FINAL TEST.
5. THIS SCHEMATIC IS FOR USE WITH BOARDS STARTING WITH SERIAL NO. 7476. BOARDS PRIOR TO 7476 USE SD100104 REV. 3.

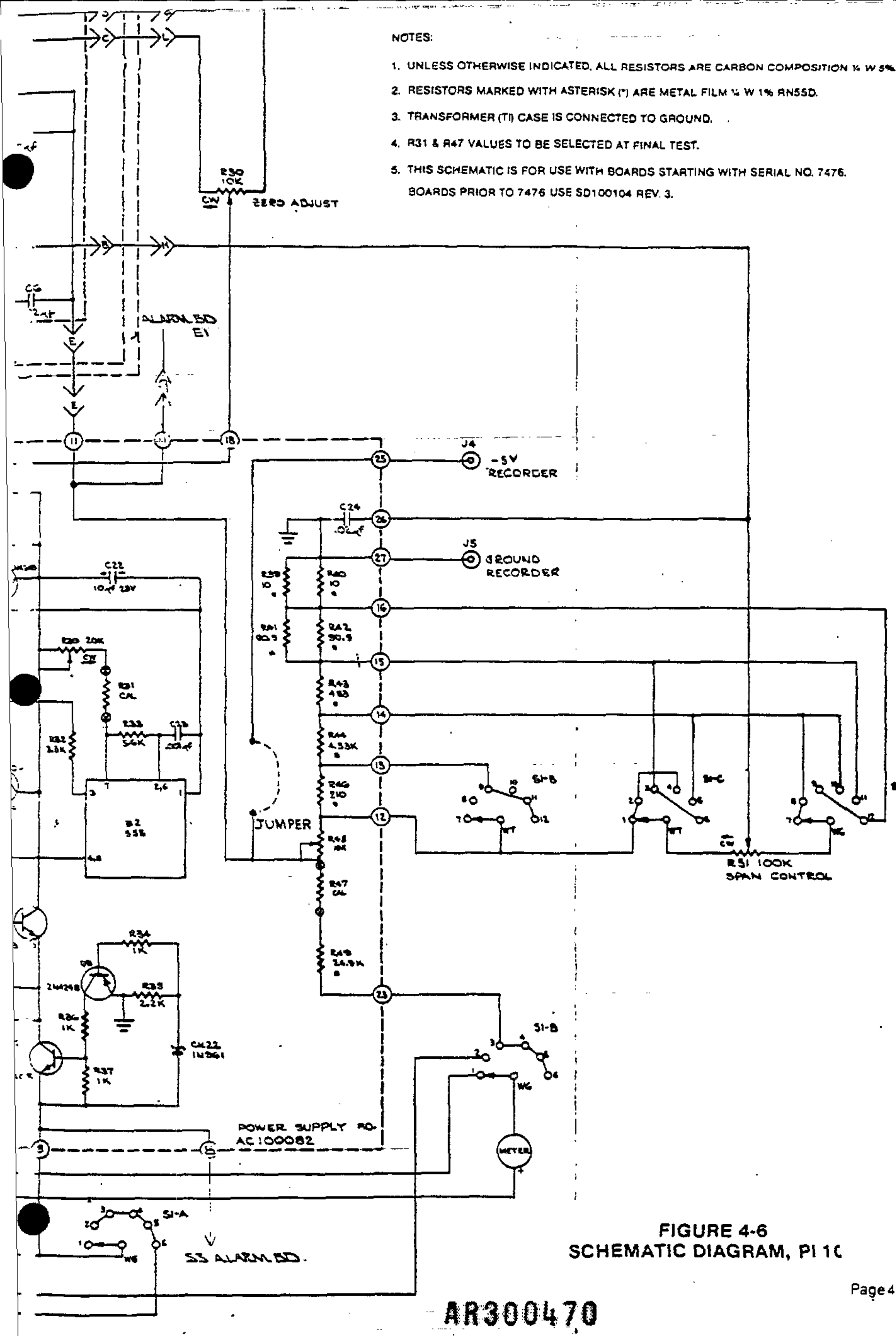


FIGURE 4-6
SCHEMATIC DIAGRAM, PI 1C

1) 9.5 and 10.2 eV lamps

   a) First clean by rubbing gently with lens tissue dipped in a detergent solution.

   b) If this does not remove deposit, apply a small amount of HNU cleaning compound (PAI01534) directly onto the lens of the lamp and spread evenly over surface with a non-abrasive tissue (e.g. Kim-Wipe) or a lens tissue.

   c) Wipe off compound with a new tissue.

   d) Rinse with warm water (about 80 degrees F) or damp tissue to remove all traces of grit or oils and any static charge that may have built up on the lens. Dry with new tissue.

   e) Reinstall lamp in detector and check analyzer operation.

   f) If performance is still not satisfactory replace the lamp. See Section 5.3 and Section 6.

2) 11.7 eV lamp

   a) Clean by putting a freon or chlorinated organic solvent on a tissue and rubbing gently.

   b) DO NOT CLEAN THIS LAMP WITH WATER OR ANY WATER MISCIBLE SOLVENTS (methanol or acetone). It will damage the lamp.

   c) DO NOT USE THE CLEANING COMPOUND used for the 9.5 and 10.2 eV lamps under any circumstances on the 11.7 eV lamp.

c. Then inspect the ion chamber for dust or particulate deposits. If such matter is present, the chamber can be cleaned by removing the outer Teflon ring, and the four screws holding the retaining ring. Carefully move the retaining ring aside (NOTE: this is soldered) and remove the screen. A tissue or cotton swab, dry or wetted with methanol, can be used to clean off any stubborn deposits. The assembly can also be gently swirled in methanol and dried gently at 50-60 degrees C for approximately a half hour. No liquid must be present at reassembly as this would affect the performance. Do not clean the ion chamber with the HNU cleaning compound cited above in para. b.1)b).

d. Reassemble the probe and check analyzer operation.

e. If performance is still not satisfactory replace the lamp. See Section 5.3.

5.4 LAMP SIZE CHANGE

If different applications for the analyzer would require different size lamps, separate probes, each with its own eV lamp, must be used. A single readout assembly will serve for any of the probes. A change in probe will require resetting of the zero control and the span pot. Calibration should be checked to verify proper operation.

5.5 PROBE DISASSEMBLY/ASSEMBLY

WARNING

Turn the function switch on the control panel to the off position before disassembly. Otherwise high voltage of 1200 V DC will be present.

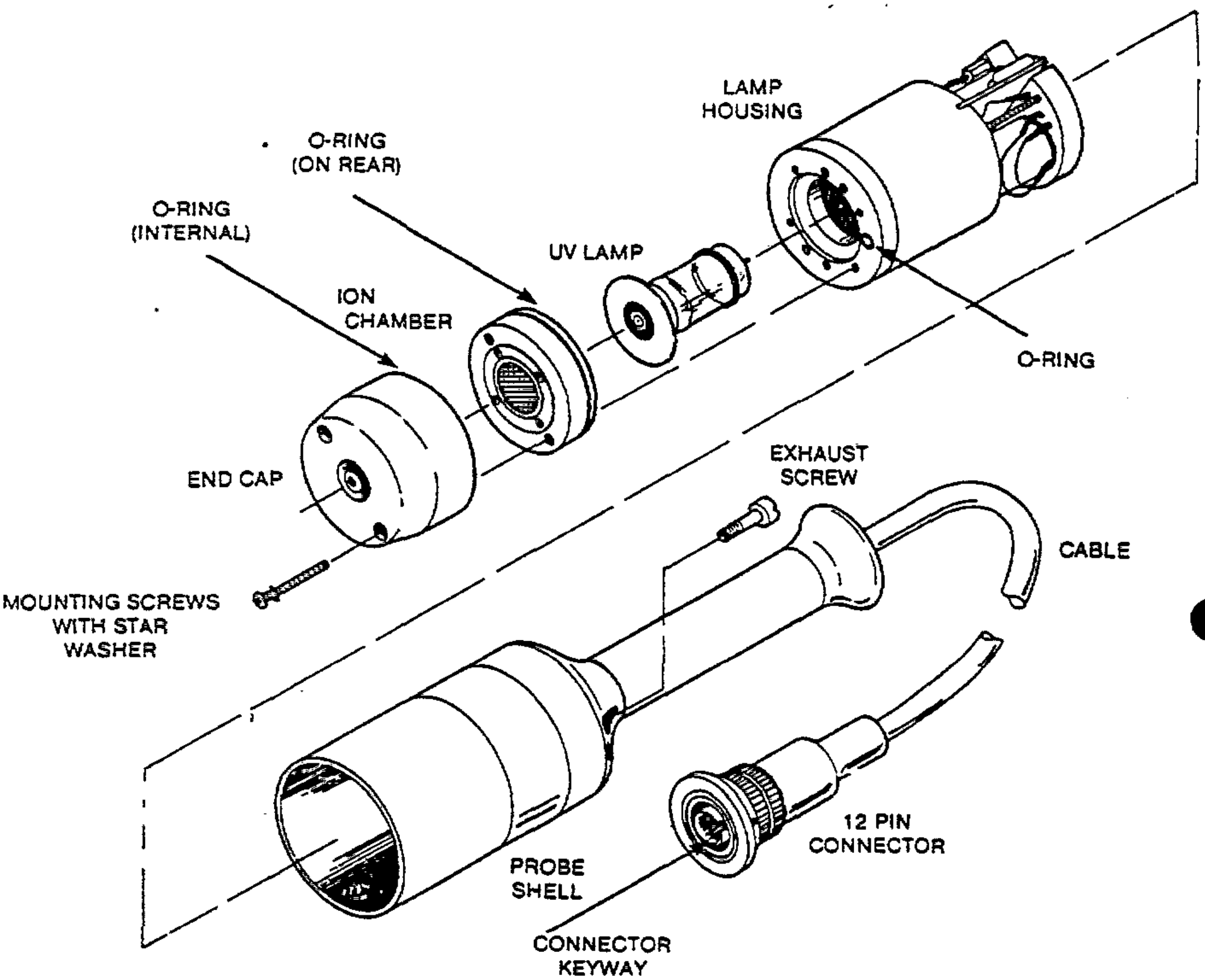


FIGURE 5-1
PROBE ASSEMBLY

CAUTION

Do not over-tighten these screws.

