

This guide provides emergency response personnel with practical information to help select chemical detection equipment.

Detection equipment is a key component of any preparedness and response plan. Personnel must understand the detector's operational technologies and performance characteristics, such as sensitivity and selectivity. An incident may take place in any environment, inside or outside, hot or cold, dry or humid. These are only a few factors to consider in detection equipment selection.

This guide offers information on the types of equipment currently available, and selection factors to consider when purchasing detection devices, and government resources on chemical exposure and toxic industrial chemicals.

Presence of Hazards

A significant challenge facing first responders today is a chemical agent warfare attack. The four classes of chemical warfare agents (CWA) include **Nerve Agents** (Tabun [GA], Sarin [GB], Soman [GD] and VX), **Blister Agents** (Mustard [HD], Nitrogen mustard [HN-1], and Lewisite [L]), **Choking Agents** (Phosgene [CG]), and **Blood Agents** (Cyanide [AC], Cyanogen Chloride [CK] and Arsine [SA]).

Detector Types

The following table provides a summary of most common, widely available detector types and how each type rates versus some of the selection factors detailed in the guide.

The "Selection Factors," listed on the reverse side of this brochure, offer questions that can be used to grade detection technologies for your specific needs and use applications.

Handheld Detection Technology Chart*

| | Ionization | | | SAW | FBIS | Electro-chemical | Colorimetric | | |
|------------------------|------------|-----|-----|-----|------|------------------|--------------|--------|--------------|
| | PID | FID | IMS | | | | Tubes | Badges | M8, M9 Paper |
| Range of TICs Detected | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Range of CWAs Detected | ● | ○ | ● | ● | ● | ○ | ● | ○ | ● |
| Selectivity | ○ | ○ | ● | ● | ● | ● | ● | ● | — |
| Sensitivity TIC | ● | ● | ● | ● | ● | ● | ● | ● | — |
| Sensitivity CWA | ● | ○ | ● | ● | ● | ○ | ● | ○ | — |
| Startup Time | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Response Time | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Alarm Capability | Y | Y | Y | Y | Y | Y | N | N | ● |
| Battery | Y | Y | Y | Y | Y | Y | N | N | N |
| Calibration | Y | Y | Y | Y | Y | Y | N | N | N |
| Cost | ● | ● | ○ | ○ | ○ | ● | ● | ● | ● |

Main Source: National Inst. of Justice (NIJ) Chemical Detection Guide 100-00.

Key

Each factor was graded upon a scale of ○ = least desirable to ● = most desirable.

No Capability = ○ 1 = ● 2 = ● 3 = ● 4 = ●

Examples: A "●" in sensitivity = most sensitive. A "○" in cost = the lowest cost.

Some selection factors are denoted by a "Y" or "N", which designates the existence or absence of the feature or item. An "N" for calibration, means the device does not need calibration.

Abbreviations

TIC – Toxic Industrial Chemicals

Chemicals, such as ammonia and chlorine that have harmful effect on humans. TICs are used in a variety of industrial and occupational settings. Exposure to some of these materials may be immediately dangerous to life or health.

CWA – Chemical Warfare Agent

Ionization

Process where an external energy source is applied to form electrically charged particles (ions) from an electrically neutral target material.

PID – Photo Ionization Detector

Ultraviolet light of a selected energy level is used to ionize the target gas. Resulting ions give rise to an electrical current in an electrically charged field. The amount of electrical current is measured and is directly related to gas concentration.

FID – Flame Ionization Detector

Hydrogen flame is used to decompose the target gas. Resulting compounds give rise to an ion current in an electrically charged field. The amount of current is measured and is directly related to gas concentration.

IMS – Ion Mobility Spectrometry

A radioactive source is used to ionize the target gas. Resulting ions are directed into a (drift) chamber where they are separated by mass and charge. Amount of ions collected of each mass/charge determines the amount and type of gas.

SAW – Surface Acoustic Wave Detector

Crystals propagate sound energy in specific modes. One of these modes is SAW. Thin coating applied to a crystal surface is used to absorb the target gas. Absorption of gas by the coating changes the resonant frequency of the SAW vibration. Change in vibration frequency is directly related to ambient gas concentration.

FBIS – Filter Based Infrared Spectroscopy; or Non-Dispersive Infrared (NDIR)

Light (typically infrared) energy absorption is used to determine concentration of gases in ambient air. A filter is used to restrict the frequency of light to a narrow band corresponding to that specifically absorbed by the target gas.

Electrochemical Sensors/Detectors

Target gases diffuse into a small element where they are oxidized or reduced in solution. Paired oxidation/reduction reactions give rise to an electrical current that is directly related to the target gas concentration. Specificity is based primarily on the chemistry of the reaction promoting catalysts and supporting materials.

Colorimetric, or Color Change Detectors

An inert supporting material is made to contain chemical reagent(s) that react in the presence of a target gas or liquid resulting in a specific color change. Colorimetric detectors may be either "paper" or tubes. Sampling method may be either passive (diffusion/time) or via pump (volumetric). Intensity of color change or length of stain (for tube) is directly related to gas concentration.

Selection Factors

Listed below are several categories of factors to be considered when selecting chemical detectors:

Hazard Detection (Selectivity)

- Can the device...
 - detect hazardous vapors? Aerosols? Liquids?
 - detect chemical warfare agents?
 - detect toxic industrial chemicals, including blood and choking agents?

Operation Features

- What is the lowest concentration of a hazardous agent that can be detected?
- Can the device resist interferants that may cause a false alarm or failure to alarm?
- What is the detector's start-up time?
- How much time is needed to collect and analyze a sample, and provide feedback?

Product Features

- Alarm: Is the alarm audible, visible or both?
- Portability: Is the device, and its components, easily transported to various locations?
- Durability: Can the device withstand rough handling and still function properly?
- Power Source: Does the device, and its components, operate by battery power (and if so, what its operating life) and/or AC electrical power?

Training

- Skill Level: What skills and training are required to properly operate the device?
- Training Requirements: How much time is needed to instruct the operator on the proper calibration, operation and/or maintenance of the device?
- What is the expected response level of the detection equipment operator? (awareness, operations, technician or specialist?)

Resources

Additional information on chemical/biological detection is available from a variety of resources.

Government Agencies

Occupational Safety and Health Administration
www.osha.gov

National Institute for Occupational Safety and Health
www.niosh.gov

National Institute of Justice
www.ojp.usdoj.gov/nij/pubs-sum/184449.htm

Detection Device Manufacturers

Biosystems, A Bacou-Dalloz Company
www.biosystems.com

Draeger Safety, Inc.
www.draeger.com

MSA
www.MSAnet.com

3M Company
www.mmm.com/occsafety

Scott Instruments
www.scottinstruments.com

*This table was independently prepared and submitted to ISEA. ISEA sought input from various interested parties on the table. ISEA did receive support from various parties for the information contained therein. It should be noted that the ratings on the table constitute our summation of the NIJ report.



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FOR FIRST RESPONDERS

Tabun (GA)
Sarin (GB)
Soman (GD)
Mustard (HD)
Nitrogen Mustard (HN-1)
Lewisite (L)
Phosgene (CG)
Cyanide (AC)
Cyanogen Chloride (CK)
Arsine (SA)