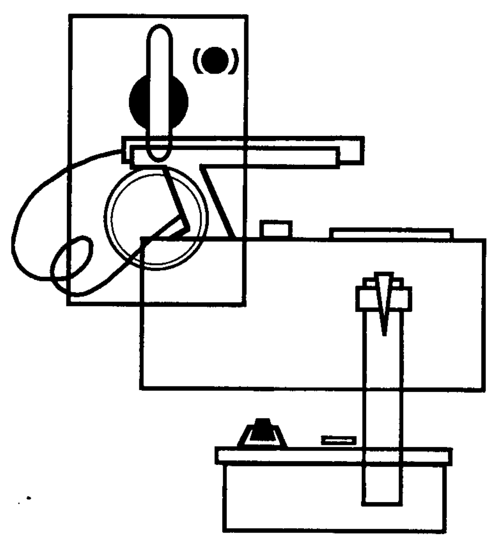
FEDERAL EMERGENCY MANAGEMENT AGENCY

Use of Civil Defense Radiological Instruments for Peacetime Radiological Emergencies



Civil Preparedness Guide
Federal Emergency Management Agency
Washington, D.C. 20472
CPG 2-2

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Use of Civil Defense Radiological Instruments for Peacetime Radiological Emergencies

Foreword

The use of Civil Defense radiation detection and measuring instruments for peacetime incidents when radioactive materials are released and public safety may be compromised is encouraged. The instruments, however, should be used, read and interpreted by those who are specifically trained and skilled in their operation.

This Civil Preparedness Guide (CPG) points out some of the peculiarities of specific instruments and of the radionuclides they may be used to detect. This CPG is intended for civil defense and emergency service workers, mainly State and local government personnel, who are called upon to operate civil defense radiological instruments.

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Distribution: B(HQDivChiefs)
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Chapter 1

General Information

1-1. Purpose. This Civil Preparedness Guide (CPG) provides Federal Emergency Management Agency (FEMA) guidance on radiological defense (RADEF) instruments and their use for peacetime radiological incidents involving the release of radioactive material. Examples of peacetime incidents are transportation accidents and nuclear power plant emergencies.

1-2. Applicability and Scope. This CPG is prepared for radiological personnel at all levels of Government. It describes the operational characteristics of civil defense radiological instruments so that they can be used effectively by trained emergency responders.

1-3. Authorities.

a. Federal Civil Defense Act of 1950, as amended.

b. Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law (PL) 93-288, as amended by PL 100-707.

1-4. References.

a. CPG 2-1, Radiological Defense Preparedness.

b. CPG 3-1, Radiological Instruments, An Essential Resource for National Preparedness.

1-5. Introduction.

a. The use of radioactive material in electric power generation, research, medicine, and industry, with the accompanying requirement for transporting radioactive material, continues to expand. The possibilities of accidental releases are also increasing. A radiation release will involve response by local and State emergency services and, if necessary, State and/or Federal emergency response teams. It is essential that all emergency service personnel be properly trained and equipped to handle assigned emergency response roles.

b. Radiological instruments which have been distributed to States and local governments for civil defense purposes can be and often are used in emergency responses. These instruments are very useful under certain conditions, and can provide information leading to the radiological assessment of the situation. FEMA recognizes and supports the use of civil defense instruments for peacetime radiological incidents.

c. In practice, civil defense resources, including instruments, should be used only in accordance with properly coordinated State and local government emergency response plans and by properly trained and authorized personnel. States and localities assume full responsibility for the proper use of these resources for peacetime incidents.

1-6. Background.

a. The Congress, in the Federal Civil Defense Act of 1950, as amended, has directed FEMA to develop a system of civil defense to protect life and property from both peacetime and attack-caused disasters. FEMA coordinates with the State and local governments in developing this protection. For their part, State and local governments have primary responsibility for developing those capabilities needed to respond to peacetime emergencies and share responsibilities for attack preparedness. Under State guidance, local jurisdictions develop capabilities to protect their citizens in all emergencies which pose a threat to their communities. FEMA's Office of Emergency Management develops, integrates, and promulgates for State and local governments and other Federal agencies, policies, plans and procedures under both the Federal Civil Defense Act of 1950, as amended, and the Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 93-288, as amended by PL 100-107. In order to ensure the development of radiological emergency preparedness and response capabilities necessary to protect the population and industry of the United States, FEMA employs the dual conduits of the Radiological Defense (RADEF) and Radiological Emergency Preparedness (REP) Programs for assistance to the States.

