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Practical Application

AND USE OF CIVIL PREPAREDNESS RADIOLOGICAL INSTRUMENTS

(RM-Practical)

Instructor Guide

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INSTRUCTOR GUIDE

FOR

PRACTICAL APPLICATION AND USE OF CIVIL PREPAREDNESS RADIOLOGICAL INSTRUMENTS (RM-PRACTICAL)

SUPERSEDES IG-11.21 DATED MAY 1963
WHICH MAY NOT BE USED

DEPARTMENT OF DEFENSE
DEFENSE CIVIL PREPAREDNESS AGENCY

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RM-PRACTICAL INSTRUCTOR GUIDE

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INFORMATION FOR THE INSTRUCTOR

The purpose of the RM-PRACTICAL training is to qualify, as radiological monitors, individuals who have completed the programmed instruction of the HS-3, Introduction to Radiological Monitoring home study course.

The RM-PRACTICAL course serves as a brief review of the HS-3 home study course and gives the student an opportunity to ask questions concerning any concepts or problems that he may have encountered while completing HS-3. This RM-PRACTICAL course provides the student with "hands on" experience with the RADEF instruments.

The objectives of the RM-PRACTICAL course are to enable the student to:

1. Qualify as a fully trained Radiological Monitor and serve as such in the individual's jurisdiction.

2. Be familiar with the principles of radiological defense, know the weapons effects reporting system, and be aware of what to expect in nuclear postattack environments.

3. Measure, record and properly report fallout radiation exposure and exposure rates.

4. Perform an operational check of the RADEF instruments and know how to properly care for them.

5. Calculate future exposure rates, exposures, mission entry and stay times with the aid of the nomograms.

6. Provide limited field guidance on radiation hazards associated with assigned operations.

Course prerequisities are:

1. Students should have an assignment or potential assignment as a radiological monitor for a local, county, or State jurisdiction or facility.

2. Student must have successfully completed the home study course, Introduction to Radiological Monitoring, HS-3. (Except as listed in scheduling - i.e., three meeting concept.)

INSTRUCTOR PREPARATION

This instructor guide is intended as an aid to the instructor. He should study this guide before each training course as well as the reference and resource materials. The instructor should not read the lesson plan verbatim to students, but use it as a guide to cover a course of study

to develop fully qualified and trained radiological monitors. The instructor should add pertinent information as the occasion demands throughout the training period.

The instructor should be thoroughly familiar with the local and State radiological defense organizational and operational plans because they are not included in this instructor guide.

Since a considerable portion of the RM-PRACTICAL course involves the use of the DCPA Radioactive Training Source set, the instructor must be a qualified "licensed user" under an "Agreement State" or Nuclear Regulatory Commission (NRC) byproduct material license. The byproduct material license must authorize the use of the source set for training radiological monitors.

If the instructor is not a licensed user under a byproduct material license, he must obtain the services of a licensed user for that portion of the course where the radioactive training sources are used. The licensed user must be physically present in the area while the sources are being used.

Only the licensed user should handle the sources. Students should be cautioned not to handle, touch or step on the sources. A count should be made and recorded of the number of source capsules present at the beginning of the course and also at the completion of each exercise. Radiation exposure records for each student must be kept in accordance with NRC regulations (see Lesson Plan No. 3).

Review of the HS-3 course is important - but the primary intent of this course is to provide "hands on" experience in using RADEF instruments and to become familiar with the organization's reporting procedures. The completion of this training course should culminate in the assignment of the student as a radiological monitor in a civil preparedness organization.

The instructor should also know that in the review of HS-3 the subject matter is keyed to certain frames in the HS-3 home study text. The selected frames will help the instructor cover the review in the same order in which the student reads it. It will also prevent the introduction of concepts which have not been presented to the student. Students should be requested to bring their copy of the HS-3, Introduction to Radiological Monitoring book with them to this course.

SCHEDULING

There are several different ways to complete the RM-PRACTICAL training course. The course has been designed to permit completion in one, two, three or possibly four meetings (sessions). How the course is scheduled will depend upon local circumstances. The 8 hours should be scheduled in a manner to best suit time available to both the students and the instructor.

For example, a three meeting class of approximately three hours per meeting might work well in one community while a two meeting class on Saturday mornings for 4 hours each may be more satisfactory in another community.

A scheduling that has worked well in some States is the three meeting concept. This has been most satisfactory with group enrollments. During the first meeting, the students are enrolled in the HS-3 home study course and provided with the course material. After this, they are given the Course Introduction (Lesson Plan No. 1) and then Instrument Operation, Use and Limitations (Lesson Plan No. 2). This is followed by actually using the instruments in the Operation Prospect exercise (Lesson Plan No. 3). The students then return to their homes and complete the HS-3 home study. Later, at a time agreed upon - usually 4 to 6 weeks, the students return for the second meeting. HS-3 is reviewed (Lesson Plan No. 4) at the second meeting and is followed by instrument exercises: Instrument Familiarization (Lesson Plan No. 5), Area Monitoring (Lesson Plan No. 6) and Radiation Protection (Lesson Plan No. 7). The third meeting concludes the course with Radiological Monitoring, Reporting and Assessment, Nomograms, Course Examination and Presentation of Certificates (Lesson Plans 8, 9, 10 and 11).

Don't forget to arrange for the use of a DCPA Training Source Set. In some areas its availability is limited and the instructor must make arrangements for its use and storage well in advance of the course meeting.

VISUALS

Visuals recommended for this course are (1) the 16mm film, "About Fallout" and (2) 2"x 2" slides. Availability of the film, "About Fallout" is through the nearest Audio-Visual Support Center (Army Film Library) as listed in the Defense Civil Preparedness Agency Motion Picture Catalog, MP-6. The set of 2"x 2" slides used in Lesson Plan No. 2 may be ordered from the U. S. Army AG Publications Center, Civil Preparedness Section, 2800 Eastern Blvd., (Middle River) Baltimore, Maryland 21220. Request the Radiological Monitoring Training Kit, K-24.

FACILITY REQUIREMENTS

The following is a list of criteria which should be helpful to the instructor in selecting a location for the training course if it is conducted in the field. This list represents an ideal classroom and exercise area and should be used as a guide only. It is recognized that effective instruction may be presented under less than ideal conditions.

A. Tables and chairs:

1. Tables and chairs are preferred to armchairs.

2. Minimum tabletop working area per student: 36" x 30".
3. Chairs should be comfortable and not contribute to distracting noises.

B. Room arrangement:

1. A wide aisle should be provided down the center of the room for issuing and collecting materials.
2. Side aisles should be provided for student and instructor access.
3. Three and one-half feet should be provided between the rows of student tables for student and instructor access.

C. Room lighting and acoustics:

1. Lighting should be bright and adequate.
2. Provisions should be made for darkening the room if visual projections are used. Low level lighting is desirable to allow note taking.
3. Acoustics should be checked for clear voice transmission.