Line up the pins (pogo contacts) on the base of the lamp housing with the pins inside the probe shell. Gently slide the housing assembly into the probe shell.

The end cap should meet the probe shell evenly after final assembly. If not, the ion chamber may be installed wrong.

CAUTION

DO NOT FORCE the assembly into the shell.
It fits only one way.

If it does not reassemble readily, remove and check pin alignment. Check to ensure pogo contacts are not bent. Refasten the exhaust screw at the base of the probe.

Align the 12 pin probe connector to the readout assembly and reconnect with a twisting motion until a click occurs. Check to ensure the high voltage microswitch is properly depressed. The lamp should light if the function switch is turned to any position except STANDBY.

5.6 READOUT DISASSEMBLY/ASSEMBLY

WARNING

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise, high voltage of 1200 V DC will be present.

Disconnect the probe cable connection. Remove recorder jacks and cable or the plastic plug cap. Loosen the screw on the botton of the case and, holding the instrument by the bezel, remove the case (see Figure 5-3).

a. The control assembly consisting of the Printed Circuit Board (PCB) and control panel can be separated from the readout assembly by the following steps:

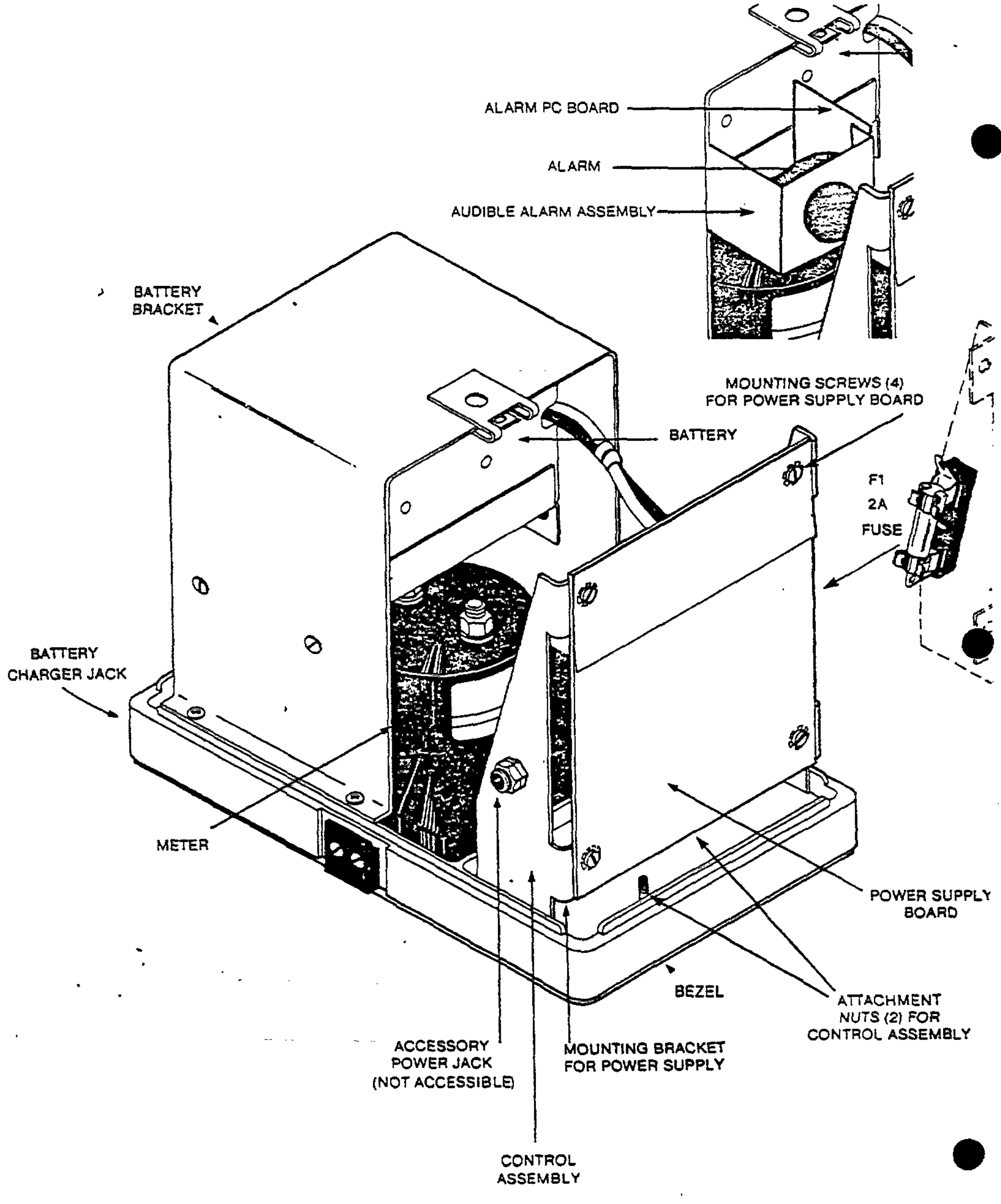


FIGURE 5-6
READOUT ASSEMBLY

TROUBLESHOOTING

.1 INTRODUCTION

The initial step of any troubleshooting is a thorough visual inspection to look for possible loose or open connections, shorts, dust or other obvious conditions.

Detailed troubleshooting for fault location and correction is accomplished by steps outlined in the following:

Troubleshooting Data	Table 6-1
Pad Data, Power Supply PCB	Table 6-2
Pad Location, Power Supply PCB	Figure 6-1
Pin Data, Amplifier PCB, P2/J2	Table 6-3
Pin Data, Probe Cable, P3/J3	Table 6-4
Pin Data, Alarm Cable, P6/J6	Table 6-5

Disassembly and reassembly as may be required for checking the equipment or replacing parts are described in Chapter 5.

WARNING

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise high voltage of 1200 V DC will be present.

WARNING

Do not observe the light source closer than 6 inches with unprotected eyes. When necessary, observe only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

WARNING

Use great care when operating the analyzer with the readout assembly outside its case due to the presence of 1200 V DC.

If, after following the steps cited in this section, the analyzer is not functioning properly, contact the HNU Service Dept. for assistance. (Phone: (617) 964-6690).

TABLE 6-1 cont.

	c. Lamp not making proper connection with high voltage contacts.	1) Remove lamp, clean and tighten contacts, reinstall lamp.
	d. Lamp faulty	1) Replace lamp.
	e. Short in high voltage lines	1) Check wiring from power supply board to probe cable connector (J3 pin D) to UV lamp contacts (D1). Remove any shorts.
4. Fan not running	a. Fan stuck	1) Disassemble probe and clean passages and fan by blowing out dust. To remove larger particles use cotton swab, Q-tip or equal. Use care to not damage impellor rotor or blades. For disassembly see Section 5.5.
	b. Fan connections faulty	1) Check for wiring connections at fan motor and at probe cable connector (J3 pins A and C). Repair as required.
	c. Low or dead battery	1) Check battery output (power supply board, pad 9). Recharge or replace battery as required.
	d. Fan voltage not correct	1) Check fan voltage (power supply board pads 19 and 21, probe cable pins A an C). If not correct, replace power supply board. 2) If fan voltages correct replace fan.
5. Meter does not respond	a. Dirty or open probe connection	1) Clean and tighten or resolder connections in probe.
	b. Broken meter	1) See 1-c-1 above.
	c. Dirty or open connections to meter	1) Clean and tighten connections at meter.
	d. Low or dead battery	1) See 4-c-1 above.
	e. Blown fuse	1) See 1-a

TABLE 6-1 cont.

8. Meter erratic, unstable or non-repeatable	a. Loose cable connection	1) Check cable connection at control panel. Observe meter. Tighten cable as required.
	b. Dirty or loose meter connections	1) Check meter connections. Clean and tighten as required.
	c. Contamination in ion chamber	1) Clean ion chamber. (see Section 5.2).
	d. Power supply board faulty	1) See 7-d-1 above.
	e. Unstable or noisy lamp	1) Observe lamp. (Important-see WARNING in Section 5.1). If operation not steady, replace lamp.
	f. Function switch in high gain, most sensitive position	1) Unstable meter operation is common with function switch in most sensitive position. Turn switch t less sensitive position if desirable.
	g. Fan not operating properly	1) Replace fan.
	h. Gas flow slow or stopped	1) See 4-a-1 above.
	i. Meter contacts dirty or loose	1) Clean and tighten contacts.
9. Drifting meter or apparent moisture sensitivity	a. Ion chamber contaminated	1) Clean ion chamber, (see Section 5.2).