b. FEMA is responsible for coordinating Federal response to all catastrophic emergencies that States are unable to handle using their own resources. Normally, Federal aid is sought by the State Governor who makes a formal request to the President of the United States to declare that particular situation an emergency or major disaster.

c. At State and local levels, radiological emergency response in peacetime involves both the radiological health and emergency services organizations. The radiological health organization usually possesses the technical expertise, and the emergency services organization typically provides those elements essential to proper operational response -- including warning, communications, emergency public information, and other capabilities. The organization designated as lead agency varies. Federal planning assistance, which is available to the States and localities upon request through the Radiological Defense (RADEF) and Radiological Emeregency Preparation (REP) programs, encourages close cooperation between these agencies. This cooperation is especially important in the training and equipping of radiological emergency response personnel.

d. State and local emergency response personnel who use radiological instruments during peacetime emergency response activities should be:

(1) Trained as prescribed by State radiological health authorities;

(2) Familiar with all standard procedures for emergency operations;

(3) Periodically exercised using scenarios representative of accidents which could occur in that State; and

(4) Totally familiar with their instruments, including performance capabilities and shortcomings.

Chapter 2

Civil Defense Radiological Instruments

2-1. Civil Defense Instruments for Dual Use.

a. The following RADEF Program civil defense radiological instrument types are suitable for use in peacetime radiological emergencies:

(1)	CD V-700	Low range beta/gamma Geiger-Mueller (GM) survey meter 0-0.5, 0-5, and 0-50 milliRoentgens per hour (mR/h) gamma; and 0-300, 0-3000, and 0-30,000 counts per minute (cpm) beta/gamma.
(2)	CD V-715	High range ion chamber gamma survey meter, 0-0.5, 0-5, 0-50, and 0-500 Roentgens per hour (R/h). NOTE: Only retrofitted types should be used.
(3)	CD V-717	High range ion chamber gamma survey meter with remote detector, 0-0.5, 0-5, 0-50, and 0-500 R/h.
(4)	CD V-138	Low range (0-200 mR) gamma dosimeter.
(5)	CD V-730	Intermediate range (0-20 R) gamma dosimeter.
(6)	CD V-740	High range (0-100 R) gamma dosimeter.
(7)	CD V-742	High range (0-200 R) gamma dosimeter.
(8)	CD V-750	Charger for all Civil Defense dosimeters.

b. Many of the above instruments are configured into standard civil defense instrument sets as described in figure 2-1. Normally, the CD V-138, CD V-730 and CD V-740 are not found in standard instrument sets.

(1) The CD V-777 set is the standard operational civil defense set that States and localities provide to emergency service organizations for self-protection radiological monitoring. This set is the one most readily available since it

is already in the possession of those most likely to be first at the scene of an accident involving radioactive materials.

(2) The CD V-777A set is the standard set recommended for surface monitoring and reporting stations.

(3) The CD V-777-1 set is an alternate set for use by emergency service organizations.

(4) The CD V-777-2 set is the standard set recommended for public fallout shelters.

c. Additional CD V-700 meters may also be made available in the States for peacetime use as individual instruments to augment the standard sets. Also, States and localities may wish to augment the standard sets with other civil defense instruments.

d. It must be kept in mind that these radiological instruments were procured for nuclear attack emergencies. They were designed and procured to address the overriding radiological problem in a nuclear attack environment which is highly penetrating gamma and strong beta radiation from fallout. Some of these instruments will detect the presence of, but not measure, high-energy beta radiation.

Figure 2-1

Recommended Composition Of RADEF Instrument Sets[1]

Type of Set	Type and Quantity of Instruments in Set				
	CD V-700	CD V-715	CD V-717	CD V-742	CD V-750
CD V-777	1	2	0	6	1
CD V-777A	1	1	1	6	1
CD V-777-1	1	1	0	6	1
CD V-777-2	0	1	0	6	1

[1]Radiological Defense Preparedness, FEMA CPG 2-1, page 5-7.

e. Instruments should always be used as sets. For example, the CD V-700 should never be used without the CD V-715 as a backup and vice versa. The reason for this is that there are situations where it is not unusual to encounter exposure rates in excess of the highest range of the CD V-700, i.e., 50 mR/h. This is often the case for accidents involving the transportation of radioactive materials.