D. Personal Comfort:

1. Temperature and fresh air should be controlled for instructor and student comfort.
2. Restrooms should be convenient to the classroom.
3. Drinking water should be close by. A coffee pot in the classroom usually is welcome to the monitoring class in day long scheduling.
4. If the class is a day long schedule - lunch facilities should be close by.
5. Smoking and non-smoking areas.

E. Radiological instrument exercise area:

1. It is desirable to conduct the radiological instrument exercises in Lesson Plans 3 and 6 out-of-doors, weather permitting. In case of inclement weather, larger than normal rooms should be ready as an alternative.
2. An exercise area about the size of an average household lawn should be suitable. The exercise area should be reasonably level.
3. The exercise area should be free of all pedestrian traffic when the radioactive sources are in place for training and must be labeled with Radiation Hazard Signs. The licensed user must be present at all times when the sources are not secured under lock and key.

PRECOURSE CHECKLIST

A. Chalkboard, chalk, eraser and pointer. Projection equipment when used.

B. Thirty-five millimeter (35 mm) slide projector and set of 2"x 2" slides.

C. Lectern and a side table to hold demonstration instruments.

D. Radiological Instruments - one CDV-777A set for the instructor; one CDV-777A set for each two students; a CDV-777 set for demonstration; and 30 CDV-138 dosimeters (or one per student for larger classes).

Each CDV-777A Set should contain:

1. One CDV-700 survey meter.
2. One CDV-715 survey meter.
3. One CDV-717 survey meter.
4. Six CDV-742 dosimeters.
5. One CDV-750 dosimeter charger.
6. Batteries, "D" size.

Each CDV-777 Set should contain:

1. One CDV-700 survey meter.
2. Two CDV-715 survey meters.
3. Six CDV-742 dosimeters.
4. One CDV-750 charger.
5. Batteries, "D" size.

E. One CDV-778 Radiological Training Source Set which contains:

1. One large lead container (lockable).
2. One small lead carrying container.
3. Six cobalt 60, radioactive sources.
4. One set handling tongs.
5. Six radiation hazard signs.
6. One CDV-700 survey meter.
7. Two CDV-138 dosimeters.
8. One CDV-750 charger.

F. Suitable temporary storage area for training source set (if required).

G. String, masking tape, grease pencil, etc. for making instrument familiarization spirals.

H. Styrofoam cups, adhesive labels, felt marking pen for making area monitoring exercise coordinate pylons.

I. Shielding materials such as solid common clay or concrete bricks, earth and wood; and radiation time-distance layout circle.

J. Student workbooks, SM-11.21.1 and Handbook for Radiological Monitors, CPG 2-6.2.2, one for each student; at least one copy of all other reference materials for student review. Other publications that may be of interest such as "Protection in the Nuclear Age," H-20.

CONDUCTING THE COURSE

Since the main purpose of this course is instrument familiarization, students should be given the opportunity to participate in the course as much as possible. They should also have a chance to ask questions, express opinions, and relate appropriate experiences. The instructor should frequently question the students to determine if they understand what is being taught.

One way of conserving time is to start the Radiation Protection Exercise and while the dosimeters are left to be exposed, begin with the next session. At an appropriate time, break and complete the exercise. There is not a need for formal breaks during the instrument exercises because the students are moving actively about. Also, the students will automatically get a break when they complete one exercise and move into another. In the case of a day long schedule, the lunch period should occur approximately between the Instrument Familiarization exercise and the Area Monitoring exercise.

EXAMINATIONS

The student must have successfully completed the four quizzes and final examination in the Introduction to Radiological Monitoring, HS-3 home study course to be accepted for the course, unless the entire training is given in the three meeting concept (as discussed in SCHEDULING) where the students are also enrolled in HS-3 at the first meeting. In this situation, the students should have successfully completed the four quizzes and final examination from HS-3 prior to attendance at the second meeting. Regardless of how the course is scheduled, the course examination listed in SM-11.21.1 should be given during the last meeting prior to the presentation of certificates.

The instructor should not have any difficulty in helping the student achieve a satisfactory proficiency in using the radiological instruments prior to awarding of certificates.

LESSON PLAN NO. 1

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Introduction TIME: .75 Hour

OBJECTIVE: At the conclusion of this unit the student will be able to:

1. Discuss the schedule of the RM-PRACTICAL course and its scope.

2. Plan his participation as a student to successfully complete the requirements for certification as a qualified radiological monitor.

SCOPE: Welcome; administrative announcements; purpose and scope of course; film, "About Fallout," 24 minutes, color.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, A Programmed Home Study Course, HS-3.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.
   c. Radiological Defense Preparedness, CPG 2-6.1.
   d. Radiological Defense Manual, CPG 2-6.2.

2. Student
   a. Introduction to Radiological Monitoring, A Programmed Home Study Course, HS-3.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.

REQUIREMENTS:

1. Instructor
   a. Chalkboard, chalk, eraser, pointer.
   b. 16 mm projector, screen.
   c. Administrative announcements to fit the situation.

2. Student
   Notebook and pencil as appropriate.

REMARKS: It is a good idea to write or print your name on the chalkboard and provide the students with a printed schedule if one is available.

MAIN TOPICS	TEACHING POINTS
A. WELCOME AND ADMINISTRATIVE ANNOUNCEMENTS	1. Officially open the course by announcing your name and title. Welcome the students and acknowledge any notables that may be present.
	2. Provide administrative details; restroom locations; drinking water; telephone; emergency exits; expected time for breaks; luncheon plans; etc.
B. PURPOSE OF COURSE	1. The purpose of the RM-PRACTICAL course is to complete the training required to become a fully qualified radiological monitor by providing hands on experience with radiological instruments. The trained monitors are expected to be assigned radiological duties to detect, measure, record and, as appropriate, report RADEF information in the event of an emergency.
	2. The Introduction to Radiological Monitoring, HS-3 home study course is used to permit individuals to complete a major portion of training at home and at times most convenient to them.
	3. The HS-3 programmed course of study must be supplemented by "hands on" training and practicing with the radiological monitoring instruments in a radiation environment.
	4. The HS-3 home study course, when supplemented by the 8 hours of practical training (RM-PRACTICAL) is the standard method for training radiological monitors.
C. SCOPE OF COURSE	1. On the chalkboard break out the scope of the course by session (lesson plan) time blocks.
	2. Give general guidelines, procedures, and what is expected of the students in completing the course - attendance, supplemental reading, examinations, participating in the exercises, etc.

MAIN TOPICS	TEACHING POINTS
D. FILM: "ABOUT FALLOUT"	1. This film introduces and illustrates "fallout" using both live action and animation to present the basic nature of fallout radiation, its effects on the cells of the body, what it would do to food and water after a nuclear attack and what common sense steps can be taken to guard against its dangers. 2. The film is designed to dispel many of the myths and fallacies now surrounding the subject in the public mind. It presents the facts, clearly and simply, in everyday layman's terms. 3. The importance of shelter from fallout is stressed as well as prescribed decontamination measures that may be taken to reduce or minimize the effects of fallout on people.

