

**RADIOLOGICAL MONITORING
INSTRUMENTS AND EQUIPMENT
(FOR CIVIL DEFENSE OPERATIONS)**

**OFFICE OF CIVIL DEFENSE
DEPARTMENT OF DEFENSE**

RADIOLOGICAL MONITORING INSTRUMENTS AND EQUIPMENT

(For Civil Defense Operations)

Although fallout can sometimes be detected by sight or touch, nuclear radiations from the fallout particles cannot be detected by the human senses. Therefore, for civil defense purposes, instruments for detecting and measuring nuclear radiation have been developed by the Office of Civil Defense (OCD).

Instrument Requirements and Capability

There is no equivalent of war emergency upon which to base requirements for civil defense radiological instruments. However, extensive tests of nuclear weapons under known conditions have indicated the kinds and extent of residual radiation that could result from their use; and knowledge gained from other types of experiments makes it possible to relate this radiation to biological effects. The radiological instruments developed by OCD can provide the measurements necessary for evaluating the hazard of this ionizing radiation. The instruments that have been developed are in two major groups: survey meters and dosimeters.

Survey Meters and Dosimeters

One group of instruments—survey meters—is designed to detect nuclear radiation and to measure the dose rate. Some of these meters measure gamma only, others are beta-gamma discriminating.

Instruments of the other group—dosimeters—detect and register total accumulated gamma dose. The units of measurement used on radiological instruments to show cumulative dose and dose rate of gamma radiation are, respectively, the roentgen (r) and the roentgen per hour (r/hr).

The scale calibrations of meters developed by OCD are not related directly to dose or dose-rate values of beta radiation. Meter indication of beta radiation can be interpreted only in a general way and is useful in estimating the ratio of beta to gamma radiation.

Survey Meters

Survey meters measure the rate of exposure and are basically reconnaissance instruments and can be used to provide the information required for direction

of radiological defense (RADEF) and other civil defense operations.

Survey meters useful for civil defense operations have direct reading scales that show the gamma dose rate in roentgens per hour. In tests by OCD, survey meters designed to give merely "go-no-go" indications, such as those with blinking lights or audible warnings, did not provide adequate information on dose rate. These models are no longer being considered for use.

The sensitivity requirements of radiation instruments depend upon the tasks the instruments must perform. An instrument that will discriminate between beta and gamma radiation is used to measure the contamination of personnel, food, water, equipment, and living quarters and must indicate very small amounts of radiation above normal background. This type of instrument would have little use in areas of heavy contamination.

To provide adequate monitoring, civil defense portable radiological instruments should be capable of measuring gamma dose rates as high as 500 r/hr, and indicating when dose rates exceed this figure. Measurement above this amount is not necessary for portable survey instruments because a higher level of radiation would preclude further surface operation.

Dosimeters

Dosimeters measure the total accumulated radiation dose. Some dosimeters may read directly, with the increase in total dosage being indicated by color changes or progressively high scale readings of the meter. Other types of dosimeters, such as film badges or packets, require rigidly controlled processing before they can be properly interpreted.

Radiophotoluminescent (phosphate glass) dosimeters have long shelf life and can be read at any time without destroying previous readings, but require the use of a complex instrument for reading. Both the photographic and phosphate glass dosimeters respond to several types of nuclear radiation. For civil defense operations, OCD recommends the use of the self-indicating, quartz-fiber electrostatic dosimeter.

Types of OCD Radiological Instruments and Equipment for Operational Use

To provide a capability for meeting the various requirements of civil defense operations, the following types of radiological instruments are presently recommended:

a. CD V-700

The CD V-700 radiation survey meter is a sensitive low-range instrument that can measure gamma radiation and detect beta radiation. It is recommended for (1) monitoring of personnel, food and water when used in a shielded facility or an area of low radiation background, and (2) followup monitoring of areas for human habitation and food production. The instrument can also be used in training programs where radiation dose rates will be encountered.

Operationally this instrument consists of a radiation detector, a regulated high voltage supply, electronic circuitry for pulse shaping and metering, and an indicating meter and headphone for audible detection of radiation. Ranges of this instrument are 0-0.5, 0-5, and 0-50 mr/hr to within 15 percent accuracy of true dose rate when calibrated against gamma rays from Cobalt 60 or Cesium 137.

The detecting element of the CD V-700 is a geiger tube shielded so that only gamma dose rate is measured or beta and gamma can be indicated together with the shield open. This instrument is designed for sensitive measurements and has limited usefulness in areas of high contamination. In radiological defense operations during the survival and early recovery periods, the instruments would have to be used in locations well shielded from fallout radiation where food, water, and personnel could be checked for contamination. A special geiger tube, now under limited procurement, will shift the range of this instrument upwards by a factor of ten, that is to 0-5, 0-50, and 0-500 mr/hr.

b. CD V-715

The CD V-715 is a high range gamma survey meter for general post-attack operational use. The ranges of this instrument are 0-0.5, 0-5, 0-50, and 0-500 r/hr within 20 percent accuracy of true dose rate.

The instrument was designed for use by radiological monitors for the major part of their operation in the period following the attack. The instrument

was intended for ground survey, but it can serve quite well as interim equipment for aerial measurements.

