

TECHNICAL  
PROCEDURAL GUIDANCE

**EQUIPMENT TRAINING, CALIBRATION, AND MAINTENANCE**

## NOTES

### **Equipment Training, Calibration, and Maintenance**

#### **GUIDANCE SUMMARY-AT-A-GLANCE**

- # Keep a weekly inventory of the equipment issued to you or to a particular response vehicle. This will ensure that the equipment will be there when you and others need it. Also keep records on when equipment was last serviced and, if necessary, calibrated.
- # Proper training in the use of equipment in your standard inventory is vital to protect your health and safety and to the success of a spill response effort. Important decisions are made based upon readings obtained with field instruments, and these instruments need to be calibrated properly and well maintained. NYSDEC provides health and safety training for BSPR personnel (see Part 2, Section 1, Personal Health and Safety Protection).
- # Practice using your equipment to develop a working understanding of each instrument's operation, calibration, limitations, and maintenance. Familiarize yourself with the operation and other manuals provided by the vendor or manufacturer. Learn how to perform simple maintenance like changing a battery and how to calibrate the instrument in the field. Don't attempt to repair equipment yourself, as this can be hazardous and/or could invalidate the warranty.
- # Use the combustible gas indicator, photoionization detector, and other air monitoring instruments routinely at all spills for detecting when conditions are unsafe (e.g., threat of explosion) or otherwise hazardous to human health. Understand what the readings mean and the actions you may need to take in response. It is important that all air monitoring equipment be calibrated frequently to ensure its proper function.
- # Follow the recommended maintenance schedules to ensure that the instruments continue to operate properly. Equipment vendors and manufacturers often suggest a particular maintenance schedule, but this schedule may need to be shortened to reflect the amount of use and the conditions under which the equipment is used.

## NOTES

### **2.2 Equipment Training, Calibration, and Maintenance**

Ensuring the health and safety of yourself and others during a spill/leak incident response requires the use of specialized monitoring and protective equipment. Other equipment is available to help contain a spill and to assist in your investigation of the incident site. Proper calibration and maintenance of this equipment ensures that it functions properly. BSPR provides training in the proper use, calibration, and maintenance of spill response equipment.

Although your standard inventory includes respiratory and other personal protective equipment for hazardous situations, BSPR personnel should not place themselves in hazardous situations during incidents. Defer to other response agencies and spill response contractors to handle emergency and hazardous conditions.

#### **1. BSPR Equipment Inventory**

Exhibit 2.2-1 lists the standard inventory of a typical BSPR spill response vehicle. This equipment (as opposed to what contractors or other responders might supply) are for the protection of your own health and safety during response activities, for initial spill containment, and for conducting your preliminary investigations of site conditions. **You are responsible for making sure that: (a) this equipment is maintained in good working order, (b) monitoring and sampling equipment is calibrated properly, and (c) each vehicle's inventory is kept intact.** Additional responsibilities include keeping records of equipment use (see Exhibit 2.2-2, Monthly Equipment Usage Report) and calibration for comparison to the recommended maintenance schedule and for supporting your other records of site activities in case the state's actions are contested.

#### **2. Equipment Training**

Protecting your health and safety and ensuring an effective spill response starts with understanding proper use, calibration, and maintenance of equipment and the ways in which this equipment can be used improperly when personnel are not adequately trained. In addition, the accuracy of the monitoring and sampling data that you collect will determine the appropriateness of your response decisions. Therefore, while you are not expected to repair your equipment (in fact, it is preferred that you don't attempt any repairs), it is important to gain a certain proficiency in the use of the basic spill response equipment.

Some of the training you'll need will be part of your NYSDEC health and safety training, and, of course, will develop over time with experience. Other sources of information can include the following:

- # Probably the best (and least expensive) source of equipment training is from the manufacturer or vendor. Some manufacturers will send a representative to train personnel in the use of their equipment. If your office purchases an instrument from a manufacturer, request that training be provided at no cost to a select group of personnel who can then

## Exhibit 2.2-1

### Standard Spill Response Vehicle Equipment, Materials, and Supplies

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#### RESPONSE EQUIPMENT

Explosimeter  
Photoionization Meter  
Combustible Gas Indicator/  
    O<sub>2</sub> Meter  
Sonic Interface Tape  
Water Level Meter  
Magnetic Locator  
Sampling Pump  
Cam Corder  
Cameras  
    35 mm SLR with Zoom  
    35 mm Auto Camera  
    Polaroid  
Cassette Recorder  
Binoculars

#### MISCELLANEOUS

Plastic Bags & Ties  
Paper Towels  
Hand Cleaner  
Rope  
Stakes  
Sledge Hammer  
Flagging  
Paint  
Dye  
PCB Test Kits  
Clip Boards

#### RADIO

Mobile  
Portable

#### SORBENTS

Boom  
Pillow  
Pads

#### CONTAINMENT BOOM

25' Oil Containment Boom for Streams

#### TRUCK EQUIPMENT

Tool Kit  
"Flare - Reflector Kit"  
Shovels, Rakes, and Hoes  
Crow Bar  
Jumper Cables  
First-Aid Kit  
Fire Extinguisher (20A 40BC)  
Flash Light - Explosion Proof  
Traffic Cones  
Manhole Cover Hook

#### CLOTHING AND PROTECTIVE EQUIPMENT

Steel-Toed Boots - Summer & Winter  
Parka  
Rain Suit  
Tyvek Disposable Overalls  
Hard Hat with Liner and Face Shield  
Work Gloves  
Splash Gloves - neoprene, butyl, others  
Neoprene Gloves  
Latex Gloves  
Ear Plugs  
Rubber Boots  
Orange Vest  
Coveralls - Winter & Summer  
Escape Air Pack

#### REFERENCES

Each Region has its own set of desired reference materials. (A listing of Region 2 references is provided as an example.)

## Region 2 Spill Response Library

*Aerial Surveillance Spill Prevention System* - U. S. EPA Technical Reports  
*Aquifer Restoration State-of-the-Art* - Knox/Kincannon/Canter/Ward/Stover - Noyes Publications  
*A Small Vacuum Oil Skimming System* - U. S. EPA Technical Reports  
*Biological Effects of Oil Pollution* - U. S. EPA Technical Reports  
*Boatmen's Guide to Light Salvage* - G. H. Reid, Cornell Munitions Press, 1979  
*Chemical Regulatory Cross Reference* - J. J. Keller & Associates, 1988  
*Chemical Technician's Ready Reference Book* - Shugar/Bauman  
*Chemical Treatment of Oil Slicks* - U. S. EPA Technical Reports  
*Chemical Treatment of Oil Spills* - U. S. Dept. of Interior  
*Chemistry of Hazardous Materials* - Meyer  
*CHRIS Hazardous Chemical Data* - U. S. Dept. of Transportation and U. S. Coast Guard  
*Common Sense Approach to Hazardous Materials* - F. L. Fire  
*Control of Hazardous Chemical Spills by Physical Barriers* - U. S. EPA Technical Reports  
*Control of Spillage of Hazardous Polluting Substances* - U. S. Dept. of Interior  
*Dangerous Properties of Industrial Materials* - N. I. Sax, 7th edition  
*Decontamination Techniques for Buildings, Structures, Equipment* - M. P. Esposito/R. Clark, Noyes Publications  
*Development of a Kit for Detecting Hazardous Materials Spills in Waterways* - U. S. EPA Technical Reports  
*Development of a Mobile System for Cleaning Oil-Contaminated Beaches* - U. S. EPA Technical Reports  
*Development & Preliminary Design of a Sorbent-Oil Recovery System* - U. S. EPA Technical Reports  
*Dictionary of Commodities Carried by Ship* - Groache, Cornell Maritime Press, 1952  
*Driver's Pocket Guide to Hazardous Materials* - J. J. Keller & Associates, Inc., 6th edition  
*Effects of Exposure to Toxic Gases/First Aid & Medical Treatment* - W. Braker, A. L. Mossman  
*Emergency Action Guides* - Association of American Railroads  
*Emergency Care Hazardous Materials Exposure* - A. C. Bronstein/P. L. Currance, 1988  
*Emergency Handling of Hazardous Materials* - Association American Railroads, HazMat Systems  
*Emergency Response Guidebook*, U. S. Dept. of Transportation, 1987  
*Engineering Formulas* - K. Crieck, 5th edition  
*EPA TSDF Listing* - U.S. EPA, 1987  
*Evaluation of Selected Earthmoving Equipment for the Restoration of Oil-Contaminated Beaches* - U. S. EPA Technical Reports  
*Farm Chemicals Handbook* - Hall/Knake/McCarty, 1988  
*Firefighter's Handbook of Hazardous Materials* - C. J. Baker  
*Fire Officer's Guide to Dangerous Chemicals* - C. W. Bahme  
*Fire Protection Guide on Hazardous Materials* - NFPA, 8th edition  
*Flammable & Combustible Liquids Code* - M. F. Henry, NFPA, 1981  
*Flammable Hazardous Materials* - J. H. Meidl, 2nd edition  
*Fundamentals of Industrial Hygiene* - National Safety Council, 1983  
*Groundwater Handbook* - U.S. EPA/R. S. Kerr Environmental Research Laboratory/Center Environmental Research  
*Handbook for Oil Spill Protection Cleanup Priorities* - U. S. EPA Technical Reports  
*Handbook of Toxic & Hazardous Chemicals* - M. Sittig, Noyes Publishing, 1981  
*Hazardous Chemical Spill Cleanup* - J. S. Robinson, Noyes Publishing, 1979  
*Hazardous Materials Emergency Planning Guide* - National Response Team, National Oil & Hazardous Substances Contingency Plan  
*Hazardous Materials Guide for Handling* - UPS