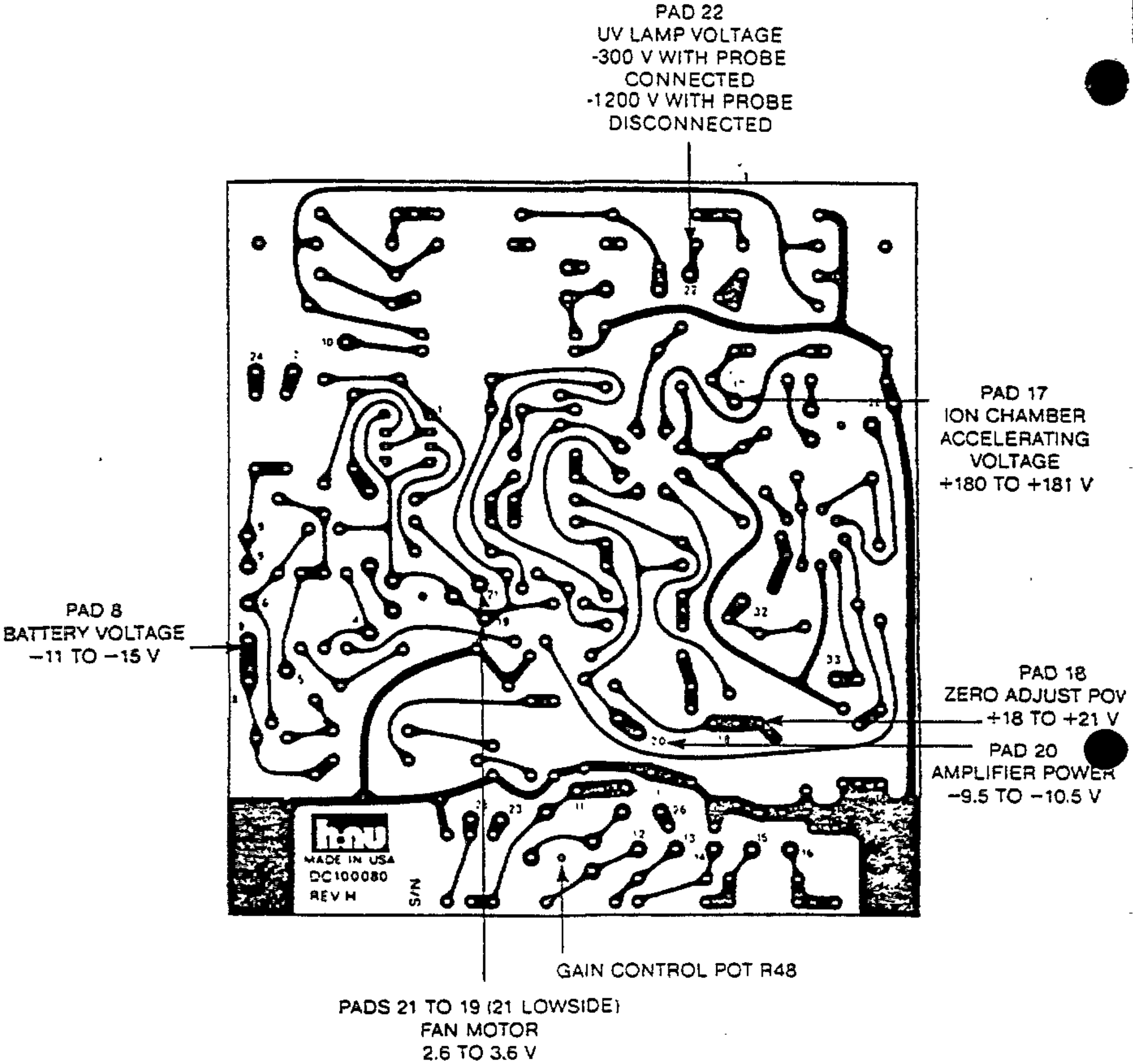


FIGURE 6-1
PAD LOCATION, POWER SUPPLY PCB

TABLE 6-4

PIN DATA, PROBE CABLE, P3/J3

Pin #	Signal Name	Voltage (V DC)
A	Fan Motor	-14.5 nominal (see NOTE)
B	Zero Adjust	varying
C	Fan Motor	-10.6 nominal (see NOTE)
D	UV Lamp	up to -1200 (see Section 4.0)
E	Amplifier Signal	0 to -5.0
F	Ground	0
H	Span Control Setting	varying
J	Ground	0
K	Zero adjust Voltage	+18 to +21
L	Zero Adjust	varying
M	Ion Chamber accelerating voltage	+180
N	Amplifier Power	-9.5 to -10.5

NOTE: Differential potential for fan motor between pads 19 and 21 will be between 2.6 and 3.6 V DC.

SECTION 7

PARTS LISTS

1 INTRODUCTION

This section lists and shows the location of all parts of the Photoionization Analyzer subject to repair and replacement. When ordering parts, specify model and serial numbers as well as part number. Return all defective warranty parts to HNU Systems Inc. Obtain a Return Materials Authorization Number (RMA#) from Service Department.

TABLE 7-2

REPLACEMENT PARTS LIST

MODEL PI-101
(See Fig. 7-2)
1 2 3 4 5 6 7 8 9 10 11

Part No.	Refer to Fig. No.	Assembly
25-680-402	1	Front Meter Glass
	2	
45-DA101316	3	Pot (span)
45-DA100029	4	Pot (zero)
79-AC100002	5	Power Supply Board
18-MDL-2	6	fuses, box of 12
79-AA100011	7	Battery
	8	
	9	
	10	
10-39-12	11	Grayhill switch

TABLE 7-4

PARTS LIST
ACCESSORIES
(No figure is provided for this list.)

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 and signal and mounting bracket for attaching recorder to side of analyzer.
101-301	Chart Paper For portable recorder, 6 rolls.
AB100278	Multiconductor Interface Cable For recorder, contains leads for connecting recorder to analyzer.)Included in part 101-300 above)
101-350	Calibration Gas Cylinder Contains 22 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 cylinder, Model 101-350, complete with gauges for reading both cylinder pressure and flow.
101-500	Cleaning Compound For removing deposits from window of 9.5 or 10.2 eV lamp (not the 11.7 eV lamp.)

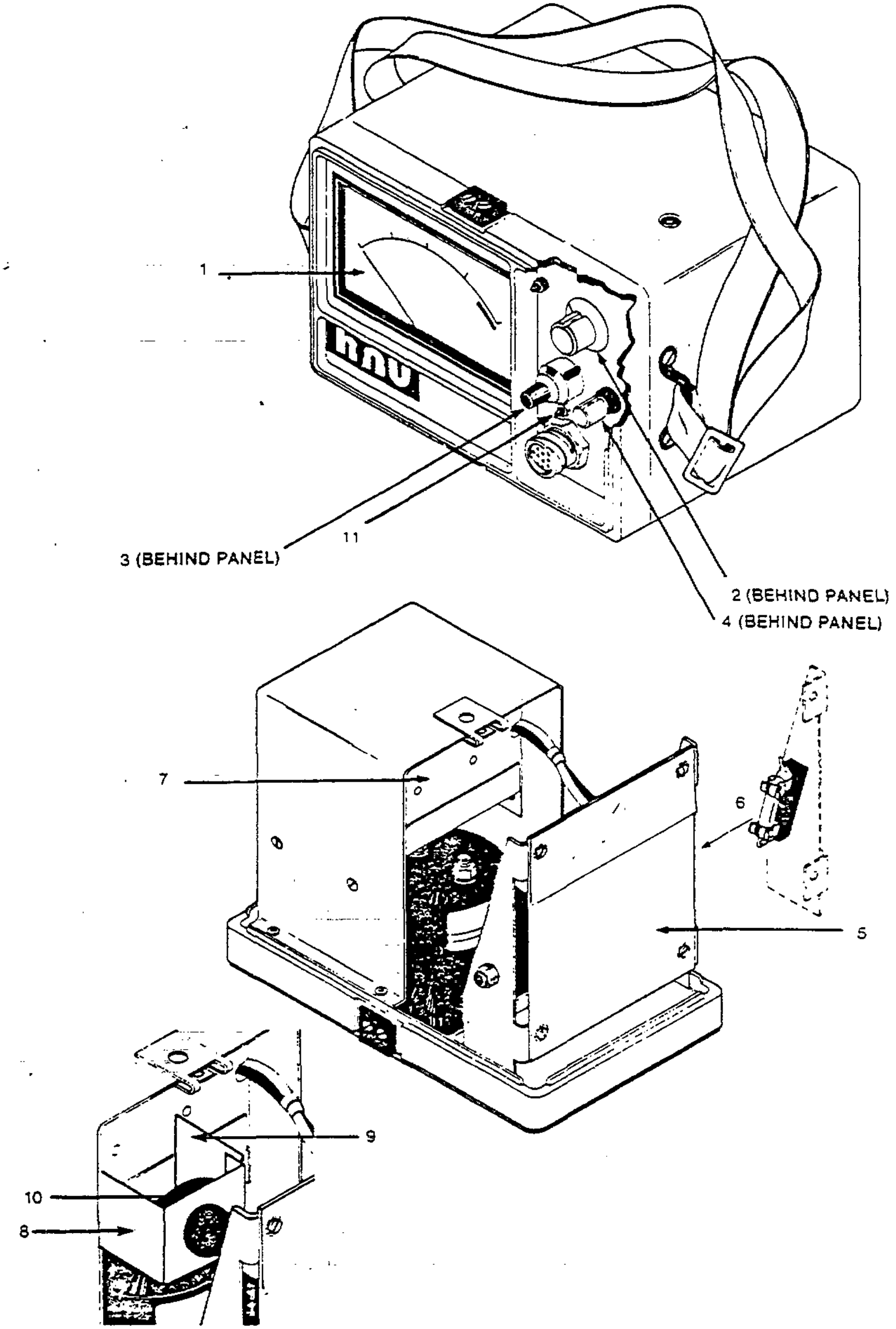


FIGURE 7-2
PARTS LOCATION. READOUT ASSEMBLY

SECTION 8

APPENDIX

This section contains the following additional information pertinent to the PI 101 Analyzer.

