APPENDIX A

INSTRUMENT CHART

The information shown in the table below is for reference only. Not every field office will have every type of instrument. Refer to the CTC ALEP for specific information, or to the SLTC.

INSTRUMENT USE		
PHYSICAL MEASUREMENTS		
Type of Instrument	**Measured Substance**	**Application**
Stop time meter	Time	Calibration
Tachometers	Mechanical speed	Flywheels, belts, cylinders, lathes, etc.
Ergonomic testing equipment	Force	Force measurements for ergonomic assessment
Electrical testers and multimeters	Electricity	Electrical circuits
Vibration meters	Vibration	Handheld power tools, bearings, gear trains, housings, walls
Thermoanemometer (air velocity meter)	Airspeed	Ventilation assessments
Detector tubes with hand pumps (bellows or piston style)	Chemical air contaminants	Screening, spot measurements for air contaminants
Pressure gauges	Air Pressure	Compressor air lines
Fibrous aerosol monitors	Fibers in air	Asbestos
Dust monitors (particle or respirable aerosol monitors)	Total dust, respirable dust	Mines, sandblasting, road construction, dusty operations, indoor air quality
GAS & VAPOR METERS		
Type of Instrument	**Measured Substance**	**Application**
Multi-gas meters	Combustible gas (LEL), oxygen (O_2), with specific toxic gas sensors	Confined spaces, underground construction, sewers
Toxic gas sensor, hydrogen sulfide	H_2S	Farms, sewers, underground construction
Toxic gas sensor, hydrogen cyanide	HCN	Industrial facilities, electroplating operations
Toxic gas sensor, sulfur dioxide	SO_2	Paper mills, bleaching operations
Toxic gas sensor, nitric oxide and nitrogen dioxide	NO and NO_2	Combustion sources, particularly from propane fuel
Toxic gas sensor, chlorine and chlorine dioxide	Cl_2 and ClO_2	Bleaching and disinfecting operations, plastics manufacture, chemical synthesis, other industrial operations
Toxic gas sensor, ammonia	NH_3	Industrial refrigeration, fertilizer, animal feed lots
Toxic gas sensor, phosphine	PH_3	Semiconductor manufacture, agricultural pesticides
Carbon monoxide monitor	CO	Garages, warehouses, other combustion sources, indoor air quality

Carbon dioxide monitor	CO_2	Indoor air quality, as a surrogate for other indoor source pollutants
Infrared analyzers	CO, CO_2, organic substances	Area surveys to determine locations with highest concentrations, waste anesthetic gases, fumigants, indoor air, leaks, spills
Photoionization Detectors (PIDs)	Hydrocarbons, other ionizable substances	Area surveys to determine locations with highest concentrations, indoor air, leaks, spills
Mercury vapor meters	Hg	Mercury plants, spills
Ozone Analyzers	O_3	Water or air purification, indoor air
RADIATION METERS		
Type of Instrument	**Measured Substance**	**Application**
Heat stress meters	Ambient (environmental) heat	Foundries, furnaces, ovens and outdoor work locations
Light meters	Light (illumination)	Indoor lighting, UV exposure
Microwave meters	Microwave radiation	Communications, microwaves, heaters
Radiofrequency instruments	Electromagnetic fields	RF heat sealers, VDTs, induction motors
Magnetic field testers	Magnetic Flux Density	Magnetic fields
Electrostatic field tester	Static electric fields	Hazardous locations
Ionizing radiation meters	Ionizing radiation	Nuclear plants, nuclear waste, laboratory and medical settings
BIOLOGICAL MONITORS		
Type of Instrument	**Measured Substance**	**Application**
Microbial sampler	Micro-organisms (microbes)	Indoor air quality

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.

APPENDIX C

BIOLOGICAL AGENT DETECTION

Sampling and analysis for biological agents is a rapidly growing field. Many techniques and technologies are still under development. There are various factors to consider when sampling for biological agents, such as: method of dispersion for the agent, purpose of the sampling (e.g., to identify the agent, determine extent of contamination, confirm decontamination, etc.), environmental conditions, persistence of the agent, physical state of the agent, area/volume to be sampled, laboratory protocols, and others. It is important to note that biological agents (such as bacteria, viruses, and endotoxins) are particulate matter, and, therefore, detection methods are designed for particulate sampling. The following sections highlight some types of equipment that may be used for sampling and detection of biological agents.