Region 2 Spill Response Unit Library  
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*Hazardous Waste Services Directory* - J. J. Keller & Associates  
*Industrial Chemical Survey (Pretreatment Program)* - NYSDEC Bureau Wastewater Facilities  
*Industrial Toxicology* - Chemical Publishing Co., Inc. - 1976  
*Industrial Waste Haulers List* - DEC (Solid & Hazardous Waste), published monthly  
*Inland Oil Spills* - U. S. EPA Technical Reports  
*Interaction Between Marine Organisms & Oil Pollution* - U. S. EPA Technical Reports  
*Manual for Spills of Hazardous Materials* - Technical Services Branch, E. P. Services Canada, 1984  
*Marine Salvage Operations* - E. M. Brady, Cornell Maritime Press  
*Merck Index* - Windholz/Budavari/Blumetti/Otterbein, 10th edition, 1988  
*Method Determining Compatibility of Hazardous Wastes* - U. S. EPA Technical Reports, April 1980  
*NALCO Water Handbook* - Kemmer, 1988  
*New York State Hazardous Waste Manifest Guide Manual* - DEC  
*NFPA 491M Manual Hazardous Chemical Reactions* - Technical Communications Hazardous Chemical Reactions, NFPA, 1986  
*NTTC Hazardous Commodity Handbook* - National Tank Truck Carriers Inc., 1988  
*Ocean & Marine Dictionary* - D. F. Tver, Cornell Munitions Press, 1979  
*Oil Dispersing Chemicals*  
*Oil & Hazardous Materials Emergency Procedures in Water Environment* - U. S. Dept. Interior/Federal WPC Ad  
*Oil & Hazardous Materials - Emergency Procedures in the Water Environment* - U. S. EPA Technical Reports  
*Oil Pollution Source Identification* - U. S. EPA Technical Reports  
*Oil Spill Containment, Investigation & Cleanup* - DEC  
*Oil Spill Laboratory Contract Manual*  
*Oil Spills Control Manual for Fire Department* - U. S. EPA Technical Reports  
*Oil Spill Dispersants Product Data* - U. S. EPA Technical Reports  
*Oil Spills & Spills of Hazardous Substances* - U. S. EPA Technical Reports  
*Oil Spill Surveillance System Study* - U. S. EPA Technical Reports  
*Oil Waste Disposal by Soil Cultivation Process* - U. S. EPA Technical Reports  
*Patty's Industrial Hygiene & Toxicology* - Clayton & Clayton, 1981  
*Petroleum Tankage & Transmission* - Grover Tank & Manufacturing Co., Inc.  
*Petroleum Tank Shipment Operations* - Arthur McKenzie, World Trade Institute, 1984 (conference manual)  
*Petroleum Transportation & Production* - M. Sittig, Noyes Publications  
*Protection of Public H<sub>2</sub>O from Groundwater Contamination* - W. A. Pettyjohn, Noyes Publications  
*Rapid Guide to Hazardous Chemicals in Workplace* - N. I. Sox/R. J. Lewis  
*Rapidly Deployable Oil Containment Boom for Emergency Harbor Use* - U. S. EPA Technical Reports  
*Remedial Action of Waste Disposal Sites* - U. S. EPA Technical Reports  
*Removal of Oil from Under Piers* - U. S. EPA Technical Reports  
*Response of a Salt Marsh to Oil Spill & Cleanup: Biotic & Erosional Effects* - U. S. EPA Technical Reports  
*Samplers & Sampling Procedures for Hazardous Waste Streams* - U. S. EPA Technical Reports, January 1980  
*Santa Barbara Oil Pollution, 1969* - U. S. EPA Technical Reports  
*Santa Barbara Oil Spill: Short Term Analysis of Macroplankton & Fish* - U. S. EPA Technical Reports  
*Selected Hazardous Materials, Emergency Action Guide* - U. S. Dept. of Transportation, 1987

Region 2 Spill Response Unit Library  
(continued)

*Shore Termination for Oil Spill Booms* - U. S. EPA Technical Reports  
*Slurry Trench Construction for Pollution Migration Control* - P. Spooner, Noyes Publications  
*Spill Prevention & Fail-Safe Engineering for Petroleum Products* - Goodier/Sielari/Garrity, Noyes Publications  
*Tank Car Manual* - General American Transportation Corp.  
*Tanker Operations* - G. S. Marton, Cornell Maritime Press  
*Testing & Evaluation of Oil Spill Recovery Equipment* - U. S. EPA Technical Reports  
*Tide Tables East Coast of N. A. & S. A.* - U.S. Dept. of Commerce, NOAA, published yearly  
*Toxic & Hazardous Industrial Chemical Safety Manual* - Tachikowa/Shimbashi/Minato-Ku  
*Toxic Substance Storage Tank Containment* - Ecology Environment, Inc./Whittman, Requardt & Associates, L. Noyes  
*Transportation & Distribution Dictionary* - J. J. Keller & Associates  
*Transportation Hazardous Materials, Questions & Answers* - New York State Dept. of Transportation, Traffic & Safety Division  
*TTMA Recommended Practices* - Truck Trailer Manufacturing Association, 1984 (construction/guidance)  
*Underground Tank Leak Detection Methods* - S. Niaki/J. A. Broschius, Noyes Publications  
*Use of Fire Streams to Control Floating Oil* - U. S. EPA Technical Reports  
*Using Fire Streams with a Self-Propelled Oil Spill Skimmer* - U. S. EPA Technical Reports  
*Welded Steel Plate Construction Design Data* - Buffalo Truck Corp. (out-of-print)  
*Wiley Engineers Desk Reference* - S. I. Heisler, 1984

**Exhibit 2.2-2**  
**Monthly Equipment Usage Report**  
**NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION**  
**INSTRUCTIONS**

**BEGINNING OF MONTH**

1. Complete identification section.
2. Enter 6 digit vehicle/equipment I.D. Number.
3. Enter 4 digit month/year, i.e. May, 1980 would be **0580**
4. Enter beginning mileage/hours, (in whole miles or hours only).
5. You are now required to estimate and record daily mileage/ hour by specific 4 digit time and activity codes. The daily activity codes should correspond to the activity codes used daily to record time on you "Time and Activity Record". Record whole miles or hours only. Cars and trucks are recorded in miles. Tractors, bulldozers, boats and construction equipment are recorded in hours.

**BEGINNING WITH DAY 1 ON THE BOTTOM OF THE FORM**

1. Check (T) each day that the vehicle/equipment is used. Circle (0) each day that the vehicle/equipment is out of service for repair.
2. Enter ending daily mileage/hours.
3. Calculate and enter total daily usage. NOTE: For day 1, or the first time the vehicle/equipment is used during the month, subtract the beginning mileage/hours for the month from the ending mileage/hours entered for the day to obtain total daily usage. Total daily usage for the remainder of the month is calculated by subtracting the previous day's ending mileage/hours from the current day's ending mileage/hours.
4. Estimate and record total daily usage by specific activity code(s). **Daily usage should be distributed to the primary activity(s) requiring primary activity(s) requiring vehicle/equipment use on a given day.**

NOTE: The total mileage/hours distributed daily should equal the sum of each amount entered in the activity code columns.

5. If more than 12 activity codes are required during the month, prepare and attach a second form.
6. Operator's name (printed) is required for all pool vehicles/equipment.

**END OF MONTH**

1. Enter ending mileage/hours.
2. Calculate and enter total monthly mileage/hours. This total should be the same as:
  - a. The total daily usage column total.
  - b. The total of all activity code columns.
  - c. The difference between beginning and ending mileage/hours.
3. Calculate and enter total days used (add each (T) in days used column).
4. Calculate and enter days out of service for repairs, (add each (0) in days used column).
5. Calculate and enter monthly totals for each activity code column used. The sum of all activity code column monthly totals should equal the total monthly usage.
6. Sign certification under vehicle I.D. number and monthly date.
7. Submit completed report to the appropriate regional office.

**FUEL USE**

1. Record gallons and tenths of fuel obtained for day vehicle is fueled.
2. At end of month, total fuel used for month at top of column.

MAINTENANCE SECTION				
LAST SERVICE		SERVICE DURING MONTH		
Date	Mileage/Hrs.	Description	Date	Mileage/Hrs.
		Lubrication		
		Oil Change		
		Oil Filter		
		Air Filter		
		Tune-up		

Exhibit 2.2-2  
(continued)

36-15-2 (3/84)

REGION		OPERATOR'S NAME (Last, First, M.I.)				SOCIAL SECURITY NUMBER				BUREAU				VEHICLE/EQUIPMENT I.D. NO.				
ENDING MILAGE/HOURS		DAYS USED DURING MONTH				OFFICE LOCATION				MONTH/YEAR								
BEGINNING MILAGE/HOURS		DAYS OUT OF SERVICE FOR REPAIRS				COUNTY ASSIGNMENT												
DAY	DAY/ USED (.) IN REPAIR	DAILY ENDING MILAGE/ HOURS	TOTAL DAILY USAGE	DISTRIBUTION OF DAILY MILAGE/HOURS BY SPECIFIC ACTIVITY CODE												I certify that travel was official State business.		
				Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	Activity Code	SIGNITURE	DATE	
MONTHLY TOTALS																OPERATOR'S NAME FOR POOL VEHICLES/EQUIPMENT ONLY (Please print)	GALLONS FUEL	<input checked="" type="checkbox"/>
31																		31
30																		30
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train others. To the extent that our equipment purchases are centralized, BSPR is working to establish such arrangements with vendors, as well.

- # Maintain a complete library of equipment guides, manuals, and other literature pertinent to the operation, calibration, and maintenance of the equipment in your inventory. Invest the time to become familiar with the guides and manuals for the equipment you operate.
- # Obtain information from regional spill program staff and perhaps from staff in other state and local agencies who have experience working with this equipment. These people are often the best source of practical information concerning the operation and limitations of spill response equipment.
- # Occasionally, there are free seminars sponsored by the U.S. EPA and other organizations that give attendees the chance to learn about and work with various kinds of spill response equipment.
- # Hold simulated response drills that make use of different pieces of equipment. These staged incidents can often help familiarize staff with response procedures as well as equipment. Try to include other response agencies in order to get practice in coordinating a response to a petroleum or hazmat release.

### 3. Equipment Calibration

Frequently check all equipment that requires calibration to ensure that it functions properly and provides accurate readings. If calibration reveals that minor adjustments are necessary, these adjustments can sometimes be performed with the zero or span knob on the instrument. If the calibration procedure reveals a major problem with the instrument, the equipment should not be used and the manufacturer should be contacted for repair. Each manufacturer's instrument manuals will describe the proper calibration procedures. Become familiar with these procedures.

Some equipment can be calibrated and/or require calibration in the field prior to their use. Other equipment can only be calibrated at a laboratory, as special equipment is needed. In either case, it is important that you keep a calibration logbook for each piece of equipment. Use this logbook to record the date that the instrument was calibrated, calibration procedures and readings, and who performed the calibration. This logbook serves as the long-term record of the instrument's response and effectiveness.

