civil defense Technical Bulletin

Appendix 5

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RADIOLOGICAL DEFENSE SERIES

A DIGEST OF TECHNICAL INFORMATION

RADIOLOGICAL INSTRUMENTS FOR CIVIL DEFENSE

This is one of a series of technical bulletins on civil defense against the radiological effects of nuclear weapons.

Nuclear radiation is not detected by any of the five human senses, but instruments have been developed which detect and accurately measure it. Such instruments are necessary equipment in civil defense. Field instruments are required which measure the beta and gamma radiation associated with fallout. Neutrons will be present in the initial radiation and alpha particles will be present in fallout. Their relative importance to the hazard from beta and gamma rays is such that field measurements of alpha and neutron radiation are not required.

There is no equivalent of combat experience upon which to base the requirements for radiological instruments. Test bombs of various yields have been detonated under various conditions. Many variables influence the concentration of residual radiation which might be encountered in civil defense —bomb size, place and height of detonation, type of bomb assembly, and meteorological conditions. This being so, it is not possible to predict accurately the radiation levels that could result from fallout. Moreover, the radiation effects upon people must be radiological defense's major consideration. People will have been in the fallout area, and emergency teams will be entering the area. Hence, for practical consideration of effect of radiation on personnel the gamma instrument must respond accurately to dose rates as high as 500 r/hr. Intense beta radiation fields would probably exist, so detection of beta radiation is required. No definite top limit for beta response has been chosen, but the instrument should read to several thousand rep (roentgen equivalent physical) per hour.[1]

Choosing the maximum sensitivity is much simpler. Rather small increments above background will need to be detected in checking contamination of food and water and personnel, and other circumstances where the early detection of above-normal concentrations of activity is important.

1 Another bulletin in this series will contain a section on radiation units.

Instruments used in the measurement of radiation dose rate are required to have a direct reading scale. Blinking lights, audible warnings, or "go-no-go" indications are not satisfactory. The radiation dose rate should not be the criterion. Rather, dose rate times time, or dose rate times length of exposure, is the critical factor. Therefore, if a particular dose rate is chosen as the "go-no-go" value, the expected duration of the exposure is also fixed. Exposure time, as well as allowable dose, will depend on the urgency of the situation and cannot be determined beforehand.[2] Radiation dose rate meters are basically reconnaissance instruments. They provide the information required to make maps of contaminated areas which show rough contour lines of dose rates and indicate local hot spots. They provide the information required by civil defense officials in directing civil defense operations.

Estimates of exposures can be made on the basis of dose rate measurements, decay rates, and probable exposure time; but these estimates should be used for planning purposes only—the actual determination of exposures must be made by measurements. The dose measuring devices (dosimeters) must be self-indicating, that is, direct reading, if they are to be used by the wearer to check his accumulated exposure. OCDM recommends the use of two operational dosimeters: 0 to 20 r, and 0 to 100 r for use by the organized civil defense services. (See Fig. 1.) Where expected exposures are small, or where small repeated doses may be received, the lower range dosimeter is used. Dosimeters covering higher ranges are also recommended for these workers to measure exposures received at the time of the bomb burst or accidental or necessary over-exposures during post-explosion activities. Without such information, workers might be asked to undertake duties involving additional exposures which would be dangerous if added to previous substantial over-exposure.

2 Another bulletin in this series will cover emergency exposures to nuclear radiation.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF CIVIL AND DEFENSE MOBILIZATION

Survey Meters

There is no one simple yet sufficiently accurate instrument to measure all ranges of dose rate required. The extremes of sensitivity are not required in a single operation. OCDM therefore has recommended the use of three survey instruments. They are:

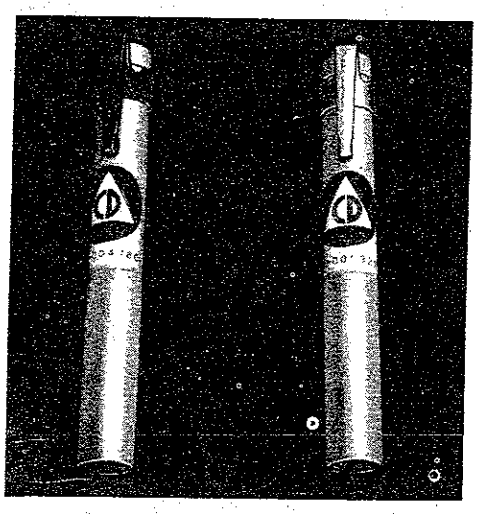

Figure 1.—Civil defense dosimeters.