2-2. <u>The CD V-700 Low Range GM Survey Meter</u>.

a. <u>General</u>.

(1) The CD V-700 low range Geiger-Mueller (GM) survey meter is one of the best known and widely used Geiger counters. More than 360,000 of these instruments have been distributed to Federal, State, and local civil defense personnel throughout the United States. They are available in many fire and police stations and other locations, such as hospitals and ambulance services, where the need to deal with radiation emergencies can occur.

(2) The CD V-700 was designed to be a training instrument for Civil Defense. With it, training exercises are conducted in very weak radiation fields permitting the simulation of serious radiological emergencies while subjecting the exercise participants to only minor radiation exposures. The CD V-700 is calibrated in the same measurement unit system (Roentgens or milliRoentgens and hours) as the higher range instruments, and its general appearance, both in shape and color, is deliberately made similar to them. Because its maximum scale reading is 50 mR per hour and the level of fallout radiation can be several hundred Roentgens, the role of the instrument is limited to preattack use for training purposes. In the event of an actual nuclear attack, it would be of little use because it is not capable of measuring the high radiation intensities that would be of concern at that time.

(3) The Chernobyl reactor incident has contributed to an increased public concern about the possibility of future radiation emergencies. The Federal, State and local authorities used civil defense radiological instruments in response to the Three Mile Island incident. The State of Pennsylvania requested and received additional civil defense radiological instruments from the Federal stockpile. Since then, the Federal stockpile has been expanded and improved. It seems natural to consider the CD V-700 survey meter for use in nuclear reactor incidents, since these meters are so widely available. Advantages and limitations of the CD V-700 survey meter for this use are examined below. These advantages and limitations apply as well to standard commercial versions of the Geiger counter survey meter.

b. Units of Measurement.

(1) The response of a CD V-700 type Geiger counter survey meter depends on the photon energy of the gamma radiation to which it is exposed, as well as to the amount of incident radiation per unit of time. The response of an ideal Roentgen per hour measuring instrument would be independent of the photon energy of the incident gamma radiation. Although the CD V-700 survey meter is referred to as a beta/gamma survey meter, it does not provide a reading that is a direct indication of the hazard when exposed to beta or a mixture of beta and gamma radiation. The reason for this is that the detector is a GM tube which reacts to beta radiation (or recoil electrons) from gamma rays which penetrate the wall of the tube and break down the special gases in the tube. Thus, the CDV-700 survey meter counts events in the form of pulses and cannot truly measure radiation over a wide energy range like ionization chamber detectors. It can, however, be calibrated to respond correctly over a very limited energy range. A Roentgen is defined in terms of the degree (or amount) of the ionization of air molecules. An ionization chamber survey meter can detect and measure radiation in milliRoentgens and Roentgens. It can do this over a wide energy range if the detector is made of air equivalent materials. This is the case for the CD V-715 and CD V-717 survey meters, and all dosimeters.

(2) The CD V-700 survey meter, which was intended primarily as a civil defense training instrument, was calibrated (the meter scale was marked) in units of milliRoentgens per hour (mR/h). Other Civil Defense instruments, such as the CD V-715 and the CD V-717 survey meters are calibrated in Roentgens per hour (R/h). The CD V-700 survey meter has a design range of sensitivity of up to 50 mR/h. It can only be calibrated to ±25 percent over a narrow energy range and only for the higher energy gamma rays. This is obvious from the radiation response curve of figure 2-2. The radiation source used in training is usually cobalt-60 which has an effective gamma photon energy of about 1.2 MeV. Therefore, the CD V-700 survey meter responds with reasonable accuracy, i.e., it indicates the degree of hazard from the cobalt-60 gamma radiation. It also responds with reasonable accuracy to cesium-137 radiation, which has an energy of about 660 keV, as well as to the radiation from some other radionuclides. A typical energy response curve for the CD V-700 survey meter is provided in figure 2-2.

(3) The operation manuals for the CD V-700 survey meter carefully point out that the instrument can detect but cannot measure beta radiation. By measure, we mean the degree of hazard of the radiation. In fact, some radioactive materials emit beta radiation of such low energy that it cannot be detected by the CD V-700 survey meter. In addition to scale markings in mR/h, markings in terms of counts per minute (cpm) are provided

on the meter face of the CD V-700 survey meter. Readings obtained from beta emitters (probe shield open) more appropriately should be reported in terms of cpm and not mR/h.