### 4. Equipment Maintenance

Equipment manuals provided by the manufacturer will recommend maintenance schedules for their instruments. Typical suggested schedules are shown in Exhibit 2.2-3 for some of the more common spill response equipment. At a minimum, your equipment should receive preventative maintenance **at least** as frequently as suggested

**Exhibit 2.2-3**

**Preventive Maintenance Procedures and Schedules**

<b>Equipment</b>		<b>Procedure</b>	<b>Interval</b>
Spill Response Vehicle	#	Verify contents against inventory	Weekly
	#	Replenish depleted supplies	
	#	Remove damaged or malfunctioning items	
Photoionization Meter	#	Check battery	Before Use
	#	Calibrate	Weekly
	#	Check lamp	
	#	Check battery	
	#	Recharge or replace battery, as needed	
#	Clean and check lamp and ion chamber	Monthly	
Combustible Gas Indicator/Oxygen Meter	#	Calibrate	Before Use
	#	Check battery and oxygen sensor	
	#	Calibrate	
	#	Check battery and oxygen sensor	
	#	Recharge or replace battery, as needed	
Escape Air Pack	#	Calibrate	Before Use (Prior to initiating any response actions) After Use
	#	Replace oxygen sensor, as needed	
	#	Check tank pressure	
	#	Check hood and air tube for leaks	
	#	Examine for damage	
	#	Clean apparatus	
	#	Refill cylinder	
	#	Check tank pressure	
	#	Verify correct packing of hood	
	#	Check all connections	
Magnetic Locator	#	Operate apparatus to check operation	Every Six Months
	#	Check batteries	Before Use
	#	Check batteries	Weekly
	#	Replace or recharge batteries, as needed	

**Exhibit 2.2-3**

**Preventive Maintenance Procedures and Schedules  
(continued)**

<b>Equipment</b>		<b>Procedure</b>	<b>Interval</b>
Sonic Interface Tape and Water Level Meter	#	Check batteries	Weekly
	#	Recharge or replace batteries, as needed	
	#	Verify operation of alarms	
	#	Check probe	
Cameras	#	Check batteries	Weekly
	#	Recharge or replace batteries, as needed	
Camcorder	#	Charge battery, if necessary	Before Use
	#	Check battery	Weekly
	#	Recharge battery	
Flashlights	#	Change batteries	Weekly
	#	Recharge or replace batteries, as needed	
Fire Extinguisher	#	Check pressure	Weekly
	#	Check insertion of locking pin	
	#	Check condition of cylinder and hose	
	#	Have contractor or manufacturer inspect and test	Yearly
First Aid Kit	#	Replenish depleted supplies	Weekly
	#	Replace expired medicines	Yearly
Flares	#	Replenish depleted supplies	Weekly
	#	Replace	Yearly
Tool Kit	#	Verify contents	Weekly
	#	Check for damage	
Portable Radios	#	Check battery	Before Use
	#	Verify proper operation	
	#	Check battery	Weekly
#	Recharge battery, if not stored in charger		

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by the manufacturer, assuming "normal" use. If, however, your equipment receives heavier use or is used under harsher conditions (e.g., dusty environments) it is often advisable to accelerate the maintenance schedule. In addition, equipment that has been contaminated (externally and/or internally) by petroleum or hazardous materials must be properly decontaminated. BSPR personnel can, for the most part, wipe clean external contaminants and dirt from equipment but will have to follow manufacturer guidelines or return the equipment to the manufacturer or authorized servicing center in order to decontaminate internal components of certain equipment.

As a general rule, it is preferred that you not attempt to service and/or repair your equipment unless you have received the necessary training and have access to the proper servicing equipment. Unauthorized servicing or repair often invalidates the manufacturer's warranty. It is also easy to make a small error (e.g., reinserting a part backwards) that may, someday jeopardize your own health and safety. Also, some pieces of equipment contain or require the use of hazardous materials (e.g. calibration gas) that themselves represent safety or health hazards if not handled properly.

### 5. Types of Spill Response Equipment

This section provides brief summaries on the operation, calibration, maintenance, and limitations of several of the more sophisticated instruments and equipment in the standard BSPR equipment inventory. The summaries are meant to familiarize BSPR personnel with the various equipment. **However, you must refer to manufacturers' manuals to obtain detailed procedures and information about specific equipment.** Attachment 2.2-1 at the back of this section summarizes information regarding a variety of environmental monitors that may be utilized at incidents by BSPR personnel and emergency responders from other agencies.

#### a. Photoionization Detector

The photoionization detector (PID) is used to monitor ambient air concentrations of most organic and selected inorganic compounds. The instrument is usually calibrated to known concentrations of benzene, and results are reported as parts per million benzene equivalent. You will use this piece of equipment to monitor for air concentrations above OSHA health and safety thresholds that signal the need to upgrade personal protection or to exit the area. You may also use it as a rough indicator of the presence and degree of volatile contamination in, for example, soils in a test pit, tank excavation, or as removed during installation of a monitoring well.

#### Operation

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A PID is composed of a survey probe and readout assembly. The probe, in general, contains sensing and amplifying circuitry, including an ionization chamber, ultraviolet (UV) lamp, fan or pump, and a probe cable. The readout assembly basically contains a meter, controls, and a battery. Depending upon the exact make and model, the PID may also have a filter for filtering out dusts or specific vapors from the sample as it's drawn into the probe and an adjustable alarm that can warn the user of specific concentration levels, as well as other special features.

The PID will normally require the use of one of several interchangeable probes, each with a UV lamp of different energy generating levels. Different lamps are needed so that a wide range of substances, with varying ionization potentials, can be detected. Available lamps come in the following energy levels: 8.3 electron volts (ev), 8.4, 9.5, 10.2, 10.6, 10.9, 11.4, 11.7, and 11.8 ev.

The PID operates by sample gases entering through an inlet orifice, passing through a filter (if present), and into the ion chamber where they are exposed to photons that are being directed at the sample from the UV lamp. If the energy of the photons is sufficient it will ionize the molecules of vapor/gas in the sample. The amount of energy necessary to photoionize a molecule is represented by its ionization potential (IP). The lamp energy must be equal to or greater than the IP of the sample compound. Once ionized, the freed electrons are collected at an electrode to generate an electrical current. The current is then amplified and displayed on the meter on the readout assembly. The greater the current, the higher the concentration level that appears on the meter.

### Limitations

Because the PID is sensitive to many organic and inorganic vapors/gases it cannot be used as a quantitative instrument in unknown situations. It is strictly qualitative, except when the nature of the contamination is known and the instrument has been calibrated to (or a calibration curve has been generated for) the contaminant being monitored. High humidity reduces sensitivity. High concentrations of methane can cause a downscale deflection of the meter. Atmospheres with concentrations of vapors and gases above the detection limits of the instrument will cause inconsistent instrument behavior.

Other limitations of this instrument are as follows:

- # It cannot measure methane, some freons, acetonitrile, oxygen, nitrogen, carbon monoxide, or water;
- # It can be affected by condensation of water vapor on the lamp window, which may occur as a result of low temperature or high humidity. The result will be erratic and erroneous

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readings. The lamp will have to be cleaned before it can be used again properly;

- # Due to the low flow rate of the fan (around 1/2 liter per minute), the instrument does not function well when there are large drops in pressure; and
- # Close proximity to AC power lines, power transformers, or portable two-way radios may cause a malfunction.

### Use

The use of each particular PID will vary depending upon the make and model. **Effective use of a PID is only possible by becoming familiar with the manufacturer's instruction manual and practicing with the instrument during training drills.** Proper use of a PID will generally involve the following tasks and considerations:

- # Assembling the PID components (i.e. probe, cable, readout assembly);
- # Performing an operational check;
- # Performing a field calibration;
- # Setting the desired range of the meter;
- # Adjusting the span control to set the desired amplification;
- # Activating the alarm switch (if applicable) and setting the concentration level at which the alarm will sound;
- # Wrapping the readout assembly in clear plastic to protect it, if desired;
- # Taking readings in desired locations;
- # Recharging the battery, when required;
- # Taking care that the PID is not exposed to excessive moisture, dirt, or contaminants that may affect readings or that may cause permanent damage to the instrument;
- # Being aware that air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings;
- # Adjusting the concentration range of the PID, as required;
- # Deactivating the PID when you are finished using it;

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- # Decontaminating the PID and obtaining proper servicing for it, when required.

When using, calibrating, or maintaining a PID, BSPR personnel must heed the following precautions to ensure their safety and to prevent damage to the PID:

- # PIDs should be used by only trained personnel wearing appropriate protective gear.
- # PIDs should be used only in atmospheres for which the instrument has been tested and approved for use. Attachment 2.2-2 at the end of this section explains the National Electrical Code's system of classifying flammable and combustible atmospheres by class, division, and group. The owner's manual will identify the specific atmospheres (in terms of the NEC system) for which the PID is considered "intrinsically safe" (i.e., will not cause an explosion when used properly).
- # The PID is designed to sample air or vapors only. DO NOT allow any liquids to get into the probe or meter assembly.
- # High concentrations of methane and/or high humidity can cause the instrument reading to vary significantly from the actual concentration of gases or vapors present. This is true even though the PID cannot read methane or water vapor.
- # Do not look at the light source from any closer than 6 inches with unprotected eyes. Observe only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to your eyes.
- # The instrument measures gases in the vicinity of the operator, so a high reading should be cause for appropriate protective actions to ensure the operator's safety.
- # Use great care when operating the PID with the readout assembly outside its case due to the presence of high voltage direct current.
- # Turn the function switch to the OFF position before disassembly so that high voltage electrical hazards will not be present.
- # During calibration, care must be taken when handling gas cylinders due their physical and chemical hazards. Never open a cylinder valve without a regulator attached.

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- # Do not interchange UV lamps of different eV ratings in a probe; a probe with the wrong lamp will not operate properly. When a different eV-rated lamp is needed, the desired lamp must be inside a different probe. A change in probe will require resetting of the zero control and recalibrating the PID.

### Calibration

The PID can usually be calibrated to any certified calibration gas. However, after calibration all subsequent instrument readings will be relative to the calibration gas used. The PID is normally factory-calibrated to benzene. The calibration should be checked before and after use with a calibration check gas such as isobutylene and corrected to benzene (isobutylene has a response factor of 0.7 with respect to benzene). Once calibrated, the span setting can be changed if necessary. Since the response of various compounds to photoionization can differ, readings taken on the instrument must be expressed as relative to the gas to which the instrument was calibrated.

Calibration should be performed before each use of the PID and after each servicing. It should also be performed after each use of the PID. During long periods of non-usage, the PID should be calibrated every two weeks.

The calibration procedure will be different for each make and model of PID, therefore, **BSPR personnel must follow the calibration instructions provided by the manufacturer for each particular PID.** Only trained personnel should perform calibration.