(a) A beta-gamma discriminating geiger counter for the high sensitivity requirement, for long range follow-up, and for training purposes. (See Fig. 2.) This instrument is also suitable for food and water and personnel monitoring. The ranges are 0-0.5, 0-5 and 0-50 mr/hr, calibrated against gamma rays from cobalt 60 or radium. This instrument, like any other instrument designed for sensitive measurements, would have limited utility in an area of significant contamination since a relatively low background would drive it off scale. In such an event, the instrument would have to be used in an area well shielded from the fallout radiation where food, water, and personnel can be brought for the contamination checks. OCDM Standard Item Specification CD V-700.

Figure 2.—Geiger counter.

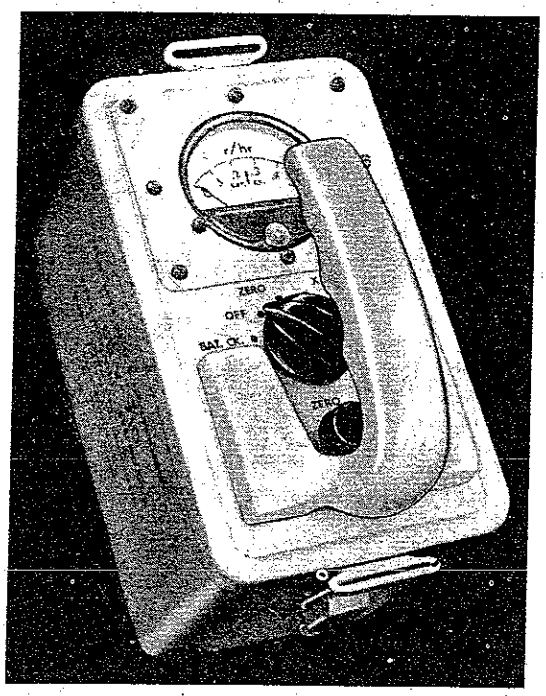

Figure 3.—Medium range gamma survey meter.

(b) A medium range gamma survey meter for use by radiological monitors for the major part of their operation in the period following the attack. (See Fig. 3.) This instrument has three scales: 0-0.5, 0-5 and 0-50 r/hr. This instrument was designed for ground survey where radiation levels would change with relative slowness, but it can serve quite well as interim equipment for aerial measurements. The instrument reading in the airplane should be multiplied by 2 for each 200 feet of altitude for an approximation of the ground reading. For example, a 10 r/hr reading at 600 feet would be multiplied by 2 x 2 x 2 to give as an approximation 80 r/hr on the ground.[3] OCDM Standard Item Specification CD V-710.

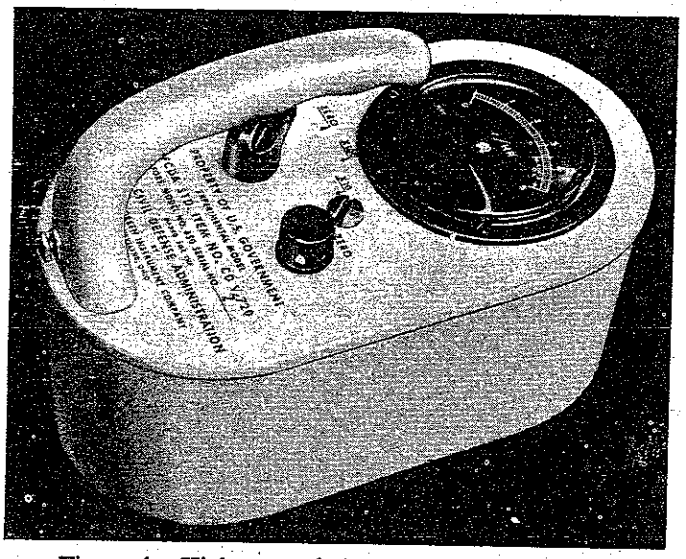

Figure 4.—High range beta-gamma survey meter.

[3] Another bulletin in this series will discuss the techniques and instrumentation for aerial survey.