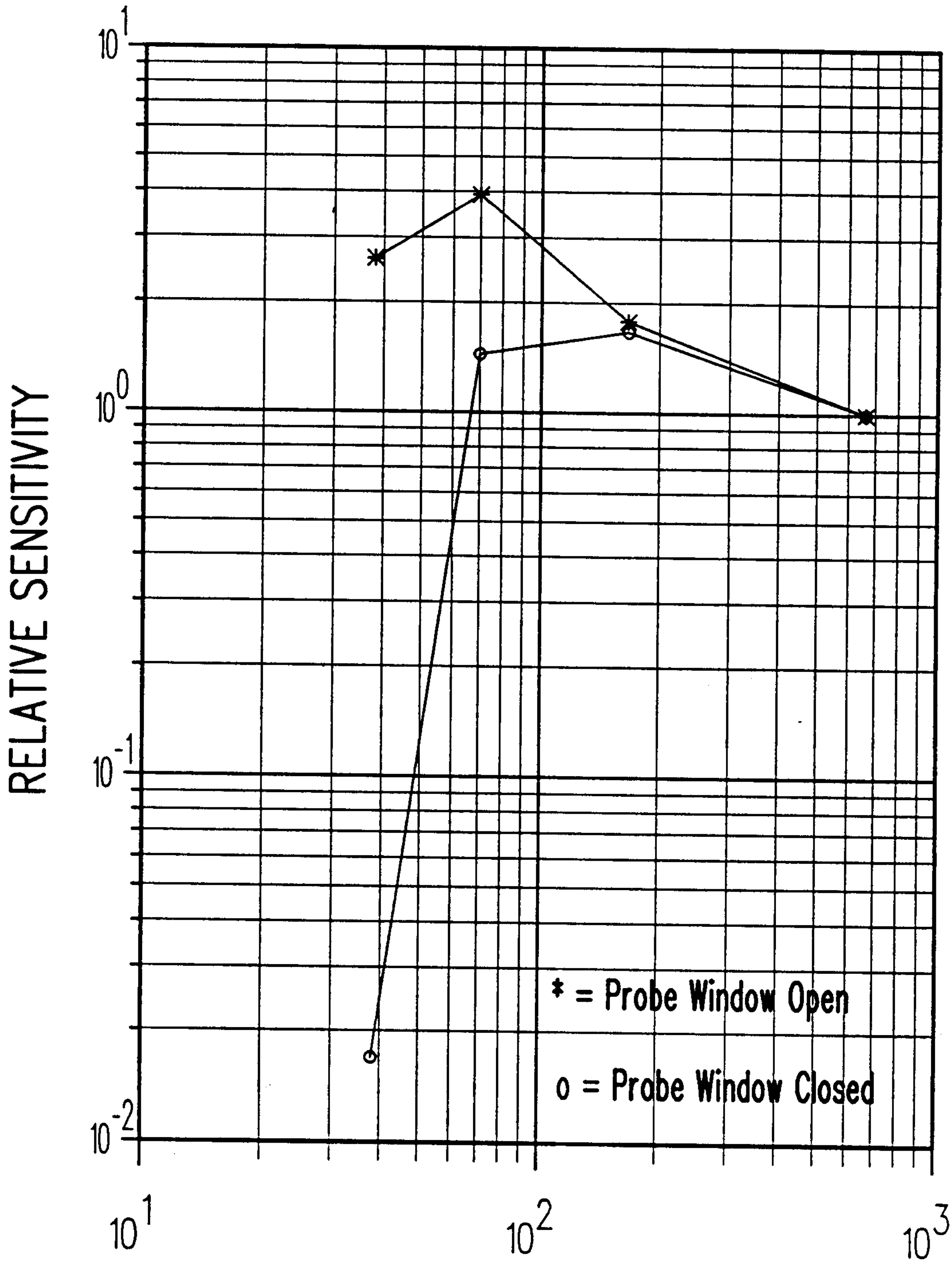
c. Measurement of Low Energy Gamma Radiation. As for many betas and all alphas, low energy gammas and x rays pose special detection and measurement problems. Many radionuclides have gamma or x ray energies below the energy cutoff of the Geiger-Mueller tube as shown in figure 2-2. The CD V-700 survey meter user cannot assume that a small or no reading means that little or no radioactivity is present. Therefore, first responders must be especially alert to this possibility. In situations where the contaminant is a low energy gamma emitter (see reference c.1.), the radiological assessment requires the use of specialized equipment and highly trained users as for alpha and beta contamination.

d. Use of the CD V-700 for Beta Emitters.