### Maintenance and Servicing

The PID's performance is affected by a number of factors. These include, but are not limited to, the decay of the UV lamp output over time and the accumulation of dust and other particulate material and contaminants on the lamp and in the ion chamber. **The following procedures are to be performed at the designated intervals for routine service.**

<b>Procedure</b>	<b>Frequency</b>
Operational Check	Prior to use and at instrument return
Field Calibration	Prior to use and at instrument return
Full Calibration	Every 2-4 weeks
Clean UV Lamp and Ion Chamber	Every 2-4 weeks
Replace UV Lamp	As needed.

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During periods of PID operation, dust and other foreign materials are drawn into the probe forming deposits on the surface of the UV lamp and in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, drifting, and which show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition regularly to ensure that the PID is functioning properly. If the instrument is malfunctioning, have it serviced by the manufacturer or an authorized service center.

Maintenance and servicing requirements will be different for each make and model of PID. **Proper maintenance requirements and schedules should be contained in the manufacturer's instruction manual.** BSPR personnel should be aware that servicing and/or repair of the instrument by anyone other than the manufacturer or authorized service center may void the instrument's warranty; the warranty should be read carefully to make this determination.

### b. Combustible Gas Indicator (Explosimeter)

Combustible gas indicators (CGI) or explosimeters are used to detect flammable/combustible gases or vapors in air at or approaching concentrations that will support an explosion/fire. CGIs actually measure the concentration of flammable/combustible vapors in air and indicate the result as a percentage of the lower explosive limit of the sample vapors.

Some CGIs also have an oxygen meter to detect oxygen deficiencies in confined, poorly ventilated spaces, or to detect oxygen-enriched atmospheres that may present a potential explosion hazard. Oxygen meters can also be separate instruments. Combination CGI/oxygen meters are discussed in the next subsection.

#### Operation

Combustible gas indicators use a combustion chamber containing a filament that combusts the flammable gas. The vapor sample, drawn through the instrument by the aspirator bulb, passes through the filter and inlet flashback arrestor, contacts the filament, passes through the outlet flashback arrestor, and is exhausted through the bulb. To facilitate combustion the filament is heated or is coated with a catalyst (like platinum or palladium), or both. The filament is part of a balanced resistor circuit called a Wheatstone Bridge. The hot filament combusts the gas on the immediate surface of the element, thus raising the temperature of the filament. As the temperature of the filament increases so does its resistance. This change in electrical resistance causes an imbalance in the Wheatstone Bridge. This is measured as the ratio of combustible vapor present compared to the total required to reach the lower explosive limit (LEL). For example, if the meter reads 50%, this means that 50% of the concentration of combustible gas needed to reach a flammable or combustible situation is present. If the LEL for the gas is 5% then the 50% meter reading indicates that a 2.5%

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concentration is present. Thus, the typical meter readout indicates concentration up to the LEL of the gas.[1]

If a concentration greater than the lower explosive limit (LEL) and lower than the upper explosive limit (UEL) is present, then the meter needle will stay beyond the 100% level on the meter indicating that the ambient atmosphere is readily combustible. When the atmosphere has a gas concentration above the UEL the meter needle will usually rise above the 1.0 (100%) mark and then return to zero because the gas mixture in the combustion cell is too rich to burn. This permits the filament to conduct a current just as if the atmosphere contained no combustibles at all. Some instruments have a lock mechanism that prevents the needle from returning to zero when it has reached 100% but must be reset in an atmosphere below the LEL.[1]

Several models of CGIs are available for testing different types of gases and vapors. For example, one model may be designed for the testing of combustible gases in general, whereas, another model may be suitable for detecting only leaded gasoline vapors. The general purpose model will likely be calibrated with pentane gas, as it is representative of petroleum vapors.

### Limitations

The response of the instrument is temperature dependent. If the temperature at which the instrument is zeroed differs from the sample temperature, the accuracy of the reading is affected. Hotter temperatures raise the temperature of the filament and produce a higher than actual reading. Cooler temperatures will reduce the reading. It is best to calibrate and zero the instrument at the sample temperature.[1]

The instruments are intended for use only in normal oxygen atmospheres. Oxygen-deficient atmospheres will produce lowered readings. Also, the safety guards that prevent the combustion source from igniting a flammable atmosphere are not designed to operate in an oxygen-enriched atmosphere.[1]

Organic lead vapors (e.g., leaded gasoline vapors), sulfur compounds, and silicone compounds (i.e., silicates, salines, etc.) will foul the filament and, therefore, seriously impair the instrument's response. Acid gases (e.g., hydrogen chloride and hydrogen fluoride) can corrode the filament. Most units have an optional filter that protects the sensor from leaded vapors.[5]

There is no difference between petroleum vapors and combustible gases. If the concern is the flammability of the combined vapors and gases in an atmosphere, this is not a problem. However, if the instrument is being used to detect the presence of a released flammable liquid - like gasoline - in a sewer system where methane may be present, the operator can't tell if the reading is the contaminant or the methane. A pre-filter can be used to

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remove the vapors but will not remove the methane. Thus, if readings are made with and without the filter, the user can compare the readings and can conclude that differences in the values indicate that a petroleum vapor (i.e., the contaminant) may be present.[1]

Another limitation is that the CGI is calibrated with one gas (usually methane, hexane, or pentane), but not all combustible gases and vapors will give the same response as the calibration gas. As a result, the instrument may not give an accurate indication of the flammable hazard. Thus, you may have to adjust the recommended danger level to less than 25 percent (e.g., 5 percent) of the lower explosive limit depending on health and safety protocols;

### Use

The use of each particular GCI will vary depending upon the make and model. In order to use the instrument effectively, BSPR personnel must follow the instructions in the owner's manual and practice using the device during training sessions. Only properly trained personnel should attempt to use the GCI meter during emergency incidents.

Proper use of a GCI will generally involve the following tasks and considerations:

- # Attaching any accessories that are needed to help draw air/vapor samples into the instrument (i.e., probe, sampling line, lowering-rope or cable, etc.).
- # Performing an operational (i.e., field) check.
- # "Zeroing" the CGI.
- # Setting the desired concentration levels at which the instrument will activate audio and/or visual alarms, if applicable.
- # Taking readings in desired locations.
- # Recharging or replacing the batteries, when required.
- # Taking care not to expose the instrument to excessive contaminants, dirt, or moisture that may affect readings or that may cause permanent damage to the instrument.
- # Being aware that air currents in the vicinity of the probe may cause fluctuations in readings.
- # Deactivating the GCI/O<sub>2</sub> meter when you are done using it.

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- # Decontaminating the instrument and obtaining proper servicing for it, when required.

When using, calibrating, or maintaining a GCI, BSPR personnel must heed the following precautions to ensure their safety and to prevent damage to the instrument:

- # During incidents, the instrument should be used by only trained personnel wearing appropriate protective gear.
- # The instrument should be used only in atmospheres for which it has been tested and approved for use. Attachment 2.2-2 at the end of this section explains the National Electrical Code's system for classifying flammable and combustible atmospheres by class, division, and group. The owner's manual will identify the specific atmospheres (in terms of the NEC system) for which the CGI is considered "intrinsically safe" (i.e., will not cause an explosion when used properly).
- # The CGI is designed to sample air and vapors only. DO NOT allow any liquids to be drawn into the device. Also, DO NOT allow the instrument to be submerged in liquid.
- # The instrument measures flammable/combustible gases in the vicinity of the operator, so a high CGI reading should be cause for taking appropriate protective actions to ensure the operator's safety.
- # Do not smoke while using or calibrating the instrument.
- # If the CGI fails the field test (i.e., operational check), do not use it until it has been serviced and calibrated.
- # Turn off the instrument before disassembly to avoid electrical shock.
- # Because of physical and chemical hazards, carefully handle gas cylinders during calibration. Never open a cylinder valve without a regulator attached.

### Calibration

CGI manufacturers provide, or sell separately, calibration kits that enable instrument owners to perform needed calibration. The calibration procedure and equipment will be different for each make and model of CGI, therefore, **BSPR personnel must obtain the proper equipment and follow the calibration instructions provided by the manufacturer.** The CGI unit will be calibrated to a combustible gas (e.g. methane) in air. Only

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trained BSPR personnel or an authorized service center should attempt to calibrate a CGI.

Calibration should be performed before each use of the instrument and after each servicing. During long periods of non-usage, the CGI should be calibrated every two to four weeks.

### Maintenance and Servicing

Maintenance and servicing requirements will be different for each make and model of CGI. **Proper maintenance requirements and schedules should appear in the manufacturer's instruction manual.** BSPR personnel should be aware that servicing and/or repair of the instrument by anyone other than the manufacturer or authorized service center may void the instrument's warranty; the warranty should be read carefully to make this determination.

Typically maintenance and servicing that is required for a CGI includes:

- # Calibration - See above.
- # Combustible gas sensor replacement - Whenever the proper sensor heating element voltage cannot be obtained (the voltage can be checked during calibration or servicing).
- # Battery replacement - As necessary for non-rechargeable batteries or whenever rechargeable batteries do not function for their normal operating period following a complete recharge.
- # Fuse check and/or replacement - Whenever the instrument does not operate following battery replacement or a complete battery recharge. (Fuses play an important role in the instrument's intrinsic safety.)

**The owner's manual should be consulted for specific maintenance requirements.**

### c. Combustible Gas Indicator and Oxygen Meter

The combination combustible gas indicator (CGI) and Oxygen (O<sub>2</sub>) meter is a dual-purpose instrument designed to monitor environments for combustible/ flammable gases and/or oxygen deficiency. With its attachable probes, it can monitor confined areas such as sewers, vaults, and utility conduits. The instrument consists of two distinct units (i.e., CGI and O<sub>2</sub> meter) housed in the same casing. A battery-powered pump draws the air sample into a manifold, where it diffuses into the sensors of the CGI and O<sub>2</sub> meter. Each indicator normally has its own warning mechanism (i.e., light and/or alarm).

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### Operation

The design and operation of the CGI portion of the CGI/O<sub>2</sub> meter is similar to that of the independent CGI discussed in subsection 5.b. above. Refer to that subsection for information.