Section	Subject
8.1	Static Calibration
8.2	Calibration Checking with Isobutylene
8.3	Calibration with Alternate Gas
8.4	Uncalibrated Operation
8.5	Ionization Tables
8.6	Warranty
8.7	Publications List

g. Allow the analyzer to sample from the container. Compression of the container by hand may be necessary since the analyzer will not sample across a pressure drop. The analyzer flow is about 100 - 200 cc/min and small changes will not effect the reading. However, the flow should be constant.

h. Observe the readings during calibration to ensure that the gas is well mixed and there are no concentration gradients within the container. This will be evident by uniform meter readings.

i. Record the reading after about 10 seconds. The reading should be stable for up to 2 minutes since the flow rate is 100 to 200 cc/min. Large fluctuations in flow could effect the readings.

j. Adjust the SPAN control to set the analyzer to be direct reading at a concentration level near the range to be used.

k. Prepare 5 or 6 different concentrations of the calibration gas and plot the instrument readings versus concentration in ppm (v/v) to obtain a calibration curve. Clean the container between each point. For spot checking the calibration, two levels close to the measured concentration which agree to within 10% are acceptable. Concentrations lower than 100 ppm of a gas can be prepared by diluting a 100 or 200 ppm level with clean air. However, do not dilute a mixture by more than a factor of 10. A bias in the calibration curve could indicate preparation/container effects, such as "hang-up" on the walls of the container at high levels resulting in lower readings. At low levels, the compound may diffuse out or evaporate off the walls resulting in higher readings. Gentle heating should alleviate this condition.

8.2 CALIBRATION CHECKING WITH ISOBUTYLENE

The calibration of the analyzer can be rapidly checked by the use of an HNU small disposable cylinder containing isobutylene (HNU pn 101-350) with a regulator (HNU pn 101-351).

At the factory, the analyzer is first calibrated on the desired gas standard at the specified concentration. Then a measurement is made with isobutylene.

The ppm reading along with the span setting using isobutylene is recorded in the calibration report.

In service, the analyzer calibration can be checked and readjusted if necessary by using this cylinder and regulator as follows:

a. Connect the analyzer to the regulator and cylinder with a short piece (butt connection) of tubing as shown in Figure 8-1. The calibration gas in the cylinder consists of a mixture of isobutylene and zero air. Isobutylene is nontoxic and safe to use in confined areas. There are no listed exposure levels at any concentration.
The regulator sets and controls the flow rate of gas at a value preset at the factory. This will be about 100 to 300 cc/min.
It is important that the tubing be clean since contaminated tubing will effect the calibration reading.
Do not use the cylinder below about 30 psig as readings below that level can deviate up to 10% from the rated value.
Safely discard the disposable cylinder when empty.
Do not refill this cylinder.
It is against the law to transport refilled cylinders.

b. With the SPAN setting and the function switch at the same positions as listed in the Application Data Sheet or Calibration Report, open the valve on the cylinder until a steady reading is obtained.

c. If the reading is the same as the recorded data, the analyzer calibration for the original species of interest is still correct.

d. If the reading has changed, adjust the SPAN setting until the reading is the same.

e. Shut off the cylinder as soon as the reading is established.

f. Record and maintain this new SPAN setting. Then recalibrate the analyzer on the species of interest as soon as possible.

g. Whenever the analyzer is recalibrated, it is to be immediately checked with the small cylinder and the reading recorded. This can then be used for later checking in the field.

8.3 CALIBRATION WITH ALTERNATE GAS

If a calibration standard with the same trace gas as that to be measured is not available or is hazardous, it is possible to use an alternate calibration gas. In this case, the expected reading for calibration must be compensated for the difference between the two gases. In operation, the meter will then give a direct reading of the gas being measured.

This calibration is illustrated in the following examples: (PS = Photoionization Sensitivity. See Table 8-14)

a. Given a case in which:

1) The trace gas to be measured is Vinyl Chloride (PS = 5.0)

2) The calibration gas to be used is Isobutylene (PS = 7.0) at a 100 ppm level

What is the ppm reading to be when calibrating to give a direct reading when measuring Vinyl Chloride?

The required reading for calibration will be:

$$= \text{Isobutylene ppm} \times \frac{\text{PS(Isob)}}{\text{PS(Vin Chlor)}}$$

$$= 100 \times \frac{7.0}{5.0}$$

$$= 140 \text{ ppm}$$

In this example, using a calibration gas with 100 ppm of Isobutylene, adjust the SPAN control so the meter reads 140 ppm. In operation, the instrument will then give a direct reading of the ppm of Vinyl Chloride.

b. Given a case in which:

1) The trace gas to be measured in Benzene (PS = 10.0)

2) The calibration gas to be used is Isobutylene (PS = 7.0) at a level of 100 ppm

3) What is the ppm reading to be when calibrating to give a direct reading when measuring Benzene.

8.4 UNCALIBRATED OPERATION

Best operation of the analyzer is accomplished by its calibration for the gas to be measured. In cases where it becomes necessary to operate with a gas for which it has not been calibrated and recalibration is not possible, correction can be made to the meter reading.

One method is by use of a chart. Figure 8-2 is such a chart. It shows performance curves for various gases being measured by an instrument with a 10.2 eV lamp and calibrated for benzene. This illustrates the effect of the different sensitivities of gases. These curves can be used directly for correcting a meter reading if the instrument is calibrated for benzene and is measuring one of the gases shown. For example, if the gas being measured is Propylene and the reading is 3 ppm, then the actual concentration is about 20 ppm.

A second method is to multiply the meter reading by a correction factor as follows:

$$\text{Actual ppm} = \text{ppm reading} \times \frac{\text{PS (Cal gas)}}{\text{PS (Trace gas)}}$$

in which

PS is the photoionization sensitivity of each of the two gases. Table 8-14 gives a list of the relative photoionization sensitivities of a number of specific gases with which the analyzer might be used. Use of this method is illustrated by the following examples:

a. Instrument calibrated for Benzene (PS = 10.0) and measuring Acetone (PS = 6.3)

$$\text{Actual ppm} = \text{ppm reading} \times \frac{10.0}{6.3}$$

$$= \text{ppm reading} \times 1.6$$

b. Instrument calibrated for Vinyl Chloride (PS = 5.0) and measuring Carbon Disulfide (PS = 7.1)

$$\text{Actual ppm} = \text{ppm reading} \times \frac{5.0}{7.1}$$

$$= \text{ppm reading} \times 0.7$$

These values are valid only for an analyzer with a 10.2 eV lamp. Different sensitivities occur with 9.5 and 11.7 eV lamps.

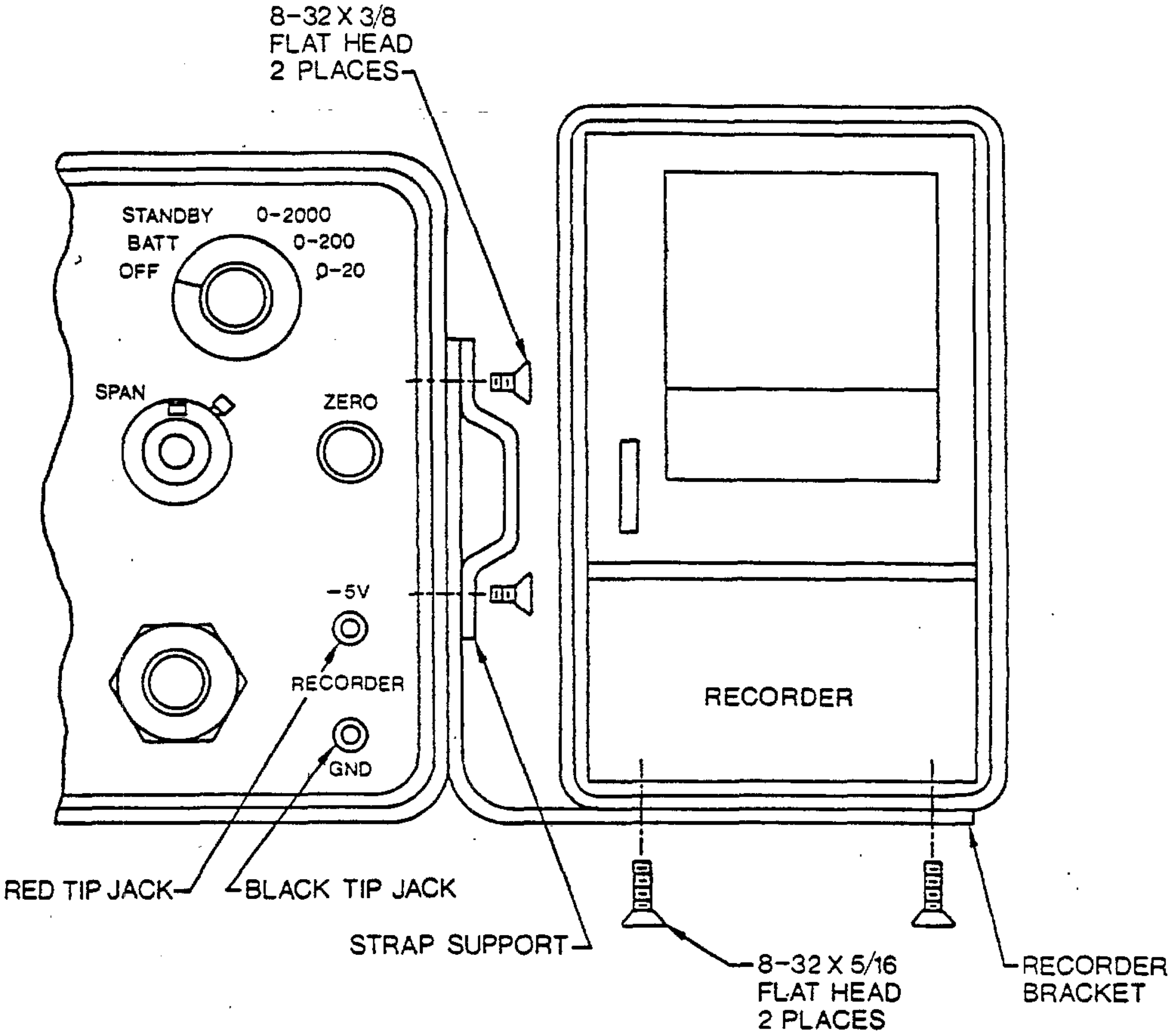


FIGURE 8-3
RECORDER MOUNTING

TABLE 8.1

SOME ATOMS AND SIMPLE MOLECULES

	IP (eV)		IP (eV)
H	13.595	I_2	9.28
C	11.264	HF	15.77
N	14.54	HCl	12.74
O	13.614	HBr	11.62
Si	8.149	HI	10.38
S	10.357	SO_2	12.34
F	17.42	CO_2	13.79
Cl	13.01	COS	11.18
Br	11.84	CS_2	10.08
I	10.48	N_2O	12.90
H_2	15.426	NO_2	9.78
N_2	15.580	O_3	12.80
O_2	12.075	H_2O	12.59
CO	14.01	H_2S	10.46
CN	15.13	H_2Se	9.88
NO	9.25	H_2Te	9.14
CH	11.1	HCN	13.91
OH	13.18	C_2N_2	13.8
F_2	15.7	NH_3	10.15
Cl_2	11.48	CH_3	9.840
Br_2	10.55	CH_4	12.98