(1) Some radionuclides such as phosphorus-32 and strontium-90 used in industry, research, and medicine emit only beta radiation and can be detected by the CD V-700 survey meter. Other radionuclides such as tritium (radioactive hydrogen), carbon-14, and sulfur-35 are also used extensively in medicine, research, and industry and only emit beta radiation, but their beta radiations cannot be detected with the CD V-700 survey meter (see reference c.1.). Shipments of such materials could be involved in an accident, and the materials could be involved in mishaps at the establishments where they are being used.

(2) The CD V-700 will detect the presence of many beta emitters but will not directly measure the degree of hazard. When the shield of the Geiger tube probe is moved from its closed to its open position, the instrument response will increase markedly if a beta radiation (energy about 250 keV or higher) source is present. The wall thickness of the CD V-700 Geiger tube itself may be as much as 50 milligrams per square centimeter (mg/sq cm). Thus the energy of the beta radiation must be about 250 keV or greater if it is to penetrate the wall of the tube. Beta radiation of less than 250 keV cannot penetrate the detector wall and will not provide any instrument response. Disregarding the energy of the beta radiation, assessment of the beta radiation hazard in any quantitative sense cannot be done directly by a CD V-700 or any other portable beta/gamma Geiger survey meter. Sophisticated special equipment and procedures designed for this purpose are required.

Figure 2-2 Typical Gamma Response of the CD V-700 Survey Meter



e. Use of the CD V-700 for Alpha Emitters. The standard CD V-700 will neither detect nor measure alpha radiation. The wall of the standard CD V-700 Geiger tube is much too thick for even the most energetic alpha radiation to penetrate. A special thin window Geiger tube which will detect alpha radiation has been developed for use with certain models of CD V-700 instruments. With such a Geiger tube installed, the instrument is designated the CD V-700M. The electronic circuitry of the CD V-700M has been modified to accommodate this type of detector. The CD V-700M may be used to detect the presence of an alpha emitter but would not provide a measure of the hazard. It would also detect any beta or gamma radiation present. As is the case for beta emitters, specialized equipment and techniques are required to measure an alpha radiation hazard. Most States have a few of the CD V-700M survey meters.

f. Effect of High Gamma Radiation Fields. The top scale marking of the CD V-700 on its least sensitive range is 50 mR/h. A serious accident that might be important to health could involve radiation levels many times higher than 50 mR/h. If the radiation environment is greater than 50 mR/h, the meter will read off scale at the high end unless the radiation field is very high. For very high fields, the instrument will in effect jam and the meter needle could indicate little or no radiation at all. THIS JAMMING ACTION IS A SERIOUS, BUT FAIRLY WELL KNOWN, SHORTCOMING OF GM SURVEY METERS. It occurs at different exposure rates depending on the particular Geiger tube as well as the CD V-700 model in which it is used. Typically, the meter needle will remain off scale up to about 25 R/hr. AT 75 TO 100 R/h, MOST INSTRUMENTS WILL COMPLETELY JAM AND THE METER NEEDLE WILL INDICATE ZERO OR A LOW LEVEL OF RADIATION. In a radiation environment where the radiation levels are very high, even life threatening, the CD V-700 could give an erroneous reading or it could falsely indicate that there is little or no hazard whatsoever. A rushing sound will be heard in the head phone when the instrument is jamming. Moving away from the radiation field reduces the radiation levels and at low enough radiation levels the jamming action will cease.

g. Summary. The CD V-700 in many cases can be very useful in the hands of someone who understands the proper use and limitations of the instrument. It can provide the basis for determining whether or not contamination by most beta or gamma emitters has occurred. If contamination has occurred, a realistic evaluation of the degree of hazard must be done by trained personnel with specialized equipment. The CD V-700 is not suitable for very low energy gamma, beta, or for alpha radiation monitoring. THE CD V-700 SHOULD ALWAYS BE USED WITH A CD V-715 OR OTHER HIGHER RANGE SURVEY METER.

2-3. The CD V-715 High Range Survey Meter.

a. General.

(1) In the event of nuclear attack, the CD V-715 and CD V-717 survey meters would assume the workhorse role in survivable crisis management. They were procured for all civil defense applications including shelter monitoring, protection of emergency services workers, and direction and control. About 480,000 CD V-715's and 90,000 CD V-717's are currently reported in State inventories as available for emergencies.