The oxygen meter component of the CGI/O<sub>2</sub> meter can be used to evaluate an atmosphere for the following:

- # Oxygen content for respiratory purposes. Normal air is 20.9% oxygen. Generally, if the oxygen content falls below 19.5%, the air is considered oxygen deficient and special respiratory protection is needed.
- # Increased risk of combustion. Generally, concentrations above 25% are considered oxygen-enriched and increase the risk of combustion.
- # Use of other instruments. Some instruments require sufficient oxygen for operation. For example, some combustible gas indicators do not give reliable results at oxygen concentrations below 10%. Also, the inherent safety approvals for instruments are for normal atmospheres and not for oxygen-enriched ones.
- # Presence of contaminants. A decrease in oxygen content can be due to the consumption (by combustion or a reaction such as rusting) of oxygen, or due to the displacement of air by a chemical. If it is due to consumption, then the concern is the lack of oxygen. If it is due to displacement, then there is something present that could be flammable or toxic, along with the oxygen deficiency hazard.[1]

The oxygen indicator has two principle components for operation. These are the oxygen sensor and the meter readout. Air is drawn into the oxygen detector with a pump. The oxygen detector uses an electrochemical sensor to determine the oxygen concentration in air. A typical sensor consists of: two electrodes; a housing containing a basic electrolytic solution; and a semipermeable Teflon membrane. Oxygen molecules (O<sub>2</sub>) diffuse through the membrane into the solution. Reactions between the oxygen, the solution, and the electrodes produce a minute electric current proportional to the oxygen content. The current passes through the electronic circuit and the resulting amplified signal is shown as a needle deflection on a meter or digital reading.[1]

### Limitations

The operation of oxygen meters depends on the absolute atmospheric pressure. The concentration of natural oxygen is a function of the atmospheric pressure at a given altitude. While the actual percentage of

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oxygen does not change with altitude, at sea level the weight of the atmosphere above is greater, and more O<sub>2</sub> molecules (and the other components of air) are compressed into a given volume than at higher elevations. As elevation increases, this compression decreases, resulting in fewer air molecules being "squeezed" into a given volume. Consequently, an O<sub>2</sub> indicator calibrated at sea level and operated at an altitude of several thousand feet will falsely indicate an oxygen-deficient atmosphere because less oxygen is being "pushed" into the sensor. Therefore, it is necessary to calibrate the instrument at the altitude at which it will be used.[1]

High concentrations of carbon dioxide (CO<sub>2</sub>) shorten the useful life of the oxygen sensor. As a general rule, the unit can be used in atmospheres greater than 0.5% CO<sub>2</sub> only with frequent replacing or rejuvenating of the sensor. Sensor lifetime in a normal atmosphere (0.04% CO<sub>2</sub>) can be from one week to one year depending on the manufacturer's design. Strong oxidizing chemicals, like ozone and chlorine, can cause increased readings and indicate high or normal oxygen content when the actual content is normal or even low.[1]

Temperature can affect the response of oxygen indicators, as well. Their normal operating range is between 32°F and 120°F. Between 0°F and 32°F the sensor may be damaged by the electrolytic solution freezing. The instrument should always be calibrated at the temperature at which it will be used.[1]

### Use

The use of each particular CGI/O<sub>2</sub> meter will vary depending upon the make and model. In order to use the instrument effectively, **BSPR personnel must follow the instructions in the owner's manual** and practice using the device during training sessions. **Only properly trained personnel should attempt to use the CGI/O<sub>2</sub> meter during emergency incidents.**

Proper use of a CGI/O<sub>2</sub> meter will generally involve the following tasks and considerations:

- # Attaching any accessories that are needed to help draw air/vapor samples into the instrument (i.e., probe, sampling line, lowering-rope or cable, etc.).
- # Performing an operational (i.e., field) check.
- # Calibrating the oxygen meter to the percent oxygen (by volume) in fresh air (normally 20.8-20.9% at sea level), and "zeroing" the CGI.

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- # Setting the desired concentration levels at which each component of the instrument (i.e., CGI and O<sub>2</sub> meter) will activate audio and/or visual alarms.
- # Taking readings in desired locations.
- # Recharging or replacing the battery, when required.
- # Taking care not to expose the instrument to excessive contaminants, dirt, or moisture that may affect readings or that may cause permanent damage to the instrument.
- # Being aware that air currents in the vicinity of the probe or sensor may cause fluctuations in readings.
- # Deactivating the CGI/O<sub>2</sub> meter when you are finished using it.
- # Decontaminating the instrument and obtaining proper servicing for it, when required.

When using, calibrating, or maintaining a CGI/O<sub>2</sub> meter, BSPR personnel must heed the following precautions to ensure their safety and to prevent damage to the instrument:

- # During incidents, the instrument should be used only by trained personnel wearing appropriate protective gear.
- # The instrument should be used only in atmospheres for which it has been tested and approved for use. Attachment 2.2-2 at the end of this section explains the National Electrical Code's system for classifying flammable and combustible atmospheres by class, division, and group. The owner's manual will identify the specific atmospheres (in terms of the NEC system) for which the CGI/O<sub>2</sub> meter is considered "intrinsically safe" (i.e., will not cause an explosion when used properly).
- # The CGI/O<sub>2</sub> meter is designed to sample air and vapors only. DO NOT allow any liquids to be drawn into the sensors. Also, DO NOT allow the instrument to be submerged in liquid.
- # The instrument measures oxygen deficiency and flammable/combustible gases in the vicinity of the operator, so a high CGI reading or a low or high oxygen meter reading should be cause for taking appropriate protective actions to ensure the operator's safety.
- # Do not smoke while using or calibrating the instrument.

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- # Prior to taking readings, allow a few minutes for the instrument to adjust to large temperature changes (e.g., temperature in BSPR response vehicle compared to very cold or very hot outside temperature). In extreme cold, the oxygen sensor will freeze and, therefore, not function.
- # If the CGI/O<sub>2</sub> meter fails the field test (i.e., operational check), do not use it until it has been serviced and calibrated.
- # Do not expose the instrument to hazardous gases for long periods as this may degrade the oxygen sensor.
- # Turn off the instrument before disassembly to avoid electrical shocks.
- # Because of physical and chemical hazards, carefully handle gas cylinders during calibration. Never open a cylinder valve without a regulator attached.

### Calibration

CGI/O<sub>2</sub> meter manufacturers provide, or sell separately, calibration kits that enable instrument owners to perform needed calibration. The calibration procedure and equipment will be different for each make and model of CGI/O<sub>2</sub> meter, therefore, **BSPR personnel must obtain the proper equipment and follow the calibration instructions provided by the manufacturer.** The CGI unit will be calibrated to a combustible gas (e.g., pentane) in air, while the O<sub>2</sub> meter will be calibrated to fresh air containing its normal 20.8-20.9% oxygen (at sea level) by volume. Only trained BSPR personnel or an authorized service center should attempt to calibrate a CGI/O<sub>2</sub> meter.

Calibration should be performed before each use of the instrument and after each servicing. It should also be performed after each use of the device. During long periods of non-usage, the CGI/O<sub>2</sub> meter should be calibrated every two weeks.

### Maintenance and Servicing

Maintenance and servicing requirements will be different for each make and model of CGI/O<sub>2</sub> meter. **Proper maintenance requirements and schedules should appear in the manufacturer's instruction manual.** BSPR personnel should be aware that servicing and/or repair of the instrument by anyone other than the manufacturer or authorized service center may void the instrument's warranty; the warranty should be read carefully to make this determination.

Typical maintenance and servicing that is required for a CGI/O<sub>2</sub> meter includes:

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- # Calibration - See above.
- # Combustible gas sensor replacement - Whenever the proper sensor heating element voltage cannot be obtained (the voltage can be checked during calibration or servicing).
- # Oxygen sensor replacement - Whenever the O<sub>2</sub> meter does not register 20.8-20.9% oxygen (at sea level) when subjected to a fresh air sample.
- # Battery replacement - Whenever the battery does not function for its normal operating period following a complete recharge.
- # Fuse check and/or replacement - Whenever the instrument does not operate following a complete battery recharge. (Fuses play an important role in the instrument's intrinsic safety.)

**The owner's manual should be consulted for specific maintenance requirements.**

### d. Sampling Pump

The 1.7 inch hand-operated sampling pump is used by BSPR personnel to sample liquids from ground-water monitoring wells whose diameters are greater than or equal to 2 inches. The pump functions by the positive displacement principle. The pump, with pipe extensions attached, permits sampling to depths of 100 ft. The pump has a user variable pumping rate up to 4 gpm and is chemically and physically compatible with a wide range of ground-water conditions. The device is primarily composed of polyvinyl chloride and stainless steel pins. Although it is portable, the pump can also be used as a dedicated pump.

### Operation

**Assembly and operating instructions are provided in the owner's manual and should be read and followed carefully.** Basically, the pump must be assembled each time it is used. The owner's manual provides step-by-step instructions and diagrams to assist the user in assembling the pump and extensions. Since the pump is being placed into the well during assembly, it is ready to use upon being "assembled." The pump is operated by stroking the actuating pipe through a range of approximately 18 inches. The fluid will then rise through the pipe segments up to the well head fixture where it will discharge through the well head outlet. BSPR personnel may wish to attach a piece of tubing to the outlet in order to direct the flow of fluid into sample bottles.

An important feature of the hand pump is that a controlled amount of leakage has been designed into the pump's reverse flow check valve system. This enables the water level in the pump to return to a static water

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level to prevent freezing in cold environments. Another advantageous design feature is that a pneumatic actuator can be attached to the actuating pipe to automatically operate the pump during extended operations.

When using the pump, it is important that the bottom of the pump cylinder be submerged slightly below the water level in the well and preferably be positioned at or near the bottom of the well installation.

### Maintenance, Care, and Servicing

The hand pump requires little maintenance and care other than cleaning following use. During assembly/disassembly, it is important that the pump's "O" rings not be exposed to direct sunlight for an extended period. Likewise, after use, the "O" rings must be stored in a dark enclosure. Following use, the pump and all its attachments must be thoroughly cleaned. **The owner's manual should be consulted for specific procedures.** The manual should also include a trouble-shooting guide with corrective measures.

#### e. Sonic Interface Tape

A sonic interface tape is used by BSPR personnel to measure hydrocarbon/water interface in ground-water monitoring wells. The instrument features a sonic probe suspended at the end of a specially treated antistatic gauging tape that is marked in feet and inches. The tape is wound upon a reel assembly that contains audible and visual indicators, handle-locking ratchet, and, most likely, a tape-wiping mechanism. The probe operates on a dual principle: sonic for level indication and conductivity for water sensing. The instrument is battery powered and may feature an automatic turn-off mechanism in case the operator forgets to shut off the power. The unit should be approved by a testing laboratory (e.g., Factory Mutual, British Approvals Service, etc.) as being intrinsically safe for use in flammable atmospheres. It should also have a grounding lug for grounding purposes. BSPR uses models with tapes in lengths of 100, 120, and 150 feet.