TABLE 8.2

PARAFFINS AND CYCLOPARAFFINS

Molecule	IP (eV)
methane	12.98
ethane	11.65
propane	11.07
n-butane	10.63
i-butane	10.57
n-pentane	10.35
i-pentane	10.32
2, 2-dimethylpropane	10.35
n-hexane	10.18
2-methylpentane	10.12
3-methylpentane	10.08
2, 2-dimethylbutane	10.06
2, 3-dimethylbutane	10.02
n-heptane	10.08
2,2,4-trimethylpentane	9.86
cyclopropane	10.06
cyclopentane	10.53
cyclohexane	9.88
methylcyclohexane	9.85

TABLE 8.3 (continued)

Molecule	IP (eV)
CF_2Br_2	11.07
CH_3CF_2Cl (Genetron 101)	11.98
$CFCl_2CF_2Cl$	11.99
CF_3CCl_3 (Freon 113)	11.78
$CFHBrCH_2Br$	10.75
CF_2BrCH_2Br	10.83
CF_3CH_2I	10.00
n-C_3F_7I	10.36
n-$C_3F_7CH_2Cl$	11.84
n-$C_3F_7CH_2I$	9.96

TABLE 8.4

ALIPHATIC ALCOHOL, ETHER, THIOL, AND SULFIDES

Molecule	IP (eV)
H_2O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
H_2S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

TABLE 8.7

ALIPHATIC AMINES AND AMIDES

Molecule	IP (eV)
NH_3	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-propyl amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

TABLE 8.8

OTHER ALIPHATIC MOLECULES WITH N ATO

Molecule	IP (eV)
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

TABLE 8.11

HETEROCYCLIC MOLECULES

Molecule	IP (eV)
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2.3-lutidine	8.85
2.4-lutidine	8.85
2.6-lutidine	8.85

TABLE 8.12

AROMATIC COMPOUNDS

Molecule	IP (eV)
benzene	9.245
toluene	8.82
ethyl benzene	3.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
α-methyl styrene	8.35
ethynylbenzene	8.815
napthalene	8.12
1-methylnapthalene	7.69
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

TABLE 8-14

RELATIVE PHOTOIONIZATION SENSITIVITIES OF VARIOUS GASES TO A 10.2 eV LAMP

Gas	Photoionization Sensitivity (see Note 1)	Span Control Setting for Direct reading (approximate)
p-xylene	11.4	
m-xylene	11.2	
benzene	10.0 (reference standard)	9.8
toluene	10.0	
diethyl sulfide	10.0	
diethyl amine	9.9	
styrene	9.7	
trichloroethylene	8.9	8.2
carbon disulfide	7.1	
isobutylene	7.0	
acetone	6.3	
tetrahydrofuran	6.0	5.5
methyl ethyl ketone	5.7	
methyl isobutyl ketone	5.7	
cyclohexanone	5.1	
naptha (85% aromatics)	5.0	
vinyl chloride	5.0	4.3
methyl isocyanate	4.5	
iodine	4.5	
methyl mercaptan	4.3	

TABLE 8-14 cont.

epichlorohydrin	0.7
nitric oxide	0.6
beta pinene	0.5
citral	0.5
ammonia	0.3
acetic acid	0.1
nitrogen dioxide	0.02
methane	0.0
acetylene	0.0

NOTE 1: PPM reading when measuring 10.0 ppm of particular gas with monitor calibrated for benzene.

SECTION 8 cont.

8.7 WARRANTY

HNU Systems, Incorporated, warrants all items to 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.

APPENDIX IV

LEVELS OF PROTECTION

LEVELS OF PROTECTION

Personnel must wear protective equipment when response activities involve known or suspected atmospheric contamination, when vapors, gases, or particulates may be generated by site activities, or when direct contact with skin-affecting substances may occur. Full face-piece respirators protect lungs, gastrointestinal tract, and eyes against airborne toxicants. Chemical-resistant clothing protects the skin from contact with skin-destructive and absorbable chemicals. Good personal hygiene limits or prevents ingestion of material.

Equipment to protect the body against contact with known or anticipated toxic chemicals has been divided into four categories according to the degree of protection afforded:

- Level A: Should be worn when the highest level of respiratory, skin, and eye protection is needed.
- Level B: Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection.
- Level C: Should be worn when the criteria for using air-purifying respirators are met.
- Level D: Should be worn only as a work uniform and not on any site with respiratory or skin hazards. It provides no protection against chemical hazards.

The Level of Protection selected should be based on:

- Type and measured concentration of the chemical substance in the ambient atmosphere and its toxicity.
- Potential for exposure to substances in air, splashes of liquids, or other direct contact with material due to work being done.

In situations where the type of chemical, concentration, and possibilities of contact are not known, the appropriate Level of Protection must be selected based on professional experience and judgment until the hazards can be better identified.

While personnel protective equipment reduces the potential for contact with toxic substances, ensuring the health and safety of responders requires, in addition, safe work practices, decontamination, site entry protocols, and other safety procedures. Together, these provide an integrated approach for reducing harm to workers.

II. LEVELS OF PROTECTION

A. Level A Protection

1. Personnel protective equipment

   - Supplied-air respirator approved by the Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH).
     Respirators may be:

     -- pressure-demand, self-contained breathing apparatus (SCBA)

     or

     -- pressure-demand, airline respirator (with escape bottle for Immediately Dangerous to Life and Health (IDLH) or potential for IDLH atmosphere)

   - Fully encapsulating chemical-resistant suit
   - Coveralls*
   - Long cotton underwear*
   - Gloves (inner), chemical-resistant
   - Boots, chemical-resistant, steel toe and shank. (Depending on suit construction, worn over or under suit boot)
   - Hard hat* (under suit)
   - Disposable gloves and boot covers* (Worn over fully encapsulating suit)
   - Cooling unit*
   - 2-Way radio communications* (inherently safe)

2. Criteria for selection

   Meeting any of these criteria warrants use of Level A Protection:

   - The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on:

     -- measured (or potential for) high concentration of

*Optional

from extremely high air concentrations, splashes, or immersion of boots or gloves in concentrated liquids or sludges. These limitations should be recognized when specifying the type of fully encapsulating suit. Whenever possible, the suit material should be matched with the substance it is used to protect against.

B. Level B Protection

1. Personnel protective equipment

- Supplied-air respirator (MSHA/NIOSH approved). Respirators may be:
  - -- pressure-demand, self-contained breathing apparatus

    or

  - -- pressure-demand, airline respirator (with escape bottle for IDLH or potential for IDLH atmosphere)
- Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one or two-piece chemical-splash suit; disposable chemical-resistant, one-piece suits)
- Long cotton underwear*
- Coveralls*
- Gloves (outer), chemical-resistant
- Gloves (inner), chemical-resistant
- Boots (outer), chemical-resistant, steel toe and shank
- Boot covers (outer), chemical-resistant (disposable)*
- Hard hat (face shield)*
- 2-Way radio communications* (intrinsically safe)

2. Criteria for selection

Meeting any one of these criteria warrants use of Level B protection:

- The type and atmospheric concentration of toxic substances has been identified and requires a high level of respiratory protection, but less skin protection than Level A. These would be atmospheres:

*Optional

-- with concentrations Immediately Dangerous to Life and Health, but substance or concentration in the air does not represent a severe skin hazard

or

-- that do not meet the selection criteria permitting the use of air-purifying respirators.

- The atmosphere contains less than 19.5% oxygen.

- It is highly unlikely that the work being done will generate high concentrations of vapors, gases or particulates, or splashes of material that will affect the skin of personnel wearing Level B protection.

- Atmospheric concentrations of unidentified vapors or gases are indicated by direct readings on instruments such as the FID or PID or similar instruments, but vapors and gases are not suspected of containing high levels of chemicals toxic to skin. (See Appendixes I and II.)

3. Guidance on selection

   a. Level B does not afford the maximum skin (and eye) protection as does a fully encapsulating suit since the chemical-resistant clothing is not considered gas, vapor, or particulate tight. However, a good quality, hooded, chemical-resistant, one-piece garment, with taped wrist, ankles, and hood does provides a reasonable degree of protection against splashes and to lower concentrations in air. At most abandoned hazardous waste sites, ambient atmospheric gas or vapor levels have not approached concentrations sufficiently high to warrant Level A protection. In all but a few circumstances (where highly toxic materials are suspected) Level B should provide the protection needed for initial entry. Subsequent operations at a site require a reevaluation of Level B protection based on the probability of being splashed by chemicals, their effect on the skin, the presence of hard-to-detect air contaiminants, or the generation of highly toxic gases, vapors, or particulates, due to the work being done.

   b. The chemical-resistant clothing required in Level B is available in a wide variety of styles, materials, construction detail, and permeability. One or two-piece garments are available with or without hoods. Disposal suits with a variety of fabrics and design characteristics are also available. Taping joints between the gloves, boots an suit, and between hood and respirator reduces the pos siblity for splash and vapor or gas penetration. Thes atmospheric vapors, gases, or particulates

or

-- site operations and work functions involves high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials highly toxic to the skin.

- Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible.