(2) Calibration instabilities and humidity problems associated with the CD V-715 have for the most part been corrected through a retrofit program at the State Radiological Instrument Maintenance and Calibration (RIM&C) facilities. The CD V-717 was produced to specifications which overcame the CD V-715 problems and, therefore, did not require a retrofit.

(3) It is important to ensure that ONLY retrofitted CD V-715 instruments are being used. All retrofitted instruments have an "R" stamped on the case top at the location of the nomenclature.

b. Accuracy and Range of Response.

(1) The CD V-715 and V-717 measure only a gamma radiation exposure rate in Roentgens per hour (R/h) over the energy range of 80 keV to 1.2 MeV. Accuracy of instrument response over this energy range on all four scales should be better than ±20 percent for a typical instrument during the first year after recalibration. Four years after recalibration, the error should be well within ±30 percent of the true exposure rate.

(2) The CD V-715 is not useful for measuring gamma energies below 80 keV. It should be noted that the instrument has absolutely no capability to detect alpha radiation. Its capability to detect beta radiation is limited to secondary effects from high levels of high energy betas that are stopped or absorbed in the wall of the detector.

(3) In the recalibration process used at the State RIM&C facilities, it is possible to set the instrument response to gamma radiation precisely on scale values which are traceable directly to the National Institute For Standards And Technology. The ionization chamber detector is hermetically sealed and thus requires no correction for ambient temperature and pressure.

c. Other Performance Characteristics.

(1) The CD V-715 and V-717 will not jam. They will indicate full scale for radiation exposure rates in excess of 500 R/h.

(2) The CD V-715 and V-717 are directional with the greatest loss in sensitivity occurring with the radiation incident at the rear. Response is optimized when the instrument is tilted at a 45 degree angle with the front/bottom leading edge pointed at the source of radiation.

(3) The most sensitive range (i.e., 0-0.5 R/h) may exhibit leakage which may be as much as 10 percent of full scale (50 mR/h). This occurs on rare occasions when the instrument is NOT turned on for long periods. This effect does not interfere with accuracy. However, the effect gives a false indication if no radiation is present. Therefore, it is recommended that the CD V-715 and V-717 always be used in conjunction with the CD V-700 GM survey meter for peacetime applications. The leakage problem can be minimized by frequent rechecking of zero set as prescribed by FEMA guidance. Turning on the instrument and leaving it on for extended periods, e.g., 8 hours or longer will usually eliminate leakage. This practice has little effect on battery life which is in excess of 100 hours for these instruments. The CD V-715 and CD V-717 should be checked for operation by the user at least quarterly and include a circuit check and a zero check on all ranges. The instruments must be stored with the battery removed and with a package of desiccant (i.e., moisture absorbing material) inside the case.

d. Summary. The CD V-715 and V-717 are recommended for use as a companion to the CD V-700 to check for the presence of gamma radiation levels above 50 mR/h. However, they also must be used by trained personnel who recognize their limitations when gamma energies are below 80 keV, or the radioactive material is emitting alpha or beta radiation. These survey meters work best when turned on frequently for extended intervals during the frequent operational checks.

2-4. Dosimeters and Chargers.

a. Dosimeters.

(1) The CD V-138 (0-200 mR). The CD V-138 registers low levels of gamma radiation and should not be used alone during an emergency response. The CD V-138 must be used in conjunction with one or more of the higher range instruments. For peacetime emergencies the use of a CD V-730 (0-20 R) in addition to the CD V-138 would be appropriate. During an emergency, cumulative exposure could be in the Roentgen range rather than the milliRoentgen range.

(2) The CD V-730 (0-20 R). This intermediate range dosimeter was designed for post attack recovery operations, and is suitable for use when responding to a peacetime incident. However, in some cases it would be prudent to also use one of the higher range dosimeters.

(3) The CD V-740 (0-100 R). This is one of the high range dosimeters specified for use in fallout shelters and all other nuclear attack-related operations for purposes of exposure control. It is suitable for use in very high exposure rate situations and for confirming whether an off-scale reading by the other dosimeters is from radiation or some other cause.