When the probe is immersed in a non-conductive liquid such as oil or gasoline, the signal that is heard will be different than the signal that is heard when the probe is immersed in water (because water is conductive). The visual indicators will be different for each medium, as well. For example, when the probe is immersed in oil, a continuous tone is heard and an amber-colored light is illuminated. Then, when the probe enters the water interface, the signal changes to an intermittent tone and a red light is illuminated. At each level (i.e., air/hydrocarbon interface and hydrocarbon/water interface) the tape is checked for a measurement in relation to a desired reference point at or near ground level. A precise measurement, usually within 1/16 inch, is normally possible.

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**In order to use the sonic interface tape effectively, BSPR personnel should read and carefully follow the instructions provided in the owner's manual.** Only properly trained personnel should use the instrument in the field.

The sonic interface tape requires a minimum of maintenance and care. Following use, the tape should be wiped clean as it's being rewound; the unit may have a tape wiping mechanism for this purpose. The battery(ies) should be checked weekly and replaced or recharged as necessary. Audio/visual indicators should be checked each time the batteries are checked and replaced/repared as necessary. The probe should be tested regularly and serviced/adjusted by the manufacturer or an authorized service center when necessary. **BSPR personnel should consult the instruction manual for specific maintenance schedules and procedures.**

### f. Water Level Meter

BSPR personnel use a water level meter to measure water levels in wells and standpipes. The meter consists of a measuring cable with a probe attached to one end. The cable is wound upon a reel that also contains a control panel. The panel is composed of an on-off/sensitivity switch, an indicator light, and a buzzer. The meter is battery powered and must be grounded. The cable is 150 feet in length and has depth markings at one-foot increments. The cable has a polyurethane jacket, and the probe is stainless steel insulated with polyethylene. The meter indicates (by buzzer and light) when the lowered probe makes contact with water. The amount of cable is then checked for depth measurement.

**In order to operate the water level meter effectively, BSPR personnel should read and follow the directions provided in the instruction manual.** In short, the meter is activated by turning the on-off/sensitivity knob to the "ON" position and setting the sensitivity to the appropriate level. The instruction manual should be consulted to assist you in determining the appropriate sensitivity setting, which relates to the quality of the water being checked (i.e., pure, saline, contaminated, etc.). With the sensitivity adjusted, the probe is lowered down the well or standpipe until the indicators go off. The cable measurement is then taken in relation to a desired reference point at or near ground level. Once again, the owner's manual should be consulted to assist you in making precise measurements.

The maintenance and care required for this instrument is quite simple. Following use, you may need to wipe off the cable as it's being retracted onto the reel. You should also wipe clean the probe. Batteries should be checked weekly and replaced or recharged as necessary. Audio/visual indicators should be checked each time the batteries are checked and replaced/repared as necessary. The meter's probe and sensitivity knob should also be checked regularly and adjusted by the manufacturer or an authorized service center when necessary. **BSPR personnel should**

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**consult the owner's manual for specific maintenance procedures and schedules.**

### g. Magnetic Locator

A magnetic locator is an instrument used for locating iron pipes, tanks, manhole covers, well casings, valves, etc. that are buried underground. The instrument functions by detecting the magnetic field of a ferromagnetic object. The magnetic locator consists of an electronic unit (containing batteries, loud speaker, controls, etc.) and a long, pole-shaped locator that houses the sensors. A headset is optional, for increased listening effectiveness.

#### Operation

A magnetic locator has two magnetic-field sensors (two sensors are necessary to balance out the effect of the earth's magnetic field) spaced approximately 18-20 inches apart. The frequency of the signal present on the instrument's loud speaker changes when the magnetic field at one sensor becomes stronger than that at the other sensor. For example, if the locator tip is held above a buried valve, the valve's magnetic field will be stronger at the lower sensor (i.e., sensor closest to the valve). As a result, the frequency of the signal on the speaker is higher than its idling frequency which exists when the field is the same at both sensors.

#### Use

A magnetic locator is fairly simple to operate, as it is light weight and normally has only two controls to operate: an on-off/volume control and a sensitivity range control. The sensitivity control will usually be set for a mid-range (or normal) for most applications but can be set for low or high sensitivity as required. The low sensitivity setting is used when there are unwanted background signals caused by nearby magnetic objects such as fences or visible manhole covers. The reduced range is useful in pinpointing strongly magnetized objects. The high sensitivity setting is used when the buried object is not near other buried magnetic objects or when the searched-for object has a weak magnetic field. A high sensitivity setting, however, will impose some constraints on operating methods.

**In order to use a magnetic locator effectively, BSPR personnel should follow the instructions provided in the manufacturer's user manual.**

Briefly stated, the instrument is operated by setting the sensitivity range control to the desired setting and grasping the device at the top of the locator just below the electronic unit. The operator must not wear a wrist watch, as it may cause changes in the tone frequency due to its proximity to the upper sensor. The operator should also avoid bringing the locator close to his/her shoes in case they contain any magnetic material. When searching for an object, the operator should sweep the locator from side to side. When the frequency tone starts to get higher, aim the locator in the

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area where the tone is loudest. Your precise search pattern and the manner in which to orient the locator will depend upon the type of object you are looking for and the presence of other objects. A skilled operator will be able to differentiate between various objects of different sizes and shapes (e.g., tanks versus manhole covers, or valves versus pipes) based on his/her search pattern and tone interpretation skills. Again, the owner's manual should describe the various search patterns and instrument orientations and provide tips on how to locate specific objects and how to differentiate between objects that are located. The instruction manual will also describe how to use the magnetic locator in snow or shallow water conditions.

That the operator should also be aware of the following:

- # The electronic unit must not be immersed in water or snow.
- # A burbling sound from the speaker indicates the presence of an energized power line.
- # The instrument will not detect nonmagnetic materials such as copper, brass, water, etc.
- # Buried telephone cables are usually undetected.

### Maintenance and Servicing

A magnetic locator requires little maintenance and does not require calibration. Normally, maintenance is limited to replacement of batteries on an "as-needed" basis. Batteries, however, must be removed and installed in the order shown in the instruction manual. The manual should also contain a trouble-shooting guide. If remedial instructions offered in the instruction manual do not solve instrument problems, the magnetic locator should be returned to the dealer or manufacturer for servicing. **BSPR personnel should refer to the owner's manual for specific maintenance instructions.**

### h. PCB Test Kits

Test kits are available for determining the concentration levels of polychlorinated biphenyls (PCB) in transformer oil and soils that have absorbed transformer oil spills. Test kits are also available for determining the concentration levels of various chlorine compounds contained in waste or used oils. The kits are used to make a quick, on-scene determination of whether PCBs or chlorine compounds are present and, if so, whether they're in a concentration above or below the significant concentration levels (i.e., 50, 500, and 1000 ppm) cited in EPA regulations and in the Toxic Substances Control Act. If the test reveals a level above 50 ppm, BSPR personnel should take immediate safety precautions and

## NOTES

obtain a complete laboratory analysis of additional samples to determine the exact concentration level.

### PCB Test Kit for Transformer Oil

The PCB test kit for screening transformer oil (i.e., no soil mixed in) includes two polyethylene tubes containing chemicals that react with the oil sample to produce a color change, where various shades of purple indicate less than 50 ppm and clear or pale yellow liquid indicates over 50 ppm. The kit works on the principle of chloride determination, as PCBs contain chlorine. A kit designed to measure concentrations above or below 500 ppm is also available and functions similarly to the 50 ppm kit.

During the test, a precise amount of transformer oil is placed into a tube containing a catalyst and metallic sodium. The sodium, activated by the catalyst, strips chlorine from the PCBs and forms sodium chloride. A buffer solution in water is then added to the oil to neutralize the excess sodium and to extract the sodium chloride into the water. The aqueous (saltwater) layer is then separated from the oil and placed into a second tube. Here, the water is mixed with a reagent (dissolved mercuric nitrate) and then with an indicator substance. The color of the solution following the reaction (which takes only 10-15 seconds) reveals whether the PCB concentration level is greater or less than 50 ppm. **BSPR personnel should use the test kit in accordance with the manufacturer's instructions.**

When using the test kit, the user should be aware of the following precautions and considerations:

- # The contents of the ampules inside the test tubes (sodium, catalyst, reagent, and indicator) are poisonous. Appropriate gloves and safety glasses or goggles should be worn in case of breakage or leak.
- # The kit contains metallic sodium, which is a flammable solid and reactive with water.
- # The ampules are made of glass and must be crushed within the plastic test tube by the user's fingers. Once each glass ampule has broken, never attempt to further crush the glass as the pieces may cut through the plastic and injure fingers. Again, wearing appropriate gloves will serve to protect against this possibility.
- # If the test tubes or their contents become contaminated by salt from perspiration or sea water, the test will give a "false" positive result even when the oil sample itself is less than 50 ppm. If salt contamination is known to have occurred, the test will have to be repeated with another test kit.

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- # If the oil sample contains any water, the test will not work. Signs of water in the oil during the test include:
  - The tube getting noticeably warm;
  - Pressure buildup in the tube;
  - Oil sample loses its gray color (in middle portion of test).
  
- # The test must be performed in a warm, dry area. In cold weather, the inside of a heated vehicle should suffice.
  
- # If, during the test, the oil layer is below the buffer solution level following mixing, stop the test. This is an indication that the oil sample is nearly pure PCB (Askarel). Continuing the test further will transfer the oil, instead of the desired salt water, into the second tube, thus, causing false results.
  
- # If time permits and there are several test kits available, it may be advisable to repeat the test to ensure that the results are reliable.
  
- # Upon completing the test, the tubes and their contents, considered as PCB waste, should be disposed of properly.

A key limitation of the PCB test kit is that testing cannot distinguish between PCBs and any other chlorine-containing compound (e.g., trichlorobenzene) that may also be in the transformer oil sample. This may cause a false positive result, in that testing of the oil sample may indicate the presence of over 50 ppm PCBs even when the sample itself is under 50 ppm.

The test kit should be stored in a cool dark place. It has a relatively short shelf life, so it will require replacement upon reaching its expiration date. The date of expiration should be clearly marked on the test kit box. Outdated kits should not be used for testing purposes.