LESSON PLAN NO. 2

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Instrument Operation, Use and Limitations

TIME: 1.25 Hours

OBJECTIVES: At the conclusion of this session the student will be able to:

1. Identify and operate the CDV-700, CDV-715 and the CDV-717 survey meters; the CDV-138 and CDV-742 dosimeters; and the CDV-750 dosimeter charger.

2. Explain the operation of the CDV-715 survey meter and the CDV-742 dosimeter.

3. Install batteries and perform an operational check on the CDV-700, CDV-715 and CDV-717 survey meters.

4. Install a battery in the CDV-750 charger and charge the CDV-138 and CDV-742 dosimeters to zero.

5. Discuss the use of each instrument and its limitations.

6. Provide the proper care and monitor's maintenance for each instrument.

SCOPE: Detection of radiation; operation of dosimeter and charger; zeroing and reading the dosimeter; initial dosimeter check; dosimeter operating characteristics; uses of dosimeters; dosimeter difficulties; dosimeter care and maintenance; operation of the CDV-700, 715, and 717 survey meters; operation of the CDV-138 and 742 dosimeters and the CDV-750 charger.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, HS-3.
   b. Radiological Defense Manual, CPG 2-6.2.
   c. Handbook for Radiological Monitors, CPG 2-6.2.2.

2. Student
   a. Introduction to Radiological Monitoring, A Programmed Home Study Course, HS-3.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.
   c. Handbook for Radiological Monitors, CPG 2-6.2.2.

REQUIREMENTS:

1. Instructor
   a. Chalkboard, chalk, eraser, pointer.
   b. RADEF Instrument Set, one each CDV-777A and CDV-777.
   c. 35mm slide projector, slides, and screen.

2. Student
   a. RADEF Instrument Set, CDV-777A (one set per two students).
   b. One CDV-138 dosimeter per student.

REMARKS: The instructor will have to cover the material in this lesson plan quite rapidly. If time is short, the instructor can delete some of the examples which require the student to convert meter readings and instrument range settings to exposure rates. The students will receive practice making these conversions during the instrument exercises.

MAIN TOPICS	TEACHING POINTS
A. DETECTION OF RADIATION Visual 4.0 Visual 4.1	1. Since nuclear radiation can cause serious injury or death to individuals, its detection is of major importance in civil defense. Nuclear radiation is invisible and as it penetrates the body it can cause damage without producing pain. A person cannot feel, see, hear, smell or taste nuclear radiation and, therefore, must rely on radiological instruments to determine its presence.
Visual 4.2 Visual 4.3	2. There are several different characteristics of nuclear radiation which can be used as a basis for detection, but only one is of major importance in the design of instruments for civil defense. This property is the ability of radiation to produce electrically charged particles as it passes through substances. The substance usually used in civil defense instruments is a gas or mixture of gases such as air. As the charged particles are produced in the gas they are collected and measured.
Visual 4.4	3. Instruments must provide two kinds of information needed for the evaluation and control of the radiological hazard from fallout. The first of these is the intensity of the radiation field which is more appropriately called the exposure rate. The second is the total exposure received by an individual. 4. This information is essential in providing guidance for emergency operations. For example, it permits the calculation of permissible entry times and stay times for personnel in contaminated areas and provides an objective means for withdrawing personnel who may be nearing a serious or critical exposure to nuclear radiation. It is also useful in anticipating the severity of radiation sickness.
Visual 4.5 and 4.6	5. No single civil defense instrument has been designed to provide the two kinds of information required for civil defense, therefore,

MAIN TOPICS	TEACHING POINTS

this information must be collected by separate instruments. Those designed to measure exposure rate are called survey meters. Those designed to measure total exposure are called dosimeters.

6. Since survey meters measure exposure rate, they are calibrated in roentgens per hour (R/hr.) or milliroentgens per hour (mR/hr.). Dosimeters which measure exposure are calibrated in roentgens (R) or milliroentgens (mR).

NOTE: During the course, the instructor should emphasize the difference between survey meters and dosimeters and the units of measurement. Whenever the wrong units are used, such as ..."This survey meter reads 50 mR"... correct the student immediately. Use of the correct units is of utmost importance.

Visual 4.7

7. The dosimeter and survey meter may be compared to an automobile speedometer. The survey meter measures the radiation exposure rate in roentgens per hour like the speedometer of an automobile records the rate of travel in miles per hour. The dosimeter measures the radiation exposure in roentgens and is like the mileage indicator (odometer) which records the total miles traveled.

B. OPERATION OF DOSIMETERS

NOTE: Have the students examine the CDV-138 dosimeter prior to explaining its operation.

MAIN TOPICS	TEACHING POINTS
Visuals 4.8 and 4.9	1. A dosimeter charger is used to place an electrical charge on the indicating mechanism inside the dosimeter. This charge controls the movement of the hairline (indicator). When the hairline is on zero, the dosimeter is said to be "zeroed" (fully charged).
Visuals 4.10 and 4.11	2. As a monitor performs his task in a radiation area, nuclear radiation will penetrate his body and penetrate the dosimeter he wears. This radiation will produce electrically charged particles inside the dosimeter and inside his body. These charged particles will reduce the electrical charge previously placed on the dosimeter by the charger. The loss in electrical charge will cause an upscale movement of the hairline. This movement is a measure of the monitor's radiation exposure.
	3. The hairline movement is a measure of the dosimeter's exposure. However, if a monitor wears the dosimeter during the exposure period, it is assumed that the monitor's exposure is the same as that measured by the dosimeter.
C. OPERATION OF DOSIMETER CHARGER Visual 4.12	1. The CDV-750, dosimeter charger, is used to zero all civil defense dosimeters. It has a charging receptacle and a downscale/upscale control. The charger is powered by a single 1.5 volt flashlight battery, which operates the charging circuit and provides the light for illuminating the dosimeter scale. There are no internal adjustments to be made to the charger.
	2. To prepare the dosimeter charger: (a) loosen the thumbscrew in the top or bottom center of the charger's case with a screwdriver or a coin, such as a dime, and remove the bottom part; (b) insert a standard "D" cell battery by placing the + end of the battery against the clip marked +. The raised center terminal on the standard flashlight battery is plus (+);

MAIN TOPICS	TEACHING POINTS
	(c) reassemble the top and bottom parts of the case and tighten the thumbscrew.
	NOTE: Instructor should demonstrate this with a "D" cell battery and a CDV-750 charger.
D. CHARGING A DOSIMETER Visual 4.13	1. To charge a dosimeter, position the charger on a flat surface such as a table. Unscrew the cap on the charging contact and place the end of the dosimeter opposite the pocket clip and eye piece on the charging contact.
	2. Apply downward pressure and you should see a scale and the hairline while looking through the dosimeter eye piece. If the hairline is not visible, rotate the control knob, located in the upper right hand corner, until the hairline appears.
	3. Set the hairline to or near zero by turning the control knob.
	NOTE: Allow sufficient time for each student to charge one of each type dosimeter available and to become thoroughly familiar with the charging operation. The instructor should check each student individually to assure that the student knows how to charge a dosimeter.
E. READING DOSIMETERS Visual 4.14	1. All civil defense dosimeters are read by holding them about one-half inch from the eye and pointing them toward any light source sufficient to see the scale and hairline. A match, candle or flashlight should provide sufficient light. Observe the position of the hairline relative to the scale. To minimize reading errors, the dosimeter should be read in the same general position each time.