(4) The CD V-742 (0-200 R). This is the highest range dosimeter in the civil defense inventory for shelter and exposure control. Like the CD V-740, it is suitable for self-protection monitoring and can reassure emergency workers concerning radiation exposure when responding to a high exposure rate situation.

b. Summary. All dosimeters in use by State and local jurisdictions are available and useful for peacetime emergency response. It is important that trained users know how to ensure that the instruments are ready to provide reliable information, if needed. Frequent (at least quarterly) operational checks are encouraged and are easily performed.

2-5. To Obtain Instruments. FEMA-procured civil defense radiological instruments have been granted to the States which are responsible for their distribution to local jurisdictions. Contact the State Emergency Management Agency or the equivalent office to obtain instruments. For a listing of State Emergency Management Directors, consult FEMA publication 9, Directory of Governors, State Officials and Adjutants General.

2-6. To Obtain Training.

a. General. Training for the use of radiological instruments is provided through the State Emergency Management Agency or equivalent office.

b. Classroom Training Courses. A variety of RADEF courses are scheduled during the year by State training officials who should be contacted for the current schedule.

c. Home Study Training Courses. FEMA has available a number of home study courses. Write for FEMA TD-19, Home Study - Management Plan.

d. FEMA Emergency Management Institute. Selected courses are available to qualified officials at the Emergency Management Institute, National Emergency Training Center, Emmitsburg, Maryland. A list and schedule of courses can be obtained by writing to FEMA, Box 70274, Washington, DC 20024. Especially, request FEMA TD-100, Management Plan for the Radiological Training Series.

Chapter 3

Instrument Maintenance and Calibration

3-1. General.

a. For peacetime use, all instruments, whether civil defense issue or other, should be subject to frequent (at least quarterly) operational checks. This should be done in addition to the routine cycling of civil defense instruments through the State RIM&C facilities. Arrangements should be made with the State RIM&C facility to replace any civil defense instruments found to be defective as a result of these checks.

b. The State's RIM&C facility personnel should be aware of all civil defense instrument sets in their State which are assigned to peacetime emergency response. Periodic follow-up on the performance of these sets could provide an indication of the general levels of performance of all sets in the States.

3-2. Interrelationship of Dosimeters and Chargers.

a. Fiber Deflection. Dosimeters and chargers are used in sets with one charger assigned to several dosimeters. It is well known that low range (and certain intermediate range) dosimeters evidence an up or down scale deflection, i.e., a kick, when removed from the charger and again when the charging electrode is discharged. The amount of deflection can vary with the make and model as well as age of the dosimeter. This is especially true when the dosimeter and/or charger have not been used for long periods of time. The kick is due to poor electrical contact either between the dosimeter charging recess and the charging pedestal or in the charging pedestal itself, or both. Electrical contact degrades when metal surfaces become oxidized during storage. This can usually be corrected by cleaning the charging recess and bottom of the dosimeter and by pulsing the charging switch at least 10 times prior to use. Applying a radial force (with the dosimeter perpendicular) during the charging operation may also help. Figure 3-1 provides a troubleshooting guide for these anomalies.

b. Deflection Compensation. The kick inherent in the dosimeter cannot be eliminated. Although the CD V-138 dosimeter has design features which minimize the deflection, it contains components and materials which change with usage and time. As a result the extent of the deflection can be highly variable. In use, one can compensate for the deflection by noting and recording an initial reading. In the 200 mR dosimeter it is important to discharge (short) the center electrode prior to taking an initial reading. This is done by making an electrical connection between the center electrode of the charging switch

Figure 3-1
Dosimeter Charging Anomalies

Problem	Cause	Correction	Disposition
Downscale deflection when dosimeter is removed from charger.	1. Poor electrical contacts in charging pedestal of charger, i.e., surface oxidation.	Depress charging switch vigorously 10 or more times.	Repeat if necessary.
	2. Dosimeter charging electrode is in contact with internal electrodes.	Reset charging switch (this requires special tool).	Return dosimeter to State shop.
Difficulty in attaining a steady state reading - fiber "jumps" from one reading to another.	Poor contact between dosimeter and charging pedestal of charger due to surface oxidation.	Clean interior of charging recess and bottom of dosimeter.	None.

and ground. If an instrument shows excessively large deflections as a result of shorting the pin, it should not be used. Dosimeters having ranges of 0-1 R to 0-20 R should be treated the same as above for the 200 mR.

> Note: Shorting of the charging electrode should be performed on all dosimeters as an operational check regardless of range. Any resultant large deflections could indicate that the internal electrodes are not isolated or that there is an open internal connection. This would result in erroneous readings. Instruments exhibiting large deflections should not be used.