(c) A high range beta-gamma survey meter is required for use by highly qualified monitors if it becomes necessary to make measurements in areas where extremely high level contamination exists and for making high level beta radiation measurements. (See Fig. 4.) This instrument will have three scales, 0-5, 0-50 and 0-500 r/hr gamma and will have a discriminating slide to permit the measurement of gamma only or of gama and beta radiation. The range of beta sensitivity will be several thousand reps per hour. OCDM Standard Item Specification CD V-720.

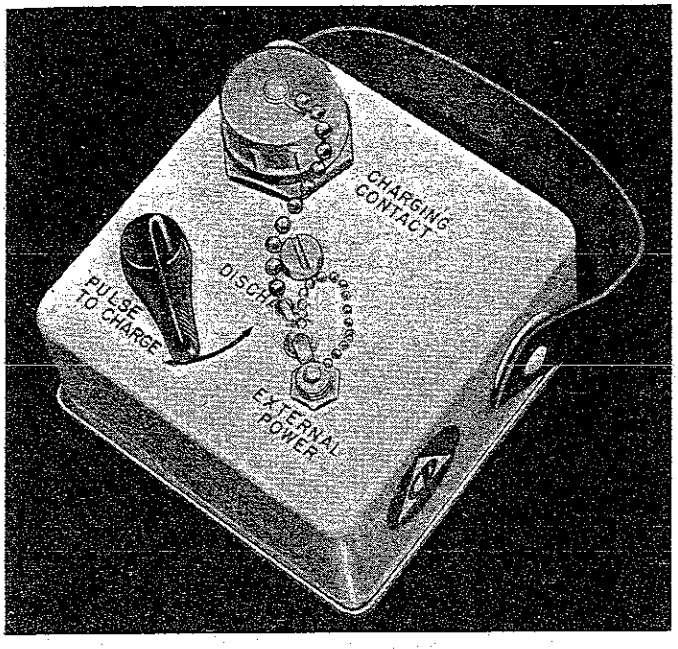

Figure 5.—Dosimeter charger.

Dosimeters

There are requirements for four types of instruments for use in measuring radiation exposures of personnel.

(a) A 0-20 r self-indicating dosimeter. This is an instrument of the quartz fiber type. It is carried in the manner of a fountain pen, which it resembles. Specification is CD V-730. (See Fig. 1.)

(b) An instrument of the type just mentioned, differing only in range, which is 0-100 r. Specification is CD V-740.

(c) An instrument for supplying a source of electric potential for charging (setting to zero) these dosimeters. Specification is CD V-750. (See Fig. 5.)

(d) A high range dosimeter to be used as a back-up instrument to the quartz fiber dosimeters V-730 and V-740. It may or may not be self-reading. An acceptable range is from about 10 r to 600 or 700 r. Dosimeters of the chemical, photographic film, phosphate glass, and electroscope type fall into this category. The instrument may require auxiliary reading equipment such as a fluorophotometer for the phosphate glass dosimeter, or a densitometer for photographic film.

All personnel who may have to execute emergency duties in a contaminated area should be equipped with a self-reading dosimeter. Because of the probabilities of widespread fallout, this now includes all services; rescue, fire, engineering, etc., as well as radiological. Economic reasons make this goal difficult to achieve, at least in the near future. An alternative is to provide at least one member of any working party with the self-reading dosimeter, while the other members of the party carry the less expensive non-self-reading type.

Radiochemical Laboratory Instruments

OCDM requires laboratory equipment to (1) make more refined analysis of decay rates; (2) identify elements in the contaminated material; and (3) analyze samples of contaminated food and water. OCDM has not sponsored the design of specific laboratory equipment or systems for this requirement. Rather, it has encouraged the State and local civil defense organizations to utilize the university, governmental or industrial isotope laboratories which may be in the particular vicinity. These laboratories have the equipment required for the job and people trained in its use. Certain States have decided that specialized laboratory equipment and/or mobile laboratories are required. Where the decision of the individual State has been to procure such equipment, and the quantities and types of instruments seem reasonable, the Federal Government provides matching funds for this purpose.

Ordinary portable equipment such as the CD V-700, or portable electrometer analysis units are suitable for field measurements to determine contamination levels of food and water. Rough determinations of decay rates could be made with the V-710 or V-720, or if the levels are low enough, with the V-700.

Instrument Calibration

The calibration of radiation instruments must be frequently checked. For the medium and high range survey meters CD V-710 and CD V-720, multicurie radiation sources are desirable

Citizens' Instruments

There are two categories of radiation instruments which might be considered for use by a person in his home or on the street: (1) personal dosimeter—a dosimeter to be worn on the person to measure the dose of radiation received at time of the burst and to measure the exposure to fallout radiation, and (2) home survey meter—a rate-meter for measuring the radiation dose rates from fallout.