MAIN TOPICS	TEACHING POINTS
Visual 4.15	2. If an adequate light source is not available, a dosimeter charger may be used to read the dosimeter. Press the dosimeter gently on the charging receptacle until the light turns on. CAUTION: If the dosimeter is pressed down too far, it may make contact with the charging circuit and the reading will be changed or completely lost.
	3. To read the dosimeter at any time, point the end opposite the eye piece toward a source of light, and observe the reading where the hairline crosses the dosimeter scale.
Visual 4.16	4. A dosimeter need not read zero in order to begin to measure a monitor's exposure. It is possible to determine the exposure for any selected period of time by subtracting the reading at the beginning of the exposure period from the reading at the end of the period. Thus, if a dosimeter reads 20 R at the beginning of a mission, and 50 R at the end, the monitor's accumulated exposure was 30 R. A dosimeter should be recharged after each use, or if it reads more than 50% of full scale.
F. INITIAL CHECK FOR DOSIMETERS	1. When dosimeters are received, a monitor should zero them and check their electrical leakage characteristics, i.e. upscale drift when not exposed to radiation.
Visuals 4.17 and 4.18	2. The leakage characteristics may be checked by zeroing the dosimeters and placing them in a radiation free area for 4 days. If the leakage rate exceeds 5% of full scale in 4 days, the dosimeters should not be used provided other dosimeters are available.
	3. If no other dosimeters are available, the leakage rate should be determined and the contribution from electrical leakage subtracted from the exposure. For example, a dosimeter reads 75 R after 7 days of exposure in a shelter. If the leakage rate is 5 R per day, what was the exposure during the 7 days? Answer: $75-(7 \times 5) = 40$ R.

MAIN TOPICS	TEACHING POINTS
G. DOSIMETER OPERATING CHARACTERISTICS Visual 4.19	1. The ranges of civil defense dosimeters are: CDV-138, 0 - 200 mR (Black Clip); CDV-730, 0 - 20 R (Green Clip); CDV-740, 0 - 100 R (Silver Clip); CDV-742, 0 - 200 R (Gold Clip). 2. The accuracy of the dosimeter is $\pm$ 20% when measuring fallout gamma radiation. 3. Pressure, temperature and humidity changes will not effect dosimeter readings. 4. Dosimeters are constructed for relative rugged use.
H. USES OF DOSIMETERS Visual 4.20	1. The CDV-138 is used for training. 2. The CDV-730, CDV-740 and CDV-742 are used for emergency operational purposes.
I. DOSIMETER DIFFICULTIES Visual 4.21 Visual 4.22 Visual 4.23 Visual 4.24	1. The hairline may not move as the control knob is rotated. This may be caused by lack of proper electrical contact between dosimeter and charger. To correct this, depress the dosimeter completely to the bottom of the charging receptacle and rotate the dosimeter a couple of times. 2. The hairline on the CDV-138 will shift when removing it from the charger. If desired, this can be corrected by setting the hairline to the left of zero a distance equivalent to the shift. 3. The hairline may appear to shift as the dosimeter is rotated around its horizontal axis. To correct for this effect, always read the dosimeter with the zero mark on the left. This effect is most noticeably on the CDV-138. 4. The hairline may move upscale over a period of a few days even though it is not exposed to radiation. This is caused by electrical leakage. If the leakage is in excess of

MAIN TOPICS	TEACHING POINTS
	5% of full scale in 4 days, the dosimeter should not be used if other dosimeters are available. If the dosimeter must be used - determine the leakage rate in a radiation free area, and subtract from the operational exposure.
Visual 4.25	5. The hairline may disappear within minutes after charging a dosimeter which has been stored in an uncharged condition. Most dosimeters require a "soak in" charge if they remain uncharged for a considerable time. Such dosimeters should be charged and the reading observed for a few hours before using them. A second charging may be required before the dosimeters are ready for use.
J. DOSIMETER CARE AND PREVENTIVE MAINTENANCE	1. Prevent radiological contamination of dosimeters. However, if dosimeters do become contaminated, they can be cleaned with a cloth dampened in a mild soap solution.
Visual 4.26	NOTE: Discuss several means by which dosimeters may become contaminated, such as dropping them in contaminated areas, handling them with contaminated gloves, and discuss means of preventing such contamination.
	2. Avoid unnecessary rough handling of dosimeters. Although designed for rugged use, dosimeters could be damaged if grossly misused.
	3. Charge dosimeters before storing and store in a dry place. When performing scheduled checks of instruments, dosimeters should be read. Recharge them to zero if they indicate more than one-half of full-scale.

MAIN TOPICS	TEACHING POINTS
	4. Remove batteries at least monthly from dosimeter chargers in frequent use and inspect battery contacts for dirt and corrosion. Dirty contacts should be cleaned. If the charger is to be stored for more than four weeks, remove the batteries from the charger and store the charger in a dry place. The batteries will last longer if stored at room temperature or below; in fact the cooler the storage temperatures the better as long as the batteries are kept dry such as by sealing in plastic. NOTE: Stress the importance of removing the battery from the charger during long term storage. NOTE: Since there are different models and manufacturers of civil defense survey instruments, the instructor should become thoroughly familiar with the particular model available. This lesson plan is sufficiently general in its content to be appropriate for all models. Emphasize the shift in lecture from a discussion of dosimeters to a discussion of survey meters.
K. OPERATION OF SURVEY METERS Visuals 4.27 and 4.28	1. As nuclear radiation penetrates the enclosed chamber of a survey meter, electrically charged particles are produced. As these particles are collected, they produce a small electrical current which is amplified

MAIN TOPICS	TEACHING POINTS
	and measured. Since the size of the current is related to the rate at which the particles are produced in the chamber and thus, to the radiation exposure rate, the meter can be calibrated in R/hr or mR/hr.
Visual 4.29	2. All civil defense survey meters are designed to measure gamma radiation, and some are able to detect the presence of beta. Operational civil defense survey meters are not designed to detect or measure alpha radiation.
	NOTE: The above item should be emphasized. The student should understand the difference between measuring gamma and detecting beta.
L. CDV-700 SURVEY METER	1. Battery installation for the CDV-700.
Visual 4.30	a. Open the case by unfastening the two case clips and remove the case bottom.
	b. Insert a standard "D" cell battery by placing + end of the battery against each clip marked +. The raised center terminal on the standard flashlight battery is plus (+). Then close case.
	NOTE: Instructor should demonstrate this with a "D" cell battery and CDV-700.
	c. Stress the importance of correct battery polarity -- plus to plus and minus to minus.
Visuals 4.31 and 4.32	2. Operational check for the CDV-700.
	a. The selector switch has four positions: OFF, X100 (reading times 100), X10 (reading times 10) and X1 (reading times 1).
	b. Rotate the selector switch to the X1 range and allow at least 30 seconds for warm-up and stabilization.