- Operations must be conducted in confined, poorly ventilated areas until the absence of substances requiring Level A protection is determined.

- Direct readings on field Flame Ionization Dectors (FID) or Photoionization Detectors (PID) and similar instruments indicate high levels of unidentified vapors and gases in the air. (See Appendixes I and II.)

3. Guidance on selection

   a. Fully encapsulating suits are primarily designed to provide a gas or vapor tight barrier between the wearer and atmospheric contaminants. Therefore Level A is generally worn when high concentrations of airborne substances are known or thought to be present and these substances could severely effect the skin. Since Level A requires the use of a self-contained breathing apparatus, the eyes and respiratory system are also more protected.

   Until air surveillance data are available to assist in the selection of the appropriate Level of Protection, the use of Level A may have to be based on indirect evidence of the potential for atmospheric contamination or other means of skin contact with severe skin affecting substances.

   Conditions that may require Level A protection include:

- Confined spaces: Enclosed, confined, or poorly ventilated areas are conducive to build up of toxic vapors, gases, or particulates. (Explosive or oxygen-deficient atmospheres also are more probable in confined spaces.) Confined space entry does not automatically warrant wearing Level A protection, but should serve as a cue to carefully consider and to justify a lower Level of Protection.

- Suspected/known highly toxic substances: Various substances that are highly toxic especially through skin absorption for example, fuming corrosives, cyanide compounds, concentrated pesticides, Department of Transportation Poison "A" materials, suspected carcinogens, and infectious substances may be known or suspected to be involved. Field instruments may not be available to detect or quantify air concentrations of these materials. Until these substances are identified and concentrations measured, maximum protection may be necessary.

- Visible emissions: Visible air emissions from leaking containers or railroad/vehicular tank cars, as well as smoke from chemical fires and others, indicate high potential for concentrations of substances that could be extreme respiratory or skin hazards.

- Job functions: Initial site entries are generally walk-throughs in which instruments and visual observations are used to make a preliminary evaluation of the hazards. In initial site entries, Level A should be worn when:

  -- there is a probability for exposure to high concentrations of vapors, gases, or particulates.

  -- substances are known or suspected of being extremely toxic directly to the skin or by being absorbed.

Subsequent entries are to conduct the many activities needed to reduce the environmental impact of the incident. Levels of Protection for later operations are based not only on data obtained from the initial and subsequent environmental monitoring, but also on the probability of contamination and ease of decontamination.

Examples of situations where Level A has been worn are:

- Excavating of soil to sample buried drums suspected of containing high concentrations of dioxin.

- Entering a cloud of chlorine to repair a value broken in a railroad accident.

- Handling and moving drums known to contain oleum.

- Responding to accidents involving cyanide, arsenic, and undiluted pesticides.

b. The fully encapsulating suit provides the highest degree of protection to skin, eyes, and respiratory system if the suit material resists chemicals during the time the suit is worn. While Level A provides maximum protection, all suit material may be rapidly permeated and degraded by certain chemicals

- Gloves (inner), chemical-resistant*
- Boots (outer), chemical-resistant, steel toe and shank
- Boot covers (outer), chemical-resistant (disposable)*
- Hard hat (face shield*)
- Escape mask*
- 2-Way radio communications* (inherently safe)

2. Criteria for selection

   Meeting all of these criteria permits use of Level C protection:

   - Oxygen concentrations are not less than 19.5% by volume.
   - Measured air concentrations of identified substances will be reduced by the respirator below the substance's threshold limit value (TLV) and the concentration is within the service limit of the canister.
   - Atmospheric contaminant concentrations do not exceed IDLH levels.
   - Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any body area left unprotected by chemical-resistant clothing.
   - Job functions do not require self-contained breathing apparatus.
   - Direct readings are a few ppms above background on instruments such as the FID or PID. (See Appendices I and II.)

3. Guidance on selection

   a. Level C protection is distinguished from Level B by the equipment used to protect the respiratory system, assuming the same type of chemical-resistant clothing is used. The main selection criterion for Level C is that conditions permit wearing air-purifying respirators.

      The air-purifying device must be a full-face respirator (MSHA/NIOSH approved) equipped with a canister suspended from the chin or on a harness. Canisters must be able to

---

*Optional

factors and other selection criteria all affect the degree of protection afforded. Therefore, a specialist should select the most effective chemical-resistant clothing based on the known or anticipated hazards and job function.

Level B equipment does provides a high level of protection to the respiratory tract. Generally, if a self-contained breathing apparatus is required for respiratory protection, selecting chemical-resistant clothing (Level B) rather than a fully encapsulating suit (Level A) is based on needing less protection against known or anticipated substances affecting the skin. Level B skin protection is selected by:

- Comparing the concentrations of known or identified substances in air with skin toxicity data.

- Determining the presence of substances that are destructive to or readily absorbed through the skin by liquid splashes, unexpected high levels of gases, vapor, or particulates, or other means of direct contact.

- Assessing the effect of the substance (at its measured air concentrations or potential for splashing) on the small areas left unprotected by chemical-resistant clothing. A hooded garment taped to the mask, and boots and gloves taped to the suit further reduces area of exposure.

c. For initial site entry and reconnaissance at an open site, approaching whenever possible from upwind, Level B protection (with good quality, hooded, chemical-resistant clothing) should protect response personnel, providing the conditions described in selecting Level A are known or judged to be absent.

C. Level C Protection

1. Personnel protective equipment

   - Air-purifying respirator, full-face, canister-equipped (MSHA/NIOSH approved)

   - Chemical-resistant clothing (coveralls; hooded, one-piece or two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls)

   - Coveralls*

   - Long cotton underwear*

   - Gloves (outer), chemical-resistant

remove the substances encountered. Quarter-or half-masks or cheekcartridge, full-face masks should be used only with the approval of a qualified individual.

In addition, a full-face, air-purifying mask can be used only if:

- Substance has adequate warning properties.
- Individual passes a qualitative fit-test for the mask.
- Appropriate cartridge/canister is used, and its service limit concentration is not exceeded.

b. An air surveillance program is part of all response operations when atmospheric contamination is known or suspected. It is particularly important that the air be thoroughly monitored when personnel are wearing air-purifying respirators. Periodic surveillance using direct-reading instruments and air sampling is needed to detect any changes in air quality necessitating a higher level of respiratory protection.

c. Level C protection with a full-face, air-purifying respirator should be worn routinely in an atmosphere only after the type of air contaminant is identified, concentrations measured and the criteria for wearing air-purifying respirator met. To permit flexibility in precribing a Level of Protection at certain environmental incidents, a specialist could consider using air-purifying respirators in unidentified vapor/gas concentrations of a few parts per million above background as indicated by a needle deflection on the FID or PID. However a needle deflection of a few parts per million above background should not be the sole criterion for selecting Level C. Since the individual components may never be completely identified, a decision on continuous wearing of Level C must be made after assessing all safety considerations, including:

- The presence of (or potential for) organic or inorganic vapors/gases against which a canister is ineffective or has a short service life.
- The known (or suspected) presence in air of substances with low TLVs or IDLH levels.
- The presence of particulates in air.
- The errors associated with both the instruments and monitoring procedures used.

*Optional

- The presence of (or potential for) substances in air which do not elicit a response on the instrument used.

- The potential for higher concentrations in the ambient atmosphere or in the air adjacent to specific site operations.

d. The continuous use of air-purifying respirators (Level C) must be based on the identification of the substances contributing to the total vapor or gas concentration and the application of published criteria for the routine use of air-purifying devices. Unidentified ambient concentrations of organic vapors or gases in air approaching or exceeding a few ppm above background require, as a minimum, Level B protection.

D. Level D Protection

1. Personnel protective equipment

   - Coveralls
   - Gloves*
   - Boots/shoes, leather or chemical-resistant, steel toe and shank
   - Safety glasses or chemical splash goggles*
   - Hard hat (face shield)*

2. Criteria for selection

   Meeting any of these criteria allows use of Level D protection:

   - No contaminants are present.
   - Work functions preclude splashes, immersion, or potential for unexpected inhalation of any chemicals.

   Level D protection is primarily a work uniform. It can be worn only in areas where there is no possibility of contact with contamination.

APPENDIX C
DATA MANAGEMENT PLAN

1.0 INTRODUCTION

This Data Management Plan presents a proposed program and method for managing data acquired during the implementation of the scope of work included in this work plan for the Saunders Supply, Inc. Chuckatuck, Virginia site. The work plan describes the activities required to perform a remedial investigation and feasibility study in order to select appropriate measures to remediate environmental concerns of the site. In the context of this plan, data are defined as 1) technical or analytical information that are either generated by, or the result of specific tasks, and 2) information that must be tracked in order to monitor, manage, and document the actual performance of tasks.

This plan will also provide a mechanism for tracking, retaining, and retrieving data in a manner which will not compromise its integrity. All analytical data will be evaluated for Quality Control (QC) and completeness by Keystone Environmental Resources in accordance with procedures described in the Quality Assurance Plan (QAP).

2.0 DATA TYPES

Information associated with the implementation of the workplan will be identified as either technical or management data and will require certain procedures regarding documentation. The properly conducted; that data reduction, validation, and reporting techniques are controlled; and that data collected are representative of the setting and that proper sampling techniques are implemented.

Technical data will be generated in the field and at the analytical laboratory. Documentation will consist of project/field log books, boring logs, geophysical logs, sample tags, sample data sheets and logs, chain of custody records and seals, receipt of sample forms, laboratory log books and data sheets, calculations, and graphs. Management data will be generated in the field and at the Keystone's Office. Documents related to this category will be management plans, task reports, and technical progress reports.

3.0 DATA MANAGEMENT

Documentation procedures are discussed in the QAP and in the following sections. Because the work plan is subject to modifications, the methods and procedures designed prior to field and analytical laboratory activities may be amended. This section presents the fundamental elements of data management required for the work plan.