3-3. <u>Radiation Response</u>. All ranges of civil defense dosimeters have a flat response to gamma radiation over the energy range 50 keV to 1.2 MeV. Instruments having an error of less than ±10 percent of true exposure rate can be selected for use in kits assigned to peacetime emergency response. For this application, frequent checks (at least quarterly) for electrical leakage are recommended. The CD V-138 should be capable of measuring background radiation exposure, i.e., about 50 to 120 mR per year. All others should indicate no more than background when stored at room temperature. Dosimeters subjected to shock and rough handling may evidence a change in reading in either direction due to mechanical shift or foreign particles in the ion chamber.

3-4. <u>Dosimeter Electrical Leakage</u>.

a. <u>Dosimeter Reliability</u>. Electrical leakage can seriously affect the reliability of dosimeters. Therefore, they should be checked quarterly for leakage. When used for peacetime response, a log should be kept of dosimeter reading versus date of reading. This will serve to assure that the dosimeters are always ready for use. The instruments should essentially measure background radiation.

b. <u>Dosimeter Accuracy</u>. Concern for electrical leakage is more important than concern for accuracy of dosimeters. If the instrument does not leak, it is almost sure to provide radiological information useful for making decisions in an emergency. Figure 3-2 provides a matrix which describes the major causes/effects of electrical leakage. Civil defense instruments granted to the States by FEMA (and its predecessor agencies) do not have the radiation damage problems mentioned on the chart.

Figure 3-2
Dosimeter Electrical Leakage

Problem	Cause	Correction	Disposition
Leakage is more than 2.5 percent of full-scale in 5 days at room temperature.	Internal contamination.	Outgas and reseal.	Return to State shop for repair.
Leaks excessively and reading is lost when charging electrode is grounded.	Internal electrode shorted to charging electrode.	Reset charging electrode with special tool.	Return to State shop for repair.
Leaks sporadically.	Foreign particles in ion chamber.	None	Return to State shop with note identifying the defect.
Lost reading due to complete discharge.	Foreign particles in ion chamber.	None	Return to State shop with note identifying the defect.
Reading change when handling.	Foreign particles in ion chamber.	None	Return to State shop with note identifying the defect.
Radiation exposure in the range of 100 R causes increase in leakage (should be negligible in CD dosimeters).	Damage to insulator by radiation	None. This is a characteristic of all insulators. It is minimized in CD dosimeters.	None

Chapter 4

Conclusion

4-1. General. This CPG presents general information on the applicability of civil defense radiological instruments for peacetime radiological emergency preparedness. It provides specific information on the response and other performance characteristics of civil defense survey meters and dosimeters so that knowledgeable operators can make effective operational use of these instruments.

4-2. Knowledge of Instrument Performance. State Radiological Defense Officers (RDO's) and Radiological Instrument Maintenance and Calibration facility technicians should be aware at all times of the use and performance of civil defense radiological instruments identified in their States for peacetime emergency response. Notable experiences in both use and performance should be reported to the FEMA Regional Office Radiological Defense Program Manager for information or corrective action, as necessary.

4-3. Familiarity With Instruments. FEMA encourages the use of civil defense radiological instruments in peacetime, providing the operators are familiar with the instruments. This familiarity is enhanced by frequent operational checks, refresher training, and exercises. Emergency response personnel should know their instruments well and be aware of what to expect from them. This should include frequent checks of background radiation, circuit checks, and where applicable, sensitivity tests using check sources. Personnel must also know where to get advice and assistance from responsible radiological authorities within the State.

4-4. Lessons To Be Learned. Use of civil defense radiological instruments in peacetime radiological emergency preparedness offers FEMA and the States opportunities to:

a. Learn more about instrument performance and reliability in the field. It must be remembered that all civil defense instruments are over 25 years old;

b. Learn more about the problems associated with the peacetime emergency response applications of the instruments, so that future instruments can be designed with the attack/peacetime dual-use concept as a primary objective; and

c. Learn more about the adequacy of FEMA programs, for example, the effectiveness of present maintenance and calibration procedures.

4-5. FEMA Contact. In view of all that has been stated, this document should promote discussion and feedback. FEMA welcomes both. Information on instrument performance should be sent to:

FEMA Radiological Instrumentation Test Facility
Route 601, Building 217
P O Box 129
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Appendix A

References

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