MAIN TOPICS	TEACHING POINTS

c. Check meter for background reading. In a non-radiation environment, normal background is about 20 counts per minute (.03 mR/hr).

d. Turn the selector switch to the X10 range.

e. Rotate the shield on the probe to the fully open position.

f. Place the open area of the probe as close as possible to the operational check source located on the side of the instrument case.

g. Observe the reading which should be on the lower half of the dial.

h. Do not adjust the calibrating potentiometer if the instrument has been calibrated by the State calibration and maintenance facility.

NOTE: Check each student individually to assure that he knows how to perform this operational check. As this is being done, suggest that the other students attach the headphones and listen to the background count. If appropriate, suggest they detect the radiation level at the surface of a luminous-dial watch. Place the probe with the shield closed, then open, to the front and to the back of the watch. Interpret the difference in the readings for the students.

MAIN TOPICS	TEACHING POINTS
	i. Once the CDV-700 is calibrated, the readings from the operational check source should be noted and recorded for future use. This reading should remain the same during future operational checks.
	j. The operational check should be used only to determine that the CDV-700 is operating properly. Its use does not replace the need for calibrating the instrument to specific gamma radiation levels.
	k. During an emergency when the operational check cannot be performed because of the presence of external radiation from fallout, the monitor should assume a calibrated CDV-700 is operating properly if it indicates radiation levels above normal background. Normal background levels should be observed and noted by each student.
Visual 4.33	3. Reading the CDV-700.
	a. On each range the meter reading must be multiplied by 100, 10 or 1, respectively to obtain the measured exposure rate.
	b. The dial indicator on the CDV-700 will fluctuate quite widely, particularly on the X1 range. To read the instrument, note the maximum and minimum deflections and average them.
	c. Meter readings should not be taken when the dial indicator reads in the lower 10% of the scale when on the X100 and X10 ranges. Turn the selector switch to the next most sensitive range to measure the exposure rate more accurately.
	d. Meter readings should not be taken on the X1 range because of the erratic meter response. At exposure rates below about 0.4 mR/hr, a reading cannot be taken to

MAIN TOPICS	TEACHING POINTS

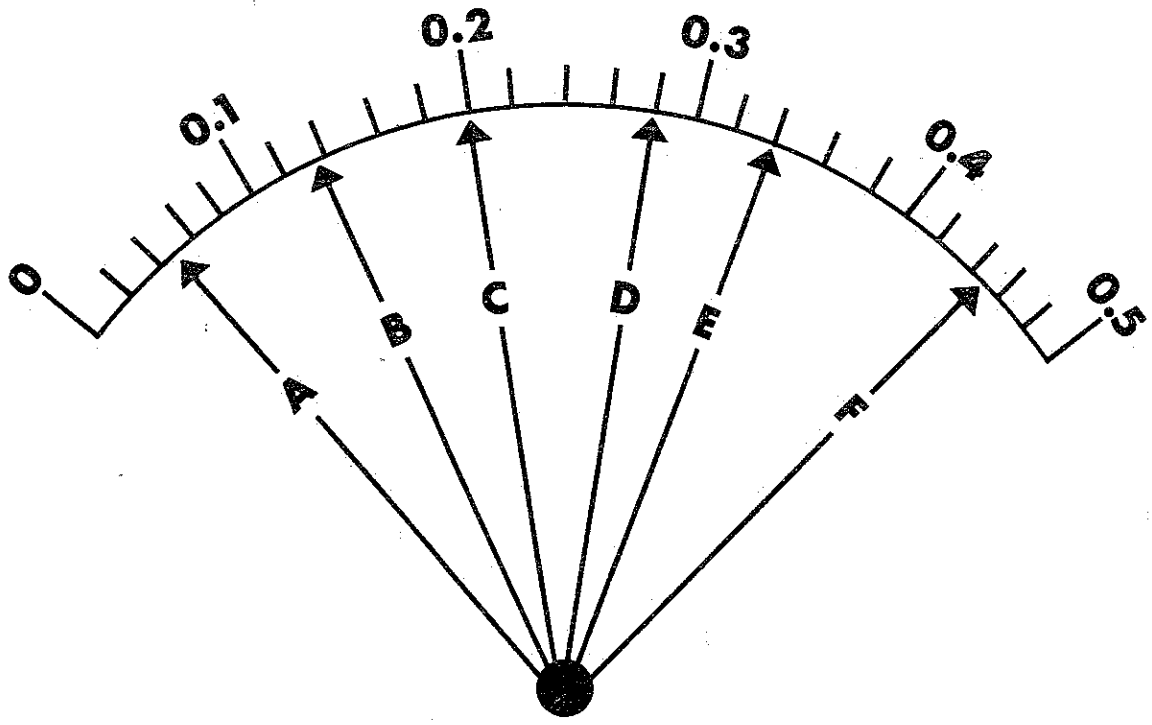
an accuracy of within ± 30%. However, this does not mean that these low levels cannot be distinguished from normal background. Normal background on the CDV-700 is about 20 to 30 counts per minute as heard in the headphones. Any significant increase in the count rate can be detected by your ear. For example, with a little practice, a count rate that is double background (approximately 40 to 60 counts per minute) can be easily distinguished by the ear, even though the meter needle may be bouncing around very erratically.

Visuals 4.34 thru 4.44

NOTE: Have the students write the correct readings from the practice visuals on the worksheet in SM-11.21.1. After the visuals have been shown, provide the correct answers to the class. If anyone has missed one of the practice problems, take time to show the correct solution to the group.

e. Have the students complete the CD V-700 practice readings (see next page) on the worksheet in SM-11.21.1.

CDV-700 METER AND PRACTICE READINGS



DIAL INDICATOR	RANGE	EXPOSURE RATE
A	X10	0.5 mR/hr
B	X100	13.5
C	X10	2.0
D	X10	2.8
E	X100	34.
F	X100	45.

MAIN TOPICS	TEACHING POINTS
Visual 4.45	f. When the probe shield on the CDV-700 is closed, beta radiation cannot penetrate through the probe shield and only the gamma exposure rate is measured. When the shield is open, both beta and gamma radiation penetrate through the tube wall and are detected. However, the difference in the unshielded reading and the shielded reading, which represents the beta contribution, can be interpreted only in a general way. An increased meter reading with the shield open may simply mean that the surface or material being monitored is contaminated with radioactive material, or that the radioactive material is enclosed in a thin walled container which allows the beta radiation to penetrate through it. The ability to detect beta radiation is mainly useful to pinpoint the exact location of radioactive material, either as a contained source or as contamination which may be removable.
Visual 4.46	g. If an audible indication is desired, a headphone (or a CDV-705 loudspeaker unit) may be attached to the connector at the lower left corner of the instrument cover. When the headphone is not in use, the protective cap on the headphone receptacle should be replaced.
Visuals 4.47 and 4.48	4. Operating characteristics of the CDV-700. a. Gamma exposure rates up to 50 mR/hr can be measured. b. The presence of beta radiation can be detected. c. Accuracy is within ± 30% when measuring fallout radiation.