A. SURFACE/BULK SAMPLING

1. Swabs

Swabs have been used frequently when sampling surface areas for the presence of biological agents. Swab tips come in a variety of materials, such as cotton, Dacron™, polyester, rayon, and foam. Shafts can be comprised of either wood or plastic. Generally, synthetic swab tips with plastic shafts are recommended because they are not of biological origin and will not interfere with DNA-based detection systems. Swabs may be used dry or wetted with a buffer solution. In general, studies have shown that wet swabs have higher collection efficiency than dry swabs.

2. Wipes and Sponges

Wipes and sponges are often used because they can sample larger surface areas and have a higher collection efficiency compared to swabs. They can also be used in a dry or wet fashion. Various styles and materials for wipes and sponges are available. As with swabs, synthetic materials are recommended to eliminate potential interference problems with detection systems.

3. Vacuum Methods

Vacuum methods can be used when it is necessary to sample very large surface areas or surfaces which are porous or irregular such as carpeting, where it is impractical to use swabs or wipes. These methods are also useful to gather bulk dust samples for analysis. One method utilizes a HEPA-filtered vacuum equipped with a dust collection filter sock which is used to capture the sample. Large surface areas can be vacuumed, and the dust gathered in the sock is then analyzed for the presence of biological agents. A similar method uses a portable sampling pump equipped with a filter cassette to "vacuum" particulate matter from smaller areas, and at lower flow rates. The filter can then be analyzed for biological agents.

4. Agar Plates

Agar plates, also known as "sticky plates," can be used to sample a surface by contacting the plate directly to the surface. The particles from the surface will adhere to the plate, which can then be analyzed by culture to identify any biological agents. This method has been used by various agencies during investigations of incidents involving biological agents.

B. AIR SAMPLING

Air sampling can be performed to determine the presence of airborne biological particulates. Essentially, a volume of air is drawn through a filter or deposited in another medium, and the captured particulates are then analyzed to identify biological agents. High flow rates are generally desirable because this allows higher sample volumes and increases the likelihood of detecting the suspect agents. However, it should be noted that some organisms are fragile, and the high velocities and impact mechanisms may kill the organism during the sampling process. Consult with SLTC to determine the appropriate flow rate and procedures for your situation.

Low flow air sampling methods consist of traditional personal sampling pumps equipped with capture devices such as filter media or liquid impingers. These low flow methods have the advantage of being small and portable; however, due to their low sample volume they will have a relatively high limit of detection.

Impactors, such as the Six Stage Viable Andersen Cascade Impactor, utilize higher flow rates (around 30 L/min), sample a greater air volume, and, therefore, increase the likelihood of detecting the agent. This and similar types of impactors capture the biological particulate directly on an agar plate which can then be analyzed in a laboratory by culture method.

High volume area samplers are also available for biological agents. These samplers possess flow rates ranging from 200 to 600 L/min, so they are able to sample very large volumes of air. Some instruments deposit the particulate matter on a filter, while others capture it in a liquid solution.

C. GENERIC DETECTION

There are several techniques and instruments available that will allow responders to perform a generic detection for biological agents. These methods will not identify a specific agent, but can be used to determine if a suspect material is of biological origin, and to rule out hoax materials. The following are some examples of equipment types:

1. **Particle Analyzers:** The particle size of a sample can be analyzed and compared to known size ranges for biological materials. If the particle size is too large or too small, biological materials can be ruled out.

2. **Fluorometer:** These instruments will detect the presence of DNA, which is a component of most biological materials. A positive response by the meter for a given sample indicates a biological material, but again, does not identify the material or agent.

3. **Luminometer:** A luminometer operates similarly to a fluorometer, except that it will detect the presence of adenosine triphosphate (ATP) in a sample. ATP is another component of a cellular organism, thereby indicating a biological material.

4. **Colorimeter:** Colorimeters can be used to detect protein from a sample. Again, protein is present in biological organisms, so these instruments can indicate if the material is biological in origin.

5. **Protein Paper:** Similar to a colorimeter, these paper strips can indicate if a given sample contains protein, and is, therefore, biological.

6. **pH Paper:** The pH of a sample is tested with pH paper strips; if the pH range is between 5 and 9, the material *may* be biological. If the pH is outside this range (below 5 or above 9), then biological materials can be ruled out.