The Personal Dosimeters.—OCDM believes that the benefits that could be derived from personal dosimeters are not sufficient to justify their use by the general public. The measurement of radiation dosage would be of value if such a measurement could provide information upon which to base medical treatment to those people who have been exposed. The dosage as indicated by radiation dosimeter does not provide an accurate index of the seriousness of the injury. This derives from three factors: (1) the dosimeter does not accurately indicate the total body exposure, (2) it gives no indication of the rate at which the dose was received, and (3) the radiation sensitivity variation from person to person is very broad. Medical authorities have concluded that the treatment of radiation injury must be based primarily on the person's signs and symptoms.

The Home Survey Meters.—The measurement of radioactive fallout resulting from nuclear explosion requires a properly organized and trained monitoring service equipped with instruments which are adequately maintained and periodically calibrated. It is not a job which can be done piece-meal by the individual citizen. The assessment of the radiological hazard must be handled by proper authorities who have access to the overall picture; the degree and extent of fallout; available emergency housing and feeding; and information on chemical, bacteriological, and other hazards. There is no lasting benefit in saving a person from a serious radiation exposure only to have him reexposed or become a victim of biological agents or nerve gases, or to have him freeze or starve to death. A home survey meter could be useful to enable a family to find places

of least danger if forced to remain indoors because of fallout. For this requirement, instruments must be easily interpretable, have reasonable accuracy, be highly reliable, and have a "fail safe" characteristic (that is, the instrument indicates when it is not working; otherwise the presence of a radiation hazard might not be detected.) In addition, they must be in the price range to allow procurement by large numbers of people. An instrument meeting these requirements is not available, although some experimental models show some promise.

Instrument Procurement

State and Local.—Primary responsibility for obtaining instruments is considered to be that of the States. Under the Federal Contributions Program, the Federal Government will assume half of the cost—subject to appropriation limitations and providing certain criteria are met. In some instances, the State will match expenditures of the political subdivisions, so that they in turn will expend only one-fourth of the market price of the instruments.

There are several methods by which instruments may be procured:

(a) THROUGH OCDM

States may order instruments through OCDM. Instruments obtained through this procedure will be those listed in the Federal Contributions Manual, and purchased on a bid basis in accordance with OCDM Standard Item Specifications.

(b) BY BIDS

OCDM Standard Item Specifications may be used and bids invited, or negotiations made directly with manufacturers for instruments built in accordance with OCDM specifications. (The States must assure OCDM that the instruments meet specifications either by providing copies of test results or by certifications from the manufacturer.)

(c) DIRECT PURCHASE

States or political subdivisions may buy directly from a manufacturer, instruments which have been tested and found to conform with OCDM specifications.

All transactions must be channeled to OCDM through the State. Political subdivisions are required to make requests of OCDM through State authority.

Federal.—The Federal Government purchases limited quantities of radiation instruments for two purposes: (1) to be available as back-up supplies in the event of emergencies, and (2) to be transferred to the States for use in training radiological defense personnel. Those in the second group include the standard OCDM instruments mentioned earlier and a special kit of instruments and accessories for use in training monitors in the fundamentals of radiation measurement. States must meet established criteria to be eligible for these instruments. The terms and conditions applicable to this program are available through regular civil defense channels. This training program in no way changes the basic philosophy that the procurement of instruments for operational use is the responsibility of the States and political subdivisions. Quantities available under this training program would not be adequate for operational purposes.

Procurement Procedures

The Federal Supply Services of the General Services Administration is the purchasing agent for OCDM. Contracts are awarded as a result of invitations to bid. OCDM Standard Item Specifications are the basis for bid invitation and manufacture of the instruments. National Bureau of Standards conducts tests of conformance to specifications. The Bureau of Standards does not have authority, however, to approve or disapprove instruments for civil defense. OCDM specifies and finances tests which are made in the Bureau's laboratories. Results are reported to OCDM and approval or disapproval given by OCDM.

Development Status of the Instrument Program

A list of manufacturers' instruments, meeting OCDM specifications, may be obtained from OCDM's Regional Offices.

Manufacturers are encouraged to submit instruments for approval under OCDM specifications.

Studies to develop an instrument for aerial survey and a citizen's instrument are now in progress.

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