MAIN TOPICS	TEACHING POINTS

NOTE: <u>There is no provision for re-calibration of CDV-700's at this time in most of the States. Therefore, the CDV-700's should only be used in practice to detect rather than measure gamma radiation.</u>

d. Normally encountered pressure, temperature, and humidity changes will not affect the instrument reading.

e. Fifteen seconds should be allowed for the instrument response to stabilize before readings are recorded. Waiting a longer period of time will not increase the accuracy of readings.

f. Exposure rates of 50 mR/hr to 1 R/hr will produce off-scale readings at the high end. However, when exposure rates significantly exceed 1 R/hr, the CDV-700 will "jam" and read less than full-scale, possibly even zero.

g. Fresh batteries should provide continuous operation for a minimum of 100 hours. Intermittent use will significantly extend the operating life of the batteries.

Visual 4.49

5. Uses of the CDV-700.

a. Training exercises with low levels of radiation.

MAIN TOPICS	TEACHING POINTS

b. Locating radioactive material.

c. Long-term clean up and decontamination operations.

Visuals 4.50 and 4.51

6. Care and preventive maintenance of the CDV-700.

a. Prevent radiological contamination. However, if the CDV-700 does become contaminated, clean with a cloth dampened in a mild soap solution.

b. Keep the shield on the probe closed as much as possible to prevent damage to the Geiger-Muller tube.

c. Coil the cable loosely around the probe support and place the cable end of the probe over the meter when returning the probe to its support. In this position, the instrument provides protection against undue bending of the cable where it enters the probe. CAUTION: Do not wrap cable too tightly!

d. Make certain the CDV-700 is turned off when not in use. Otherwise, the batteries will be discharged and the instrument rendered ineffective and/or permanently damaged by the acid from battery leakage.

e. Remove batteries monthly from the CDV-700's that are in daily use and inspect battery contacts. Dirty contacts should be cleaned. If the CDV-700 is not in daily use, remove the batteries from the instrument and store the instrument in a dry place. The batteries will last longer if stored at room temperature or below; in fact the cooler the storage temperature the better as long as the batteries are kept dry such as by sealing in plastic.

NOTE: Stress the importance of removing batteries from the instrument during long-term storage.

MAIN TOPICS	TEACHING POINTS
	f. Avoid rough handling of the CDV-700.
	g. Follow the local Standing Operating Procedure (SOP) for periodic operational checking of the CDV-700 to verify that it is operating properly.
	NOTE: Although the monitor may be requested to inform the RADEF Officer or other civil preparedness officials when instruments require corrective maintenance and may be requested to return the instruments to a central location, he is not responsible for assuring that it is done. The monitor must not attempt calibration adjustment or corrective maintenance because this requires specialized equipment and specially trained personnel.
M. CDV-715 SURVEY METER Visual 4.52	1. Battery installation for the CDV-715.
	a. Open the case by unfastening two case clips, and remove the case bottom.
	b. Insert a standard "D" cell flashlight battery by placing the + end of the battery against the clip marked +. The raised center terminalon the standard flashlight battery is plus (+). Close the case and fasten.
	NOTE: Instructor should demonstrate this with a "D" cell battery and CDV-715.

MAIN TOPICS	TEACHING POINTS
	c. Stress the importance of correct polarity.
Visuals 4.53 and 4.54	2. Operational check for the CDV-715.
	a. Rotate the selector switch to zero position. Allow instrument to warm up for about two minutes.
	b. Rotate the zero knob until the pointer is on zero of the meter scale.
	c. Rotate the selector switch counter clockwise to the circuit check position and hold. The meter should give an upscale reading in or near the red area marked, "Circuit Check." If the meter does not indicate a reading in or near the red area, replace the battery and repeat the above steps. If the instrument still does not respond properly, try another battery. The instrument may be considered faulty if it will not zero and/or circuit check after trying several batteries and performing the preceding steps.
	NOTE: The CDV-715 will not detect or measure ionizing radiation when the selector switch is in the zero and circuit check positions. Emphasize that the circuit check position is spring loaded and will return to its original position. The selector switch must be held in position during the circuit check operation.
	d. Recheck the zero setting as the selector switch is rotated through the zero position to the range settings. The meter should still read zero.

e. If the instrument will not zero or circuit check properly, obtain a replacement.

f. Rotate the selector switch clockwise to the X100, X10, X1 and X0.1 switch positions. When only normal background radiation is present, the meter should read not more than three minor meter divisions upscale from zero on the X100, X10, or X1 ranges and not more than six meter divisions upscale from zero on the X0.1 range.

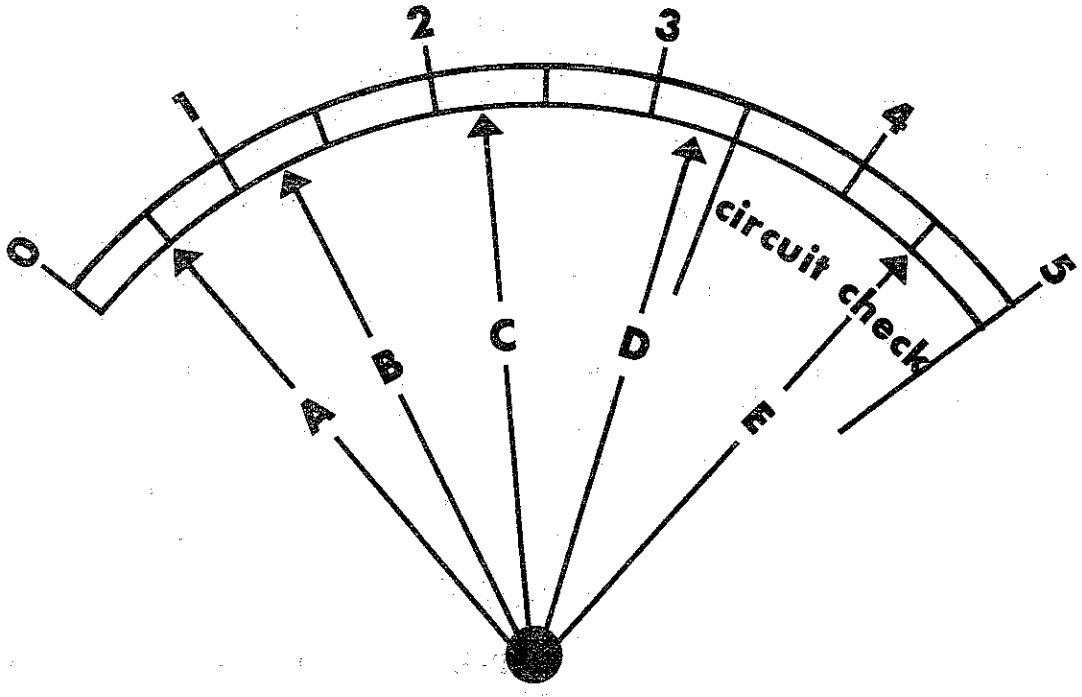
NOTE: If the instrument has not been operated for a prolonged period of time (over a year or more), the amount of upscale leakage can be reduced significantly by leaving the instrument on for 1 to 16 hours with the selector switch in the zero or X0.1 position. This conditions the electrometer tube. If excess upscale leakage still exists after 16 hours of reconditioning, then other problems are present and the instrument should be repaired by the State M&C facility.

g. For emergency use under fallout conditions, an instrument with upscale leakage (even in excess of the limits stated above) will be operationally effective and therefore, should be used. The reason for this is that in the first day or two, fallout levels of concern are in excess of 0.5 R/hr.