D. IDENTIFICATION

1. Immunoassay/Handheld Assay

An immunoassay test, also known as a handheld assay (HHA), can be performed on a sample to identify a specific agent. These HHA tests rely on an antigen/antibody reaction to identify the suspect agent. The test is presumptive, meaning that a given agent must be suspected and then tested with its specific HHA for confirmation. For example, if *Bacillus anthracis* (anthrax) is suspected, the sample is tested using an HHA designed for *Bacillus anthracis*; a positive result confirms the presence of the organism while a negative result indicates that the sample does not contain that specific organism. The HHA units are small, the test can be performed in the field, and they rely on a visual colorimetric change for sample results. Some HHA systems come with an electronic reader to aid in detecting the colorimetric change.

HHAs are under scrutiny due to limitations on sensitivity and specificity; i.e., high rates of false-negative and false-positive results. The results from an HHA test should not be relied upon alone and further confirmatory analysis should always be performed. However, these tests are used widely by first responders as a rapid field test. Although they are presumptive, their results can assist decision makers in taking protective actions, treating potential infections, and involving other authorities as necessary.

2. Polymerase Chain Reaction

Polymerase chain reaction (PCR) is a system that allows identification of an agent based on its DNA. The DNA from the sample is obtained and reproduced rapidly to produce a quantity that is detectable by the instrumentation. For example, after 30 cycles with the PCR system, one copy of DNA from an agent sample can be reproduced until there are one billion copies, which can then be analyzed and identified.

PCR is performed real-time through detection by fluorescence. During the PCR cycle, DNA-specific "probes" with fluorescent dyes are attached to the DNA sample which allows detection. PCR can be performed in a laboratory, or in the field with semi-portable instrumentation. Specific reagents and supplies are necessary to perform the analysis.

PCR has been useful for biological agent detection because it has excellent sensitivity, good specificity, and provides real-time results. Some weaknesses of PCR to consider are the following: potential interferences from other substances in the sample, reagent stability, and sample viability, because PCR will detect the presence of both live and dead organisms, but will not distinguish between the two.

3. Culture

Analysis by culture is considered by many to be the "gold standard" for the identification of biological agents. Samples are sent to a laboratory where they are prepared and applied to an agar plate on which the suspect biological organisms are allowed to grow. After a sufficient period of time (usually 24 hours or more), visible growth can be examined to detect the presence of the biological agent(s). Often, culture is used for the confirmatory analysis of previous detection methods for a given sample (HHAs, PCR). Some disadvantages of culture include delayed results and the procedure will only detect living organisms. Any biological agent that has died before the analysis has begun will not be detected. Note that biological toxins or allergens associated with nonviable/nonculturable agents may still cause health effects.

HRT Availability

The following equipment is maintained by the HRT for use in biological agent sampling and analysis:

- Handheld Assays for the following agents: anthrax, plague, brucellosis, tularemia, Venezuelan equine encephalitis, staphylococcal enterotoxin B, botulinum toxin, ricin, smallpox, and Q fever.

- HEPA Vacuums: Two units with filter socks and other supplies specifically for use with biological agent sampling.

- Andersen Cascade Impactors: Two units.

- Dry Filter Units (DFU): Two units. The DFU is a high-volume air sampler designed for biological agent sampling. It operates at flow rates up to 600 L/min and utilizes a filter pad for capturing the agent.

- Surface/Bulk Sampling: Various wipe, sponge, and swab sampling kits.

NOTE: The HRT also serves as the coordinator for OSHA's biological SRT and can provide additional assistance and technical information regarding biological agent detection. Special precautions such as PPE and/or other work practices are also necessary to prevent exposure when working with biological agents. This information is provided as a reference for specially trained personnel and is not generally intended for CSHO use. Contact the HRT for more details.

APPENDIX D

IONIZING RADIATION MONITORS AND METERS

The following sections contain a brief description of the types of instruments that may be used for monitoring exposures to ionizing radiation and radioactive materials.

A. SURVEY METERS

Application and Principle of Operation

Radiation survey meters are used to locate and quantify sources of ionizing radiation or to quantify the exposure rate from sources of ionizing radiation. To assess the quantity of radioactive materials present, survey meters are typically calibrated to measure counts per minute (cpm). To measure the exposure rate from gamma (γ) or X radiation sources, survey meters are calibrated to measure roentgens per hours (R/h). Most survey meters have either gas filled detectors or scintillation detectors. Not all survey meters are configured to measure all radiation types. Survey meters must be chosen based on the type and energy of the radiation you expect to measure and whether you wish to measure cpm or R/h.

