APPENDIX B

CHEMICAL WARFARE AGENT DETECTION

There are several methods and types of instruments that can be used in the detection of chemical warfare agents, such as nerve, blister, blood, and choking agents. However, most of these agents (nerve and blister) have extremely low occupational exposure limits, and nearly all the detection methods lack the sensitivity required to provide results at these low levels. It is important to understand the capabilities, uses, and limitations of each type of detection device or instrument. The manufacturer of each system provides clear and specific use instructions with each kit. Users should familiarize themselves with these instructions, know the limitations of each device or instrument, and practice the use of the kits while wearing appropriate PPE in a non-contaminated environment. The following sections highlight some types of equipment that are used for detection of chemical warfare agents. Generally, use of these detection systems will be limited to specially trained and equipped personnel at the SLTC or other specially trained and equipped OSHA personnel. The following summarizes specialized direct-reading capabilities that OSHA has access to and should be considered informational by all other personnel. These systems should only be used after consultation with the SLTC and under close SLTC guidance.

A. MILITARY DETECTION PAPERS/KITS

1. M8/C8 Detector Paper

The M8 detector paper was developed to detect liquid agents, specifically V- and G-type nerve agents, and H-type blister agents. The C8 paper is equivalent to the M8 paper; the "C" indicates a version manufactured for commercial use. These papers do *not* detect chemical agent vapors. The sheets are impregnated with chemical compounds that change to green, yellow, or red depending on the type of liquid agent encountered. A color chart accompanying the booklet helps determine the type of agent detected. The result is qualitative, but the detector paper has a sensitivity of about 20 microliters (µL) of liquid. Some substances can act as interferences and produce false positives, such as insecticides, antifreeze, and petroleum products.

A similar product, termed "3-way" paper is also available. This detector paper is equivalent to the M8/C8 papers, except that it includes an adhesive backing that can be used to apply the paper to equipment or PPE.

2. M9 Detector Paper

The M9 paper detects the presence of liquid nerve and blister agents by turning a reddish color. It does not distinguish the type of agent, nor does it detect chemical agent vapors. It will detect a liquid agent droplet with a diameter of approximately 100 micrometers (µm). Interfering substances that will produce a false positive include petroleum products, antifreeze, and insecticides. The papers come in a roll and are adhesive-backed.

3. M256A1 Detector Kit

The M256A1 Chemical Agent Detector Kit is designed to detect and identify chemical agent vapors, including blood (AC and CK), blister (H, HN, HD, CX, L), and nerve (V and G series) agents. The test consists of a series of chemical ampoules that are broken and exposed to the air. The reagents in the ampoules react with chemical agent vapors to produce a color change. A color chart and instructions included with the kit are used to determine the type of agent(s) that is/are present. The M256A1 is

relatively sensitive, and can detect some of the agents below the IDLH levels. The kit also includes booklets of M8 paper for detecting liquid agents.

4. C-2 Detector Kit

The C-2 Chemical Agent Detector Kit is used by the Canadian Military for detecting chemical agent vapors. The C-2 kit utilizes various colorimetric detection tubes for identifying nerve, blister, blood, and choking agents. Similar to the M256A1 kit, it will allow detection of some agents below IDLH levels. It also contains a booklet of M8 paper for use with detection of liquid agents.

B. COLORIMETRIC TUBES

Colorimetric tubes are made by several manufacturers, and their function is essentially the same. They contain a series of tubes which can be used to detect airborne chemical agents, as well as toxic industrial chemicals. Conducting a single test with one or more tubes takes two to five minutes to complete. There are some tubes, such as those for blister and nerve agents, which give a qualitative detection of the presence of that family of chemicals up to near IDLH levels. The industrial agents (blood agents and choking agents) can be specifically identified and quantitatively measured in ppm to levels below applicable exposure limits. An example of colorimetric tubes designed specifically for chemical agents is the Dräger Civil Defense Simultest™ (CDS) Kit.

C. PORTABLE CHEMICAL AGENT DETECTORS

Most types of portable, traditional chemical detection equipment, such as photoionization detectors, flame ionization detectors, electrochemical sensors, infrared analyzers, etc. can be used for chemical agent detection. These types of instruments are discussed in other sections of the Technical Manual. However, due to the acute toxicity of chemical warfare agents at very low concentrations, these instruments lack adequate sensitivity and cannot provide detection below IDLH levels. Some instruments have been developed for use specifically with chemical agents, and research is ongoing. Some of the more popular technologies and instruments are discussed below.

1. Ion Mobility Spectrometers

An ion mobility spectrometer (IMS) operates by drawing air into the instrument where it is ionized with a radioactive source. The ionized molecules travel through a charged tube, where they become separated according to their mass and mobility before reaching a collector electrode. An electronic signature is produced for each ion, which gives an indication of the type and relative concentration of agent present. IMS detectors are used mainly to detect nerve, blister, and blood agents. Examples of IMS detectors include the Chemical Agent Monitor (CAM), Improved Chemical Agent Monitor (ICAM), APD 2000 (Advanced Portable Detector), and SABRE 4000.

These instruments will not detect at levels below IDLH for most chemical agents. They are best used for site reconnaissance, or to screen for contamination on equipment or personnel. Some interferents that may cause false alarms with an IMS include the following: cleaning compounds and disinfectants that contain additives such as menthol and methyl salicylate (oil of wintergreen); aromatic vapors, such as perfumes and food flavorings; and exhaust from some motors and fumes from explosives and propellants.

2. Surface Acoustic Wave

Surface acoustic wave (SAW) sensors are comprised of piezoelectric crystals with selective surface coatings. As the mass of a chemical vapor sample flows over the sensors, it is absorbed onto the surface

which results in a change in vibration frequency of the sensor. An internal microprocessor in the instrument measures these changes, providing detection and identification of the chemical agent. Portable instruments utilizing SAW technology are available for detection of nerve and blister agents. Examples of SAW instruments include the HAZMATCAD and SAW MiniCAD. As with IMS detectors, SAW instruments will not allow detection of most chemical agents below IDLH levels. However, SAW detectors are less susceptible to false positive alarms from interfering substances.

D. GAS CHROMATOGRAPHS/MASS SPECTROMETERS

Additional instruments that can be used for chemical agent detection and identification are gas chromatographs (GC) and mass spectrometers (MS). These are generally laboratory-type instruments which require skilled laboratory technicians for operation and interpretation of results. A few have been hardened for use in vans and portable handheld units can be used in the field; however, the technicians normally must collect a sample from the suspect material and bring it to the instrument. Currently, the GC or GC/MS is the only instrument that can verify the concentrations of nerve agents down to levels which are below applicable TWA occupational exposure limits. TWA levels (PEL/TLV). This is important for applications where it is important in determining the appropriate types and levels of PPE or to verify that decontamination is complete.

An example of a portable GC is the MINICAMS Continuous Air Monitor. This instrument is used extensively in Department of Defense depots where chemical agents are stored and used by other agencies in the field. The MINICAMS can provide automatic, quantitative identification of the chemical agents for which it was calibrated.

E. HRT AVAILABILITY

The following equipment is maintained by the HRT for use in chemical agent detection:

1. Military Detection Papers/Kits: M8/C8 paper, M9 paper, M256A1 kits, and C-2 kits.

2. APD 2000; 2 IMS detection units as described above. Each OSHA region is also equipped with a single APD 2000 unit.

NOTE: The HRT also serves as the coordinator for OSHA's SRTs and can provide additional assistance and technical information regarding chemical warfare agent detection. Special precautions, such as PPE and/or other work practices, are also necessary to prevent exposure when working with chemical warfare agents. Contact the HRT for more details.