CAUTION: Upscale leakage cannot be determined if the instrument is in a radiation field.

MAIN TOPICS	TEACHING POINTS
	Upscale leakage will have very little or no effect on the overall accuracy of radiation readings of concern. By the time the X0.1 range becomes useful, the upscale leakage will have been eliminated or will not be sufficient to affect the instrument's response to radiation.
	NOTE: Check each student individually to assure that he is able to perform the operational check on the CDV-715.
Visuals 4.55 thru 4.65	3. Reading the CDV-715.
	a. To make a radiation exposure rate reading, rotate the range selector switch to the position that produces the highest upscale meter reading.
	b. Multiply the meter reading by the range switch setting. For example, suppose the meter reading is 2.5 and the range switch is set on X100. The exposure rate would be 2.5 times 100 or 250 Roentgens per hour.
	NOTE: Have the class write the correct readings from the practice visuals on the worksheet in SM-11.21.1. After the visuals have been shown, provide the correct answers to the class. Go through the correct procedure for converting meter readings to exposure rates for all missed examples.
	c. Have the students complete the CD V-715 practice readings (see next page) on the worksheet in SM-11.21.1.

CDV-715 METER AND PRACTICE READINGS



DIAL INDICATOR	RANGE	EXPOSURE RATE
A	X100	50. R/hr
B	X10	12.5
C	X1	2.25
D	X0.1	.33
E	X10	45.

MAIN TOPICS	TEACHING POINTS

d. Rig several instruments to simulate exposure rate readings for the students to practice by setting the range selector switch on a range position and then adjust the zero control until the dial indicator is at an appropriate location on the dial scale.

Visual 4.66

4. Operating characteristics of the CDV-715.

a. Measures gamma exposure rates up to 500 R/hr.

b. Accuracy within $\pm$ 30% when measuring fallout if instrument is properly calibrated. Re-calibration service is available from State M & C facilities in most States.

c. Normally encountered pressure, temperature, and humidity changes will not affect the instrument reading.

d. Fifteen seconds should be allowed for the instrument response to stabilize before taking readings.

e. New batteries should provide continuous operation for a minimum of 150 hours. Intermittent use will significantly extend the operating life of the batteries.

Visual 4.67

5. Uses of the CDV-715.

a. Used for making ground surveys in general.

b. Used in shelter areas to locate places where the exposure rates are lowest.

c. Surveys for Weapons Effects Reporting Stations, self-protection monitoring, etc.

MAIN TOPICS	TEACHING POINTS

Visual 4.68 and 4.69

6. Care and preventive maintenance of the CDV-715.

   a. Prevent radiological contamination. However, if the instrument should become contaminated, clean with a cloth dampened in a mild soap solution.

   b. Remove batteries monthly from the CDV-715's in daily use. Inspect the battery contacts and clean if dirty. If the CDV-715 is not in daily use, remove the batteries from the instrument and store the instrument in a dry place. The batteries will last longer if stored at room temperature or below; in fact the cooler the storage temperature the better as long as the batteries are kept dry such as by sealing in plastic.

NOTE: Continue to emphasize the importance of removing batteries from the instruments for long-term storage.

   c. Avoid rough handling of the CDV-715.

   d. Make certain the CDV-715 is turned off when not actually being used.

   e. The monitor must not attempt calibration adjustment or corrective maintenance. For such service, the instrument must be returned to the State M&C facility.

   f. Perform periodic operational checks in accordance with the local SOP for RADEF instrument sets.

MAIN TOPICS	TEACHING POINTS
N. CDV-717 SURVEY METER Visual 4.70	1. The CDV-717 is similar to the CDV-715 in all respects except that the ionization chamber is in a separate portion of the case and is removable. The controls, range and operational check procedure is the same for the CDV-715 and the CDV-717. 2. The operating characteristics are identical to the CDV-715, except that the removable ionization chamber may be placed up to 25 feet from the meter which permits a remote reading capability. The ionization chamber may be placed outside the Weapons Effects Reporting Station in an unshielded area. A bag or cover of light weight material may be placed over the chamber to protect it from possible contamination. All readings may then be observed from within the station (shelter). 3. After the early periods of heavy fallout and the requirement for a remote reading instrument diminishes, the removable ionization chamber should be visually checked for contamination, and if radiation levels permit, with the CDV-700. Decontaminate if necessary, and reassemble the instrument. The CDV-717 may then be used for other monitoring operations in the same manner as a CDV-715.
O. RADEF SET OPERABILITY TEST	1. A checklist for a RADEF Set Operability Test is included in the Handbook for Radiological Monitors. All instruments should be checked for physical damage and missing accessories including the Handbook for Radiological Monitors. A detailed operational check is recommended for each type of RADEF instrument. The monitor should perform this Operability Test on the RADEF instrument set assigned to him as specified by the local SOP.
P. SUMMARY	1. Detection of radiation. 2. Dosimeter operation. 3. Operation of the dosimeter charger.

MAIN TOPICS	TEACHING POINTS

4. Charging the dosimeter.
5. Reading the dosimeter.
6. Initial check of dosimeters.
7. Dosimeter operating characteristics.
8. Dosimeter uses.
9. Dosimeter difficulties.
10. Dosimeter care and maintenance.
11. Survey meter operation.
12. The CDV-700 Survey Meter.
13. The CDV-715 Survey Meter.
14. The CDV-717 Survey Meter.
15. RADEF Set Operability Test.