### PCB Test Kit for Transformer Oil-Contaminated Soils

The PCB test kit for screening soils that are contaminated with transformer oil containing PCBs operates by the same principle as the previously described PCB test kit for transformer oil samples. The test procedure, however, is a little more complicated due a few extra initial steps involving additional test kit components. During these initial steps, the person conducting the test must take action to extract the PCB oil from the soil sample. This is done by weighing a precise amount of soil (per instructions) and placing it into the kit's empty plastic test tube. An extraction solvent is then added to the tube to draw off PCBs from the soil

## NOTES

layer. The solution containing the PCBs is then passed through a filter tube into the reaction tube. From this point on, the procedure is identical to that described above for the PCB test kit for transformer oil (i.e., no soil mixed in). The same precautions, considerations, and limitations also apply. As with the other test kit, **BSPR personnel should use this kit in accordance with the manufacturer's instructions supplied in the kit.**

### Chlorinated Compound Test Kit for Waste/Used Oils

The test kit for screening waste or used oils for chlorinated compounds operated by the same principle as the above described PCB kits. The test kit normally works well on all types of used and waste oils including crankcase, hydraulic, diesel, lubricating, fuel oils and kerosene. The kit will not work, however, on oil samples that contain more than 30% water. A sample containing water can normally be determined quite easily, as the syringe sampler's plastic tubing used in one of the early steps will lose its gray color if the sample contains water.

The test procedure is very similar to that described for the PCB test kit for transformer oil but is a little more complicated due to a few additional steps. For example, an initial step involves drawing an oil sample (by use of a syringe sampler and glass capillary) in a specialized manner described in the instructions and transferring it to the reaction tube. The other extra step involves using the supplied plastic filtration funnel when transferring the solution from the reaction tube to the tube containing the reagent and indicator substance. Otherwise, the procedure is the same as that used when utilizing the PCB test kit for transformer oil. The same precautions, considerations, and limitations apply, as well. As with the PCB test kits, **BSPR personnel should use this kit in accordance with the manufacturer's instructions provided with the kit.**

### i. Containment Boom

Containment booms are used to confine a floating spill on the water surface so that the substance can be collected and removed. BSPR utilizes a boom that consists of plastic material containing rolled foam. The boom is a miniature version of the full-size boom deployed in harbors, thus, it is referred to as a "mini-boom". It is designed for use on non-turbulent, narrow waterways. BSPR uses the 25-foot long booms that can be fastened together when necessary.

Mini booms can be deployed from shore or from boats. The boom is often anchored at each end (a shoreline usually provides a good anchor). Boom lengths are chosen based upon the size and volume of the spill, the width of the waterway, and the velocity of the current. The boom should normally be placed across the stream on an angle (approx. 30°) and pulled taut so that the floating, spilled substance will be diverted into a pocket on one side of the stream at the shoreline/boom connection point. This allows for shore-based removal of the contained substance during clean-up operations.

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When currents are too strong to set up the boom in this manner, the boom can be stretched across the stream less tautly so that it will bow out into a widened "U" shape. When set up in this manner, the floating substances will collect in the center of the stream, thus, making removal more complicated (most likely necessitating the use of a boat). **Booms and boom deployment are discussed in more detail in Part 1, Section 6, No. 5, Free Product on Water Surface. BSPR personnel should refer to that subsection when deploying booms.**

A containment boom holds only a limited amount of product before the product will overflow the boom collar. Only substances that are lighter than or near the density of water can be collected with containment booms. A substance that is denser than water will sink in the water column to a point where it can flow underneath the boom. Containment booms are useful only when ambient wind conditions are less than 20 miles per hour, as higher wind speeds will blow collected product over the collar, thus limiting its effectiveness. High, fast-flowing water will make boom deployment difficult and dangerous and may undermine the boom's effectiveness, possibly to the point of total uselessness.

Since boom deployment involves working in, on, or near water, BSPR personnel should always wear life jackets and other appropriate protective equipment when deploying booms. Stretching and anchoring of booms may require personnel to enter shallow streams on occasion. In such cases, when setting the boom in position, check the stream's depth with a branch or pole prior to each step forward. A muddy or dark-colored stream will make it difficult to see sudden drops in the stream bottom. Testing with a branch or pole for depth and for bottom composition (i.e., gravel, sand, mud) may prevent you from getting wet (above your wader boots) and contaminated (by floating product) and/or stuck in mud.

Following use, the mini-boom can usually be decontaminated so that it can be reused. BSPR may assign the task of decontaminating their booms to the agency or contractor who is responsible for cleaning up and removing the contained substance from the waterway. If BSPR personnel must clean the booms themselves, they must consult technical assistance sources for the proper decontamination solutions and procedures. Following decontamination, the booms should be wiped or air dried before being folded and stored them.

### j. Overalls and Gloves for Hazardous Environments

BSPR personnel are provided with various clothing to protect them from the weather and from hazards. Most of the clothing is for weather-related protection. Clothing meant for protection from hazardous substances and petroleum include tyvek overalls and various splash protection gloves (e.g., neoprene, butyl, etc.). These overalls and gloves provide limited protection to BSPR personnel, but should, nonetheless, be worn when required. **Selection and use of personal protective clothing and**

## NOTES

**equipment is covered in Part 2, Section 1, Personal Health and Safety Protection. BSPR personnel should refer to that section when selecting and using protective gear.**

Following use of tyvek overalls, it is recommended that BSPR personnel discard them if they are contaminated, torn, or otherwise damaged. If they are to be saved for future use, BSPR personnel should clean the overalls thoroughly and air-dry them prior to folding and storing them. Neoprene and other specialized gloves can be quite expensive and should, therefore, be cleaned and reused whenever possible. On the other hand, gloves that are grossly contaminated, torn, degraded, or otherwise damaged should be discarded. Salvageable gloves should be decontaminated with appropriate solutions, rinsed, and air dried prior to storage.

### k. Escape Air Pack

BSPR personnel are equipped with a 5-minute duration supplied-air respiratory unit that is intended to provide them with sufficient air to escape from a toxic or oxygen-deficient atmosphere. The air pack consists of a small compressed air cylinder, a cylinder pouch/harness assembly, anti-fogging plastic (usually polyurethane) hood, detachable regulator, and breathing air tube. The components are normally corrosion resistant, and the air tube is usually reinforced with a stainless steel spring to eliminate crimping. The air tube may also be permanently fused to the hood. The air packs are normally approved by NIOSH and MSHA.

In order to use the 5-minute air pack safely and effectively, BSPR personnel should refer to the owner's manual. Basically, the air pack can be worn, at the user's discretion, with the strap around the neck, over the shoulder, or around the waist. Either way, the pouch/air cylinder is worn at waist level. The hood is placed over the head and a pull cord is adjusted for a comfortable fit. The on-off valve is then turned on to provide a continuous flow of fresh air. The air valve is normally designed for full flow and cannot be set for partial flow. The unit delivers 5 minutes of air and is not intended for use while working. **BSPR personnel should only use the air pack for protection while escaping from a known or suspected toxic or oxygen-deficient atmosphere.**

The escape air pack is fairly easy to maintain. Following use, the unit should be decontaminated and inspected and the air cylinder recharged in accordance with manufacturer's instructions. The hood may require replacement if heavily contaminated or damaged. During periods of non-usage, the air pack's cylinder pressure should be checked weekly and the cylinder recharged if necessary. Repeated recharging is a sign of leakage and, if this occurs, the cylinder and appurtenances should be checked and repaired. At least every six months, the air pack should undergo a complete inspection. At this time, the following maintenance should occur:

## NOTES

- # Unfold the hood and inspect for holes, tears, or other damage and for cleanliness. Check the neckband or drawstring for damage.
- # Check the condition of the air hose and make sure that it can be (is) securely attached to the hood.
- # Check the harness and pouch for holes and weak spots in the stitching.
- # Test the air pack by putting it on and turning the control to the ON position.
- # Have the cylinder checked and recharged by a qualified individual or authorized service center.
- # Replace or repair any damaged components of the air pack.

**For specific information regarding the maintenance, servicing, and storage of your 5-minute escape air pack, refer to the instruction manual provided by the manufacturer.**

## **REFERENCES**

1. Hazardous Materials Incident Response Operations, EPA, Office of Emergency and Remedial Response, Hazardous Response Support Division, 1988.

Attachment 2.2-1

Monitoring Equipment for General  
and Specific Surveys

Some Direct-Reading Instruments for General Survey

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Combustible Gas Indicator (CGI)	Combustible gases and vapors.	Measures the concentration of a combustible gas or vapor.	A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.	Accuracy depends, in part, on the difference between the calibration and sampling temperatures. Sensitivity is a function of the differences in the chemical and physical properties between the calibration gas and the gas being sampled.  The filament can be damaged by certain compounds such as silicones, halides, tetraethyl lead, and oxygen-enriched atmospheres.  Does not provide a valid reading under oxygen-deficient conditions.	Effective use requires that operator understand the operating principles and procedures.	Recharge or replace battery. Calibrate immediately before use.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Flame Ionization Detector (FID) with Gas Chromatography Option	Many organic gases and vapors.	In survey mode, detects the total concentrations of many organic gases and vapors. In gas chromatography (GC) mode, identifies and measures specific compounds.  In survey mode, all the organic compounds are ionized and detected at the same time. In GC mode, volatile species are separated.	Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.	Does not detect inorganic gases and vapors, or some synthetics. Sensitivity depends on the compound.  Should not be used at temperatures less than 40 °F (4 °C).  Difficult to absolutely identify compounds.  High concentrations of contaminants or oxygen-deficient atmospheres require system modification.  In survey mode, readings can be only reported relative to the calibration standard used.	Requires experience to interpret data correctly, especially in the GC mode.  Specific identification requires calibration with the specific analyte of interest.	Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual. Check for leaks.	8 hours; 3 hours with strip chart recorder.