The detecting element of the CD V-715 is an ionization chamber. Operationally this instrument consists of the ionization chamber, electronic circuitry to amplify the minute current from the ionization chamber, and an indicating meter.

c. CD V-717

The CD V-717 remote survey meter now in procurement is essentially a CD V-715 gamma survey meter with a removable detector unit for making remote measurements to distances of 25 feet. The ranges of this instrument are 0-0.5, 0-5, 0-50, and 0-500 r/hr. The accuracy of the instrument is to within 20 percent of the true dose rate. When the remote cable is connected for use, the instrument reads to within 5 percent of the dose rate reading without the cable. This instrument was designed for use by radiological monitors in monitoring stations during the early period following a nuclear attack. The instrument was intended to decrease the radiation exposure to the monitor.

d. CD V-742

Office of Civil Defense recommends the use of self-indicating, quartz-fiber electrostatic dosimeters in civil defense operations to measure the radiation exposure of radiological monitors and workers exposed to radiation. The dosimeter recommended for general operational use is the CD V-742, which has a measurement range of 0-200 roentgens. Until these were available in sufficient quantity, the CD V-730 with a range of 0-20 roentgens and the CD V-740 with a range of 0-100 roentgens have been furnished. They resemble a fountain pen in size and shape. The CD V-742 can also be identified by its bronze colored pocket clip. These dosimeters are zeroed with the radiological dosimeter charger, CD V-750.

Quartz-fiber electrostatic dosimeters contain two electrically conducting components: a coated quartz fiber and a metal mounting ring. To prepare the instrument for operation, these two electrodes are charged using a battery operated charger, CD V-750.

Radiation passing through the dosimeter loses energy by ionization. As the ions are drawn to the electrodes, there is a reduction in the charge and the quartz fiber moves. Through a built-in optical sys-

tem, the user of the dosimeter can read the position of the fiber image on the graduated scale.

Electrostatic dosimeters are accurate to within 10 percent of true dose when calibrated against Cobalt 60. The accumulated dose can be read directly at any time. By recharging, these dosimeters can be used again and again. A disadvantage is that they can give erroneous readings if roughly handled or because of electrical leakage over a very long period.

e. CD V-750

The CD V-750 dosimeter charger is a device for supplying the needed electric potential for zeroing dosimeters such as the CD V-742. Electrical circuitry of the instrument "steps up" the battery voltage required to zero the dosimeter. A voltage control is used to adjust the output voltage to the exact value required.

f. CD V-781

The CD V-781 aerial survey meter now in procurement is designed for general post-attack surveying by light aircraft after fallout has been deposited. The instrument consists of an indicating unit to be mounted on the aircraft control panel and interconnecting cable to the detector unit which uses three geiger tubes, each with a separate indicating meter. The instrument ranges are 0-0.1, 0-1, and 0-10 r/hr within plus or minus 10 percent accuracy of true dose rate. This reading must be corrected for the effect of altitude on dose rate to approximate the ground dose rate. The instrument operates from the aircraft power supply but also has an emergency battery power supply. A tape recorder with associated throat microphone and a remote control switch permits inflight recording of necessary data. The unit also includes a means for simulating radiation environment for test flight purposes.

g. CD V-794

The CD V-794 calibration unit consists of a heavy lead container housing approximately 100 curies of radioactive Cesium 137 with a shielded test chamber attached. This unit will provide a choice of radiation levels in the test chamber adequate to calibrate all models of civil defense radiological instruments up to 500 r/hr. Movable slides which are electromechanically pushbutton operated provide for changing the dose rate in the test chamber. The unit is designed to minimize the radiation hazard to the operator at all times.

Maintenance and Calibration

The importance of proper maintenance and calibration of radiological instruments cannot be over emphasized.

All operational instruments should be given at least bimonthly operability checks and provided maintenance as required. Also, all operational instruments must be calibrated at least every 12 months or in accordance with the local civil defense calibration schedule. Many States are beginning to establish their own statewide maintenance and calibration program. On an interim basis for non-participating States, the service of federally operated maintenance shops may be utilized. RADEF Officers have the responsibility for making arrangements for the maintenance and calibration of all radiological instruments.

Availability of Radiological Equipment

Radiological equipment for licensed community shelters, training, and operational purposes is available from Office of Civil Defense to States and their political subdivisions. Detailed information on policies, requirements, and procedures is described in the following OCD publications: OCD Instruction No. 9667.1, Radiological Equipment Available to States for Training and Operations; OCD Instruction No. 9667.2, Availability of Dosimeters for State and Local Emergency Operations; OCD Memo No. 59-62, For all Regional Directors, Subject: Availability to the States of Shelter Radiation Kits, and OCD Memo No. 12-63, For all Regional Directors, Subject: Availability to the States of Shelter Radiation Kits for Use in Multiple Shelter Areas.

Federal financial assistance is also available to States and their political subdivisions for purchase of radiological instruments and additional radiological defense equipment. The Federal Government will assume up to a maximum of one-half of the unit cost, as indicated in Annex 15-A, Chapter 15 of the Federal Contributions Manual, AM 25-1, subject to appropriation limitations and provided that certain criteria are met. In some instances, States will match expenditure of their political subdivisions. There are three ways in which radiological defense equipment may be obtained by States or political subdivisions: (1) grant or loan from OCD; (2) purchase through OCD, and (3) direct purchase.