3.1 Scheduling

Upon approval of the work plan a number of activities will commence, some in sequence and others concurrently. In order that the documentation of these activities progresses with minimal delay or problems, pre-data collection operations need to be identified and scheduled. These operations include identification of sample types and quantities (including blanks and duplicates); location of sampling points; methods of sample collection; ranking of samples for particular analyses (priority); coordination of sampling with analytical laboratory to include obtaining sample containers, packing material, preservatives, and shipping containers; and preprocessing of sample labels and chain of custody forms. Also, sample numbers should be assigned to the samples prior to collection of the samples. These sample numbers will then put into the computerized management system.

3.2 Field Data Recording

Field measurements and observations will be recorded in project log books, boring logs, field data records, or other suitable recordkeeping books are required. Data will be recorded directly and legibly in field log books with all entries singed and dated. If entries must be changed, the change should not obscure the original entry. The reason for the change will be stated, along with a signature and date of the change. Field data records will be organized into standard formats and retained in files at Keystone's office.

3.3 Sample Identification and Chain of Custody

Field samples will be identified by a sample tag or other appropriate labeling technique. The information on the sample tag will include: the sampling location, the sample number, the date and time the sample was collected, type of analyses, types of preservatives (if any), and any instruction or pertinent remarks.

In order for the sample to be processed within the stated QA/QC guidelines and to maintain sample integrity, sample possession must be traceable from the time the sample is collected. Chain of custody procedures will provide the method of tracking samples and minimize any subsequent tampering of the sample while it is in transit from the site to the analytical laboratory. These procedures will address custody procedures. One copy of the chain of custody form will be placed in the site file and eventually the permanent project file. The second copy will accompany the samples during transportation to the sample carrier and ultimately, the laboratory.

3.4 Data Management System

The data management system will be designated to store, process, and analyze special data. This involves:

1. Data collection, transformation, storage and organization.
2. Editing and updating of data files.
3. Manipulation, analysis, and retrieval of entire files or selected portions of one or several files.
4. Generation of a variety of outputs, including displays and statistical reports.
5. Considerations of data back-up and system security.

As the samples are received by the analytical laboratory the computerized database will be updated to include the date of sample collection and shipment for each discrete sample. Following laboratory analysis the raw data will be forwarded to Keystone for evaluation and validation. Raw data may be in the form of computerized data or hard copies. Computerized data will be checked by the

Project Manager and/or assigned individuals. Validation of data entered into the system manually will include.

1. Input of data to the system.
2. Checking and editing of input.
3. Independent check of a representative number of entries (10%) by a second individual who did not participate in the original entry.
4. Edit and reenter any inaccurately transcribed data sets.
5. Check reasonableness of the database by the Project Manager.
6. Database is determined complete and ready for analysis.

In addition to storage of the data in the database, all hard copy documentation including logbooks, chain of custody forms, analytical data, etc., are to be retained in a locked limited access file cabinet.

3.5 Data Manipulation

Information in the data base will be manipulated to compute characteristics such as the following:

- Water surface elevations
- Coordinate conversions
- Sorted compilations of well information
- Groundwater surface contours
- Analytical results displayed in various forms

3.6 Data Presentation

Information from the data base will be displayed in tabular form. Selected information or groupings of information can be structured and presented in various forms if desired. Graphs, contour maps, strata profiles, etc., will be utilized as needed to portray data in an informative display format.

APPENDIX D
COMMUNITY RELATIONS PLAN

1.0 COMMUNITY RELATIONS PLAN

It is assumed that the U.S. EPA will take the lead in the community relations role at the Saunders Supply site. Saunders Supply and its contractor, Keystone Environmental Resources, will provide assistance to the U.S. EPA upon request. Such assistance might consist of providing selected individuals to speak at meetings and preparing public meeting materials, project updates, technical summaries, and public notices. Examples of these activities are provided below:

- Public Meeting Materials - Assist in preparing slide shows, graphics, and presentation materials for the public meetings.
- Project Updates - Provide assistance in preparing project updates for distribution by the U.S. EPA to the general public.
- Technical Summaries - Prepare brief technical summaries. These will be distributed to the general public.
- Public Notices - Prepare public notices and small display ads to announce each public meeting.

No activities will be started without specific instructions from the U.S. EPA.

If determined to be necessary, Keystone Environmental Resources will provide assistance to the agency including personnel experienced in public relations activities to prepare a site specific community relations plan. Additionally, recognizing the long term involvement of representations of Saunders Supply in the local community, the agency may seek their assistance in formulating a site specific community relations plan.

APPENDIX E

COMPUTATION OF TOXIC EQUIVALENT FACTORS FOR DIOXINS AND FURAN ISOMERS

COMPUTATION OF TOXIC EQUIVALENCY FACTORS FOR DIOXINS AND FURAN ISOMERS

2,3,7,8-Tetrachlorinated dibenzo-p-dioxin (TCDD) is recognized by the U.S. EPA as a probable human carcinogen. Also some CDDs and CDFs have toxic effects similar to those of 2,3,7,8-TCDD. The U.S. EPA has developed a list of toxic equivalency factors (Table E-1) for assessing the toxicity of CDDs and CDFs.

Dioxin sampling was performed at the Saunders Supply Company site on December 2, 1984 and August 13, 1985. Analytical results along with 2,3,7,8-TCDD equivalents are given in tables E-2 and E-3. Samples collected on December 2, 1984 were analyzed for dioxins and furans but not for the different dioxin isomers. TCDD equivalencies were calculated for these samples assuming all the dioxin being 2,3,7,8 dioxin. The TCDD equivalents were calculated by multiplying the analytical results by the appropriate toxic equivalency factor from table E-1.

Samples collected on August 13, 1985 were analyzed for the different dioxin isomers. TCDD equivalents for the analytical results report as 2,3,7,8 dioxins were calculated by multiplying the analytical result by the appropriate toxic equivalency factor from table E-1.

TCDD equivalents for analytical results report as total dioxins were calculated by first, subtracting the 2,3,7,8 dioxin portion from the total dioxin, multiplying the result by the appropriate TCDD toxic equivalency factor, and then dividing the result by 100.

TABLE E-1

TOXIC EQUIVALENCY FACTORS FOR DIOXIN AND FURAN ISOMERS

Isomer	TEF
2,3,7,8 TCDD	1.0
2,3,7,8 PCDD	.5
2,3,7,8 HCDD	.04
2,3,7,8 HpCDD	.001
2,3,7,8 OCDD	0
2,3,7,8 TCDF	.1
2,3,7,8 PCDF	.1
2,3,7,8 HCDF	.01
2,3,7,8 HpCDF	.0001
2,3,7,8 OCDF	0

NOTE:

TEF = **Toxic Equivalency Factor.**
Divide above TEFs by 100 for isomers witout chlorines in one or more of the 2,3,7 or 8 positions.

Source: **Federal Register, September 12, 1985**
Volume 50, No. 177, pg. 340.

TABLE E-2
SAUNDERS SUPPLY COMPANY, INC.
TCDD EQUIVALENTS
December 2, 1984

Sample	Units	TCDD 2,3,7,8	TCDD	Equiv TCDD	Total PCDD	Equiv TCDD	Total HxCDD	Equiv TCDD	Total HpCDD	Equiv TCDD	Total OCDD	Equiv TCDD	Total Equiv TCDD
Auger Bore #1	ug/kg						0.53	0.021	5.5	0.006	12	0	0.029
Auger Bore #2	ug/kg	0.5	18	17.5	54	27	230	9.200	890	0.890	920	0	56.196
Auger Bore #3	ug/kg	0.36	16	15.64	57	28.5	160	6.400	640	0.640	670	0	52.497
Lab Duplicate of #3	ug/kg	0.36	19	18.64	55	27.5	170	6.800	540	0.540	620	0	54.617
Auger Bore #4	ug/kg	0.32	19	18.68	61	30.5	200	8.000	380	0.380	720	0	59.327
Field Duplicate of #4	ug/kg						0.53	0.021	5.5	0.006	16	0	0.030
Background	ug/kg								0.31	0.000	1	0	0.000
Spiked Backgound	ug/kg								0.36	0.000	1.1	0	0.000
TCE Rinsate	ug/kg										0.01	0	0.000
2,3,7,8-TCDD Audit Sample	ug/kg	2.9	6.2		2.2		5.4		31		201	0	2.900

Sample	Units	TCDF 2,3,7,8	Total TCDF	Equiv TCDD	Total PCDF	Equiv TCDD	Total HxCDF	Equiv TCDD	Total HpCDF	Equiv TCDD	Total OCDF	Equiv TCDD
Auger Bore #1	ug/kg						0.2	0.002	1.6	0.000	2.3	0
Auger Bore #2	ug/kg	0.17	2.7	0.253	1	0.100	56	0.560	230	0.023	130	0
Auger Bore #3	ug/kg	0.17	2.9	0.273	0.88	0.088	41	0.410	160	0.016	110	0
Lab Duplicate of #3	ug/kg	0.16	2.6	0.244		0.000	36	0.360	130	0.013	83	0
Auger Bore #4	ug/kg	0.23	3.7	0.347	2.1	0.210	65	0.650	95	0.010	105	0
Field Duplicate of #4	ug/kg						0.34	0.003	1.3	0.000	2.2	0
Background	ug/kg											
Spiked Backgound	ug/kg											
TCE Rinsate	ug/kg											
2,3,7,8-TCDD Audit Sample	ug/kg											