Calibration

Calibration is performed by the manufacturer on a periodic (usually annual) basis.

HRT Availability

1. Ludlum Model 3 with 44-9 Pancake GM Detector

The Ludlum Model 3 is a general purpose survey meter fitted with a pancake Geiger Mueller (GM) detector capable of measuring alpha (α), beta (β), γ, and X radiations. This instrument will measure count rates over a range of 0–500,000 cpm.

2. Ludlum Model 2360 with 43-93 Alpha/Beta Scintillator

The Ludlum Model 2360 is a survey meter capable of measuring and discriminating between α and β radiations. It is fitted with a Ludlum 43-93 alpha/beta scintillation detector. The meter will measure count rates over a range of 0–500,000 cpm.

3. Ludlum Model 192 MicroR™ Meter

The Ludlum Model 192 is a low level (μR/h) γ and X radiation exposure rate meter. The meter has an internal sodium iodide detector capable of measuring dose rates between 0 and 5,000 μR/h.

4. Thermo Scientific® FH40GL Dose Rate Meter with FHZ732GM Pancake Probe

The FH40GL is a stand-alone radiation survey meter equipped with an internal proportional detector capable of measuring γ and X radiation exposure rates from 1 μR/h–10 R/h. The unit is also equipped with an FHX732GM pancake GM detector capable of measuring count rates from α, β, and γ radiations over a range of 0.01–100,000 counts per second.

5. Thermo Scientific® FH40TG Teleprobe™

The FH40TG telescoping probe can be used with the FH40GL to measure γ and X radiation exposure rates over a range of 10 μR/h–1,000 R/h. The probe is equipped with two GM detectors that can be extended up to 13 feet away from the user, allowing exposure rate measurements to be made at a distance from the source.

6. Thermo Scientific® RO-20 Ionization Chamber

The RO-20 is capable of measuring exposure rates from β, γ, and X radiations. The instrument is equipped with an air filled ionization detector capable of measuring exposure rates up to 50 R/h.

7. Thermo Scientific® PM1703M Gamma Pager

The PM1703M is a pager-sized survey meter that can be worn on the belt. The meter contains a cesium iodide scintillator-photodiode detector capable of measuring γ and X radiation. The instrument will measure exposure rates from 0–5,000 μR/h. The PM1703M is a highly sensitive instrument that can be set to alarm when the background varies by a user-set factor. This meter can be used to warn the user that he/she has entered a radiation area that is above background radiation levels.

B. SCALARS

Application and Principle of Operation

Scalars are used to analyze samples of radioactive material and to quantify the amount of material present. They are often used to measure the amount of radioactive material in air samples, wipe samples, and nasal swabs. Scalars use the same detector types used in survey meters. These instruments can typically be set to count a sample for a specified time.

Calibration

Calibration is performed by the manufacturer on a periodic (usually annual) basis.

HRT Availability

1. Ludlum Model 3030 Alpha/Beta Scalar

The Ludlum Model 3030 is a dual alpha/beta scalar used for sample counting. The instrument has a silver-activated zinc sulfide [ZnS(Ag)] coated scintillation detector capable of discriminating between α and β radiations. The readout on the front of the instrument reports both α and β counts for the specified period. Counting time can be set from 0.1–30 minutes.

2. Ludlum Model 2000 Scalar with 43-10 Alpha Sample Counter

The Ludlum Model 2000 scalar with 43-10 sample counter is capable of counting samples for α particle emissions. The sample counter has a ZnS(Ag) scintillation detector. Counting time can be set from 6–990 minutes.

3. Thermo HandECount Scalar

The HandECount is a battery or AC powered sample counter used for determining the α and β activity present in a sample. The instrument is controlled by a Palm™ hand-held computer platform and operating system which communicates with a standard modular detector board to perform all counting operations. All data is automatically logged to a file for later retrieval to a PC. The HandECount will report both α and β counts for a sample.

C. ELECTRONIC PERSONAL DOSIMETERS

Application and Principle of Operation

Electronic personal dosimeters are used to measure the dose received by an individual. They are normally worn on the front of the body in the chest area. Most electronic dosimeters measure the deep dose equivalent (Hp(10)) to γ radiation. Some electronic dosimeters also measure the shallow dose equivalent (Hp(0.07)). Most electronic dosimeters allow the user to set alarms for integrated dose and/or dose rates.