## Attachment 2.2-1

Monitoring Equipment for General  
and Specific Surveys  
(continued)

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Portable Infrared (IR) Spectrophotometer	Many gases and vapors.	Measures concentration of many gases and vapors in air.  Designed to quantify one- or two-component mixtures.	Passes different frequencies of IR through the sample.  The frequencies adsorbed are specific for each compound.	In the field, must make repeated passes to achieve reliable results.  Requires 115-volt AC power.  Not approved for use in a potentially flammable or explosive atmosphere.  Interference by water vapor and carbon dioxide.  Certain vapors and high moisture may attack the instrument's optics, which must then be replaced.	Requires personnel with extensive experience in IR spectrophotometry.	As specified by manufacturer.	
Ultraviolet (UV) Photolionization Detector (PID)	Many organic and some inorganic gases and vapors.	Detects total concentrations of many organic and some inorganic gases and vapors. Some identification of compounds is possible if more than one probe is used.	Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.	Does not detect methane.  Does not detect a compound if the probe used has a lower energy level than the compound's ionization potential.  Response may change when gases are mixed.  Other voltage sources may interfere with measurements.  Readings can only be reported relative to the calibration standard used.  Response is affected by high humidity.	Effective use requires that the operator understand the operating principles and procedures, and be competent in calibrating, reading, and interpreting the instrument.	Recharge or replace battery.  Regularly clean lamp window.  Regularly clean and maintain the instrument and accessories.	10 hours; 5 hours with strip chart recorder.
Gamma Radiation Survey Instrument	Gamma radiation.	Environmental radiation monitor.	Scintillation detector.	Does not measure alpha or beta radiation.	Extremely easy to operate, but requires experience to interpret data. Rugged, good in field use.	Must be calibrated annually at a specialized facility.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

## Attachment 2.2-1

Monitoring Equipment for General  
and Specific Surveys  
(continued)

## Air Monitoring

## Some Direct-Reading Instruments for Specific Survey

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Direct-Reading Colorimetric Indicator Tube	Specific gases and vapors.	Measures concentrations of specific gases and vapors.	The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.	The measured concentration of the same compound may vary among different manufacturers' tubes. Many similar chemicals interfere. Greatest sources of error are (1) how the operator judges stain's end-point, and (2) the tube's limited accuracy. Affected by high humidity.	Minimal operator training and expertise required.	Do not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate prior to use to maintain shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.	
Oxygen Meter	Oxygen (O <sub>2</sub> ).	Measures the percentage of O <sub>2</sub> in air.	Uses an electrochemical sensor to measure the partial pressure of O <sub>2</sub> in the air and converts that reading to O <sub>2</sub> concentration.	Must be calibrated prior to use to compensate for altitude and barometric pressure. Certain gases, especially oxidants such as ozone, can affect readings. Carbon dioxide (CO <sub>2</sub> ) poisons the detector cell.	Effective use requires that the operator understand the operating principles and procedures.	Replace detector cell according to manufacturer's recommendations. Recharge or replace batteries prior to expiration of the specified interval. If the ambient air is more than 0.5% CO <sub>2</sub> , replace or rejuvenate the O <sub>2</sub> detector cell frequently.	8 to 12 hours.

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

### Inherent Safety of Portable Monitors

The portable instrumentation used to characterize hazardous material spills or waste sites must be safe to use. Electrical devices, including instruments, must be constructed in such a fashion as to prevent the ignition of a combustible atmosphere. The sources of this ignition could be: an arc generated by the power source itself or the associated electronics, or a flame or heat source necessary for function of the instrument. Several engineering, insurance, and safety organizations have standardized test methods, established inclusive definitions, and developed codes for testing electrical devices used in hazardous locations. The National Fire Protection Association (NFPA) has created minimum standards in its National Electrical Code (NEC) published every 3 years. This code spells out among other things:

- Types of areas in which hazardous atmospheres can be generated and the types of materials that generate these atmospheres.
- Design safeguards acceptable for use in hazardous atmospheres.

#### 1. Hazardous Atmospheres

Depending upon the response worker's background, the term "hazardous atmosphere" conjures up situations ranging from toxic air contaminants to flammable atmospheres. For the National Electric Code (NEC) purposes, an atmosphere is hazardous if it meets the following criteria:

- It is a mixture of any flammable material in air whose concentration is within the material's flammable range (LFL to UFL) i.e. between the material's lower flammable limit (LFL) and its upper flammable limit (UFL).
- There is the potential for an ignition source to be present.
- The resulting exothermic reaction could propagate beyond where it started.

To adequately describe the characteristics of those environments and what controls can be used, the National Electrical Code defines each characteristic.

##### a. Class and Group

Class is a category describing the type of flammable material that produces the hazardous atmosphere:

- Class I is flammable vapors and gases, such as gasoline and hydrogen. Class I is further divided into groups A, B, C, and D on the basis of similar flammability characteristics.

Inherent Safety of Portable Monitors  
(continued)

- Class II consists of combustible dusts like coal dust or grain dust and is divided into groups E, F, and G.
- Class III is ignitable fibers such as produced by cotton milling.

b. Division

Whereas the flammability of a material may define the hazard associated with a given product, the occurrence of release (how often the material generates a hazardous atmosphere) dictates the risk.

Division is the term describing the "location" of generation and release of the flammable material.

- Division 1 is a location where the generation and release are continuous, intermittent, or periodic into an open, unconfined area under normal conditions.
- Division 2 is a location where the generation and release are only from ruptures, leaks or other failures from closed systems or containers.

Using this system, a hazardous atmosphere can be routinely and adequately defined. As an example, a spray-painting operation using acetone solvent paint would be classified as a Class I, Division 1, Group D environment. Additionally, an abandoned waste site containing intact closed drums of methyl ethyl ketone, toluene and xylene would be considered a Class I, Division 2, Group D environment. However, when transferring of the flammable liquids takes place at the site, or if releases of flammable gases/ vapors is considered normal, those areas would be considered Class I, Division 1.

2. Controls

The following three methods of construction exist to prevent a potential source from igniting a flammable atmosphere:

- Explosion-proof: Encase the ignition source in a rigidly built container. Explosion-proof instruments may allow a flammable atmosphere to enter. If an arc is generated, the ensuing explosion is contained within the specially built enclosure. Within it, any flames or hot gases are cooled prior to exiting into the ambient flammable atmosphere so that the explosion does not spread into the environment.

## Attachment 2.2-2

### Inherent Safety of Portable Monitors (continued)

- **Intrinsically Safe:** Reduce the potential for arcing among components by encasing them in a solid insulating material. Also, reducing the instrument's operational current and voltage below the energy level necessary for ignition of the flammable atmosphere provides equal protection. An "intrinsically safe" device, as defined by the National Electrical Code, "is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration. Abnormal conditions shall include accidental damage to any wiring, failure of electrical components, application of overvoltage, adjustment and maintenance operations, and other similar conditions".
  
- **Purged:** Buffer the arcing or flame-producing device from the flammable atmosphere with an inert gas. In a pressurized or "purged" system, a steady stream of, for example, nitrogen or helium is passed by the potential arcing device, keeping the flammable atmosphere from the ignition source. This type of control, however, does not satisfactorily control analytical devices that use flame or heat for analysis such as a combustible gas indicator (CGI). It also requires a source of gas which would reduce instrument portability.

Portable instruments are usually designed as intrinsically safe rather than explosion-proof or purged.

### 3. Certification

Certification means that if a device is certified as explosion-proof, intrinsically safe, or purged for a given Class, Division, and Group, and is used, maintained, and serviced according to the manufacturer's instructions, it will not contribute to ignition. The device is not, however, certified for use in atmospheres other than those indicated. All certified devices must be marked to show Class, Division, and Group.

Any manufacturer wishing to have an electrical device certified must submit a prototype to a laboratory for testing. If the unit passes, it is certified as submitted. However, the manufacturer agrees to allow the testing laboratory to randomly check the manufacturing plant at any time, as well as any marketed units. Furthermore, any change in the unit requires the manufacturer to notify the test laboratory, which can continue the certification or withdraw it until the modified unit can be retested. NFPA does not do certification testing. Testing is done by such organizations as Underwriters' Laboratory (UL) or Factory Mutual (FM).

Attachment 2.2-2

Inherent Safety of Portable Monitors  
(continued)

To ensure personnel safety, it is recommended that only approved instruments be used on-site and only in atmospheres for which they have been certified. When investigating incidents involving unknown hazards, the monitoring instruments should be rated for use in the most hazardous locations. The following points will assist in selection of equipment that will not contribute to ignition of a hazardous atmosphere:

- The mention of a certifying group in the manufacturer's equipment literature does not guarantee certification.
- Some organizations test and certify instruments for locations different from the NEC classification. The Mine Safety and Health Administration (MSHA) tests instruments only for use in methane-air atmospheres and in atmospheres containing coal dust.
- In an area designated Division 1, there is a greater probability of generating a hazardous atmosphere than in Division 2. Therefore, the test protocols for Division 1 certification are more stringent than those for Division 2. Thus a device approved for Division 1 is also permitted for use in Division 2, but not vice versa. For most response work this means that devices approved for Class I (vapors, gases), Division 1 (areas of ignitable concentrations), Groups A, B, C, D should be chosen whenever possible. At a minimum, an instrument should be approved for use in Division 2 locations.
- There are so many Groups, Classes, and Divisions that it is impossible to certify an all-inclusive instrument. Therefore, select a certified device based on the chemicals and conditions most likely to be encountered. For example, a device certified for a Class II, Division 1, Group E (combustible metal dust) would offer little protection around a flammable vapor or gas.

Attachment 2.2-2

Inherent Safety of Portable Monitors  
(continued)  
SELECTED CLASS I CHEMICALS BY GROUPS

Group A Atmospheres

acetylene

Group B Atmospheres (not sealed in conduit 1/2 inch or larger)

1,3-butadiene  
ethylene oxide  
formaldehyde (gas)  
hydrogen  
manufactured gas (containing greater than 30% H<sub>2</sub> by volume)  
propylene oxide  
propyl nitrate  
allyl glycidyl ether  
n-butyl glycidyl ether

Group C Atmospheres (selected chemicals)

acetaldehyde	epichlorohydrin	nitropropane
carbon monoxide	ethylene	tetrahydrofuran
crotonaldehyde	ethyl mercaptan	triethylamine
dicyclopentadiene	hydrogen cyanide	ethylene glycol
diethyl ether	hydrogen selenide	monoethyl ether
di-isobutyl amine	hydrogen sulfide	hydrazine
methylacetylene	morpholine	chloroaldehyde
ethylene glycol monoethyl ether acetate (39 others)		tetraethyl lead

Group D Atmospheres (selected chemicals)

acetone	methane	acetonitrile
methanol	acrylonitrile	methyl ethyl ketone
ammonia	naphtha	benzene
propane	butane	styrene
chlorobenzene	vinyl chloride	cyclohexane
xylenes	dichloroethane	ethylene glycol
ethanol	fuel oils	monomethyl ether
acetic acid	ethylenediamine	ethane
hexane	gasoline	aniline
isophorone	liquified petroleum gas	isoamyl acetate

Source: Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (classified) Locations, 1986 National Fire Protection Association ANSI/NFPA 497M.

Attachment 2.2-2

Inherent Safety of Portable Monitors  
(continued)

SELECTED CLASS II BY GROUPS

Group E Conductive Dusts

Atmospheres containing metal dusts, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics.

Group F Semi-Volatile Dusts

Atmospheres containing carbon black, coal or coke dust with more than 8% volatile material.

Group G Non Conductive Dusts

Atmospheres containing flour, starch, grain, carbonaceous, chemical thermoplastic, thermosetting and molding compounds.

Source: Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (classified) Locations, 1986 National Fire Protection Association ANSI/NFPA 497M.

Source: Hazardous Materials Incident Response Operations, EPA, Office of Emergency and Remedial Response, Hazardous Response Support Division, 1988.