Eq *CCDs assume all isomers have chlorines in the 2,3,7, or 8 positions

TABLE E-3
SAUNDERS SUPPLY COMPANY, Inc.
TCDD EQUIVALENTS
August 13, 1985

	Units	2,3,7,8 TCDD	Total TCDD	Equiv TCDD	1,2,3,7,8 PCDD	Equiv TCDD	Total PCDD	Equiv TCDD	1,2,3,4,7 ,8-HxCDD	Equiv TCDD	1,2,3,6,8 ,8-HxCDD	Equiv TCDD	Total HxCDD	Equiv TCDD	Total HpCDD	Equiv TCDD	Total OCDD	Equiv TCDD	Total Equiv TCDD
Burn Pit - Saunders																			
BP1A - 7.2 ft	ug/kg	0.100	1.200	0.011	0.750	0.375	11.900	0.056	0.790	0.032	1.800	0.072	20.700	0.007	217.000	0.002	422.000	0	0.65
BP1B - 8.0 ft	ug/kg	0.100	1.900	0.018	1.500	0.750	28.200	0.134	2.400	0.096	3.500	0.140	67.200	0.025	392.000	0.004	750.000	0	1.27
BP2A - 8.0 ft	ug/kg	0.030	0.100	0.001	0.120	0.060	0.910	0.004	0.180	0.007	0.550	0.022	3.500	0.001	45.300	0.000	130.000	0	0.13
BP2B - 9.0 ft	ug/kg	0.070	0.055	0.000	0.084	0.042	0.480	0.002	0.160	0.006	0.180	0.007	1.900	0.001	29.000	0.000	75.300	0	0.13
BP3A - 8.0 ft	ug/kg	0.090	0.019	0.000	0.001	0.001	0.070	0.000	0.150	0.006	0.150	0.006	0.610	0.000	6.400	0.000	22.500	0	0.10
BP3B - 9.0 ft	ug/kg	0.020	0.120	0.001	0.073	0.037	0.089	0.000	0.160	0.006	0.160	0.006	0.630	0.000	15.100	0.000	45.600	0	0.07
BP4A - 8.0 ft	ug/kg	0.030	0.150	0.001	0.094	0.047	0.090	0.000	0.250	0.010	0.250	0.010	1.400	0.000	29.500	0.000	114.000	0	0.10
BP4B - 9.0 ft	ug/kg	0.030	0.010	0.000	0.058	0.029	0.029	0.000	0.150	0.006	0.100	0.004	0.720	0.000	20.500	0.000	69.100	0	0.07
Burn Pit - Kellys																			
K1A - Surface	ug/kg	0.060	0.610	0.006	0.810	0.405	8.700	0.039	3.100	0.124	3.100	0.124	20.000	0.006	354.000	0.004	807.000	0	0.77
K1B - 5.0 ft	ug/kg	0.480	6.200	0.057	6.200	3.100	172.000	0.829	10.400	0.416	28.500	1.140	594.000	0.222	11400.000	0.114	3480.000	0	6.36
K1C - 6.0 ft	ug/kg	0.090	2.300	0.022	0.960	0.480	25.500	0.123	1.500	0.060	2.800	0.112	46.100	0.017	581.000	0.006	708.000	0	0.91
K2A - Surface	ug/kg	0.560	0.790	0.002	1.400	0.700	24.400	0.115	2.900	0.116	7.100	0.284	75.000	0.026	1270.000	0.013	1550.000	0	1.82
K2B - 2.5 ft	ug/kg	0.820	2.300	0.015	7.200	3.600	145.000	0.689	12.900	0.516	17.600	0.704	598.000	0.227	4340.000	0.043	2950.000	0	6.61
K2C - 5.5 ft	ug/kg	0.110	2.100	0.020	0.450	0.225	25.200	0.124	1.300	0.052	2.500	0.100	42.100	0.015	478.000	0.005	785.000	0	0.65
K3A - Surface	ug/kg	0.270	0.050	0.000	0.380	0.190	2.000	0.008	0.320	0.013	0.320	0.013	11.400	0.004	112.000	0.001	228.000	0	0.50
K3B - 1.0 ft	ug/kg	0.110	0.012	0.000	0.170	0.085	0.092	0.000	0.120	0.005	0.120	0.005	0.480	0.000	6.900	0.000	17.500	0	0.20
K3C - 4.5 ft	ug/kg	0.070	0.035	0.000	0.120	0.060	0.250	0.001	0.078	0.003	0.078	0.003	0.150	0.000	5.200	0.000	13.100	0	0.14
Pond Sediment																			
P1	ug/kg	0.040	1.600	0.016	6.800	3.400	33.500	0.134	5.600	0.224	28.500	1.140	120.000	0.034	12000.000	0.120	4040.000	0	5.11
P2	ug/kg	0.140	0.440	0.003	2.800	1.400	18.500	0.079	3.500	0.140	14.700	0.588	67.600	0.020	2190.000	0.022	1500.000	0	2.39
P3	ug/kg	0.130	2.200	0.021	19.800	9.900	118.000	0.491	23.000	0.920	151.000	6.040	695.000	0.208	9610.000	0.096	1210.000	0	17.81
P4	ug/kg	0.250	2.000	0.018	2.300	1.150	21.700	0.097	24.000	0.960	7.700	0.308	46.500	0.006	1440.000	0.014	1560.000	0	2.80
Godwins Millpond																			
R1	ug/kg	0.070	0.022	0.000	0.064	0.032	0.124	0.000	0.039	0.002	0.120	0.005	1.100	0.000	12.200	0.000	43.800	0	0.11
R2	ug/kg	0.200	0.014	0.000	0.046	0.023	0.040	0.000	0.120	0.005	0.290	0.012	0.490	0.000	5.900	0.000	19.100	0	0.24
R3	ug/kg	0.100	0.046	0.000	0.110	0.055	0.450	0.002	0.070	0.003	0.210	0.008	1.600	0.001	22.500	0.000	71.600	0	0.17
R4	ug/kg	0.050	0.035	0.000	0.130	0.065	0.030	0.000	0.100	0.004	0.100	0.004	1.300	0.000	14.900	0.000	49.200	0	0.12
Kelly Field																			
K4	ug/kg	0.110	0.044	0.000	0.330	0.165	1.000	0.003	0.520	0.021	2.400	0.096	0.100	0.000	234.000	0.002	487.000	0	0.40
K5	ug/kg	0.040	0.014	0.000	0.120	0.060	0.029	0.000	0.110	0.004	0.110	0.004	0.022	0.000	1.200	0.000	2.800	0	0.11
K6	ug/kg	0.080	0.007	0.000	0.083	0.042	0.019	0.000	0.810	0.032	0.081	0.003	0.040	0.000	1.000	0.000	12.000	0	0.16
Wood Storage Area																			
Y1A	ug/kg	0.240	0.034	0.000	2.600	1.300	4.700	0.011	1.500	0.060	43.900	1.756	194.000	0.059	8980.000	0.090	5980.000	0	3.52
Y2	ug/kg	0.240	0.430	0.002	20.200	10.100	41.100	0.105	9.400	0.376	39.300	1.572	391.000	0.137	1610.000	0.016	3335.000	0	12.55
Y3A	ug/kg	0.080	0.015	0.000	0.780	0.390	1.800	0.005	0.150	0.006	3.000	0.120	21.900	0.008	1620.000	0.016	1790.000	0	0.62
Y4	ug/kg	0.250	0.260	0.000	3.500	1.750	7.800	0.022	0.900	0.036	6.900	0.276	77.400	0.028	9950.000	0.100	4560.000	0	2.46
Y5	ug/kg	0.120	0.037	0.000	0.830	0.415	1.800	0.005	0.120	0.005	0.610	0.024	17.800	0.007	192.000	0.002	536.000	0	0.58
Y1B - Yard Soil Average	ug/kg	0.070	0.023	0.000	0.082	0.041	0.180	0.000	0.082	0.003	0.082	0.003	0.700	0.000	35.600	0.000	133.000	0	0.12
Y3B - Yard Soil Average	ug/kg	0.050	0.012	0.000	0.061	0.031	0.062	0.000	0.041	0.002	0.041	0.002	0.041	0.000	1.400	0.000	4.600	0	0.08
Background	ug/kg	0.040	0.218	0.002	0.091	0.046	0.130	0.000	0.059	0.002	0.059	0.002	0.880	0.000	1.000	0.000	6.400	0	0.09
Spiked Background	ug/kg	0.910	1.460	0.006	1.030	0.515	0.840	0.000	0.840	0.034	0.053	0.002	1.180	0.000	2.230	0.000	7.240	0	1.47
Duplicate - K1B	ug/kg	0.420	3.900	0.035	9.200	4.600	170.000	0.804	4.700	0.188	9.800	0.392	518.000	0.201	8900.000	0.089	3070.000	0	6.73
Duplicate - K1B	ug/kg	0.370	3.600	0.032	15.500	7.750	178.000	0.813	18.800	0.752	19.300	0.772	1070.000	0.413	6570.000	0.066	2250.000	0	10.97
Rinsate No. 2	ug/l	0.003	0.004	0.000	0.006	0.003	0.008	0.000	0.004	0.000	0.004	0.000	0.004	0.000	0.170	0.000	0.300	0	0.01
Background	ug/kg	0.060	0.009	0.000	0.068	0.034	0.032	0.000	0.052	0.002	0.052	0.002	0.022	0.000	0.035	0.000	1.200	0	0.10
Spiked Background	ug/kg	1.140	0.920	0.000	0.970	0.485	1.250	0.001	1.110	0.044	0.070	0.003	1.400	0.000	1.510	0.000	5.870	0	1.67
Duplicate BP2B	ug/kg	0.070	0.031	0.000	0.080	0.040	0.450	0.002	0.120	0.005	0.180	0.007	3.500	0.001	31.400	0.000	77.500	0	0.13
P.E. Sample	ug/kg	0.070	0.074	0.000	0.043	0.022	0.480	0.002	0.088	0.004	0.110	0.004	2.400	0.001	36.300	0.000	76.900	0	0.10
Rinsate No. 1	ug/l	6.300	6.300	0.000	0.058	0.029	0.039	0.000	0.040	0.002	0.040	0.002	0.021	0.000	0.170	0.000	0.410	0	6.33
Spike	ug/kg	0.009	0.001	0.000	0.013	0.007	0.003	0.000	0.016	0.001	0.016	0.001	0.002	0.000	0.008	0.000	0.025	0	0.02