Calibration

Calibration is performed by the manufacturer on a periodic (usually annual) basis.

HRT Availability

1. Thermo Electronic Personal Dosimeter (EPD) Mk.2

The Thermo EPD Mk.2 is an electronic dosimeter capable of measuring Hp(10) (deep dose) and Hp(0.07) (shallow/skin dose). It is sensitive to γ and X radiations for Hp(10) measurements, and is sensitive to γ, β, and X radiations for Hp(0.07) measurements. Alarms can be set for accumulated doses and for dose rates for both Hp(10) and Hp(0.07).

2. Rados RAD-60 Electronic Personal Dosimeters

The Rados RAD-60 is capable of measuring Hp(10) from γ and X radiations. Alarms can be set for both dose and dose rate.

D. SPECTROSCOPY

Application and Principle of Operation

Portable handheld radiation spectroscopy instruments allow the user to identify radionuclides. These instruments typically use a sodium iodide detector with a multichannel analyzer to measure the energy spectrum emitted by a radioactive source. The instrument compares the spectrum to a library of spectra and provides the user with a list of likely sources. Spectra can also be downloaded to a computer if the user wishes to perform the spectral analysis manually or wishes to print the spectra for documentation.

Calibration

Calibration is performed by the manufacturer on a periodic (usually annual) basis.

HRT Availability

EXPLORANIUM™ GR-135N

The EXPLORANIUM™ GR-135N is a handheld isotope identification device. The GR-135N has a sodium iodide detector capable of identifying radionuclides, a GM detector for measuring exposure rate, and a solid state neutron detector. Spectra from the GR-135N can be downloaded to a computer for analysis and printing.

E. ELECTRET-PASSIVE ENVIRONMENTAL RADON MONITORING

Application and Principle of Operation

The Electret-Passive Environmental Radon Monitor (E-PERM) system is a passive integrating detector system for the measurement of radon (^{222}Rn) or thoron (^{220}Rn) concentrations in air. It consists of a charged Teflon® disk (electret), an open-faced ionization chamber, and an electret voltage reader. When the electret is screwed into the chamber, an electrostatic field is established and a passive ionization chamber is formed. The chamber is deployed directly in the area to be measured. Radon gas diffuses passively into the chamber and the α particles emitted from the decay of radon ionize the air molecules. These ions are then attracted to the charged surface of the electret, and the charge on the electret is reduced. The electret charge is measured before and after the exposure with a portable electret voltage reader, and the rate of change of the charge (change divided by the time of exposure) is proportional to the concentration of radon in the area.

Calibration

Calibration factors are provided for each type of electret. Calibration factors are voltage dependant and instructions for calculating the calibration factors are in the E-PERM manual provided by the manufacturer.

HRT Availability

The HRT has 12 E-PERM chambers, electrets, and a voltage reader.

F. RADIATION PPE AND SHIELDING

In radioactively contaminated areas, PPE is typically used in order to prevent workers from becoming contaminated, and to minimize the spread of radioactive contamination. The choice of appropriate shielding for ionizing radiation depends on the type and energy of the radiations to be shielded. Alpha particles have very low penetrating power and travel only a few centimeters in air and will not penetrate the dead outer layer of skin. Shielding is generally not required for alpha particles because external exposure to alpha particles delivers no dose. Where particulates contaminated with alpha particles are present, HEPA-filtered respiratory protection is critical to prevent an internal dose. Beta particles can travel several meters in air and can penetrate several millimeters into the skin. Beta particles should be shielded using an appropriate thickness of low atomic mass (low-Z) materials such as aluminum or plastics (e.g., Plexiglas®). Shielding beta particles with high-Z materials should be avoided as this can result in production of secondary X radiation (i.e., bremsstrahlung radiation). Gamma and X-rays can travel kilometers in air and can penetrate deep into the human body or pass through it entirely. Gamma and X-rays are most efficiently shielded using an appropriate thickness of high-Z materials such as lead or steel, or with an appropriate thickness of concrete. Neutrons are most efficiently shielded using an

appropriate thickness of hydrogenous materials such as paraffin, water, or plastics, or with an appropriate thickness of concrete.

NOTE: The HRT also serves as the coordinator for OSHA's radiation SRT and can provide additional assistance and technical information regarding radiation measurements. Special precautions are also necessary to prevent exposure when working with radioactive materials, such as PPE and/or other work practices. Contact the HRT for more details.