LIST OF VISUALS

Visual No.	Visual Title
4.0	Man is Aware of His Environment Through His Five Senses
4.1	But He Must Rely on Instruments to Detect Nuclear Radiation
4.2	Radiation Produces Charged Particles as it Penetrates Matter
4.3	Instruments Measure Radiation by Collecting and Measuring Charged Particles
4.4	Radiological Information Required: Exposure Rate and Exposure
4.5	Survey Meter Measures Exposure Rate in R/hr or mR/hr
4.6	Dosimeters Measure Exposure in R or mR
4.7	Comparison of Exposure and Exposure Rate (Related to Odometer and Speedometer)
4.8	Dosimeters (Title Slide)
4.9	Prior to Use a Dosimeter Must be Zeroed
4.10	Radiation Penetrates Monitor and Instruments and Produces Charged Particles
4.11	Dosimeter Measures Exposure as Charged Particles Reduce Electrical Charge on Dosimeter
4.12	CD V-750 Dosimeter Charger (Picture)
4.13	To Charge a Dosimeter
4.14	Read Dosimeters by Pointing Them Toward a Light
4.15	Read Dosimeters by Depressing Them Lightly on Charger
4.16	Measuring Dosimeters
4.17	Initial Check for Dosimeters
4.18	Electrical Leakage Check
4.19	Dosimeter Operating Characteristics
4.20	Dosimeter Uses
4.21	Dosimeter Difficulties: Symptom - Corrective Action
4.22	Dosimeter Difficulties: Symptom - Corrective Action
4.23	Dosimeter Difficulties: Symptom - Corrective Action
4.24	Dosimeter Difficulties: Symptom - Corrective Action
4.25	Dosimeter Difficulties: Symptom - Corrective Action
4.26	Dosimeter and Charger Care and Preventive Maintenance
4.27	Survey Maters (Title Slide)
4.28	The Exposure Rate is a Measure of How Fast Charged Particles Are Produced in a Survey Meter
4.29	Survey Meter Capabilities
4.30	CD V-700 Survey Meter
4.31	CD V-700 Operational Check
4.32	CD V-700 Operational Check (Continued)
4.33	Reading the CD V-700
4.34	CD V-700 Reading 1 - .42 mR/hr
4.35	CD V-700 Reading 2 - .70 mR/hr
4.36	CD V-700 Reading 3 - 1.5 mR/hr
4.37	CD V-700 Reading 4 - 2.8 mR/hr
4.38	CD V-700 Reading 5 - 3.2 mR/hr

Visual No.	Visual Title
4.39	CD V-700 Reading 6 - 4.5 mR/hr
4.40	CD V-700 Reading 7 - 9.0 mR/hr
4.41	CD V-700 Reading 8 - 18 mR/hr
4.42	CD V-700 Reading 9 - 24 mR/hr
4.43	CD V-700 Reading 10 - 48 mR/hr
4.44	Answers for CD V-700 Readings #1 through #10
4.45	Beta-Gamma Readings
4.46	Attach the Headphone to the CD V-700
4.47	CD V-700 Operating Characteristics
4.48	CD V-700 Operating Characteristics (Continued)
4.49	Uses of the CD V-700
4.50	CD V-700 Care and Preventive Maintenance
4.51	CD V-700 Care and Preventive Maintenance (Continued)
4.52	CD V-715 Survey Meter
4.53	CD V-715 Operational Check
4.54	CD V-715 Operational Check (Continued)
4.55	CD V-715 Reading 11 - .08 R/hr
4.56	CD V-715 Reading 12 - .26 R/hr
4.57	CD V-715 Reading 13 - .38 R/hr
4.58	CD V-715 Reading 14 - 1.2 R/hr
4.59	CD V-715 Reading 15 - 4.5 R/hr
4.60	CD V-715 Reading 16 - 22 R/hr
4.61	CD V-715 Reading 17 - 42 R/hr
4.62	CD V-715 Reading 18 - 60 R/hr
4.63	CD V-715 Reading 19 - 350 R/hr
4.64	CD V-715 Reading 20 - 490 R/hr
4.65	Answers to CD V-715 Readings #11 through #20
4.66	CD V-715 Operating Characteristics
4.67	Uses of the CD V-715
4.68	CD V-715 Care and Preventive Maintenance
4.69	The CD V-717

LESSON PLAN NO. 3

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Operation Prospect (Exercise) TIME: .50 Hour

OBJECTIVE: At the conclusion of this unit the student will be able to:

1. Attach headphones and operationally check the CDV-700.
2. Locate radioactive sources with the aid of the CDV-700.
3. Charge and zero the CDV-138 dosimeter.

SCOPE: Operational check of the CDV-700; charging the CDV-138 dosimeter; locating hidden radioactive sources; recording location of hidden sources; observing pick-up of sources; recording personal exposure on record of radiation exposure.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, HS-3.
   b. Radiological Defense Manual, CPG 2-6.2.
   c. Radiological Monitoring Student Workbook, SM-11.21.1.
2. Student
   Radiological Monitoring Student Workbook, SM-11.21.1.

REQUIREMENTS:

1. Instructor
   a. Chalkboard, chalk, eraser, pointer.
   b. RADEF Instrument set, CDV-777A.
   c. Training Source Set, CDV-778.
   d. Handling tongs and radiation hazard signs.
2. Student
   a. RADEF Instrument set, CDV-777A (one set per two students).
   b. One CDV-138 dosimeter per student.
   c. Radiological Monitoring Student Workbook, SM-11.21.1.

REMARKS: Make a sketch of the exercise area and hide the radioactive sources prior to the student's entry. Be sure to post the entry to the exercise area with the radiation hazard signs. Licensed user must remain present in area while sources are not in storage. Care should be taken when hiding the sources so they will be secure and easily recovered and not

be inadvertantly stepped on or picked up. A count should be made and recorded of the number of source capsules (1) present in the lead storage container immediately after unlocking and before starting to distribute them for use in the exercise and (2) returned to the lead storage container after the completion of each exercise.

MAIN TOPICS	TEACHING POINTS
A. OPERATION PROSPECT (Exercise)	1. Have the students operationally check the CDV-700 and zero the CDV-138 dosimeter. If this is the first time the students have been exposed to the instruments, the instructor will have to lead them through the procedures with the explanation that a more detailed operational check of the instruments and zeroing of the dosimeters will be presented later. Have each student (a) record his dosimeter reading if not on zero and (b) place the dosimeter in his shirt pocket.
Attachment 3.1 (Example)	2. Explain the boundaries of the exercise area. A chalkboard may be used to sketch the area for greater clarity.
Attachment 3.2 (Worksheet from SM-11.21.1)	3. Explain that when the hidden sources are located, as indicated by an increase in the instrument reading and headphone signal, their location should be noted on the worksheet. Caution students not to touch or handle the sources. Also indicate that one student should monitor with the instrument and earphones while the other person does the recording. About halfway through the exercise the instructor should notify the students to change activities so each will have an opportunity to use the instrument.
	4. During the exercise the X10 range is the only range that need be used. Have the students switch to the X10 range and leave the instruments on this range for the entire exercise.
	5. The instrument operator should hold the instrument in one hand, the probe in the other hand and wearing the earphones, go into the exercise area and locate the sources. They do not need to see the sources -- merely record on the worksheet the location where they think the sources are hidden, as indicated by a maximum meter reading and headphone signal. (Caution the students not to hold the probe cord with the hand and dangle the probe or swing it along the ground. The swinging action can cause failure where the cord attaches to the probe.)

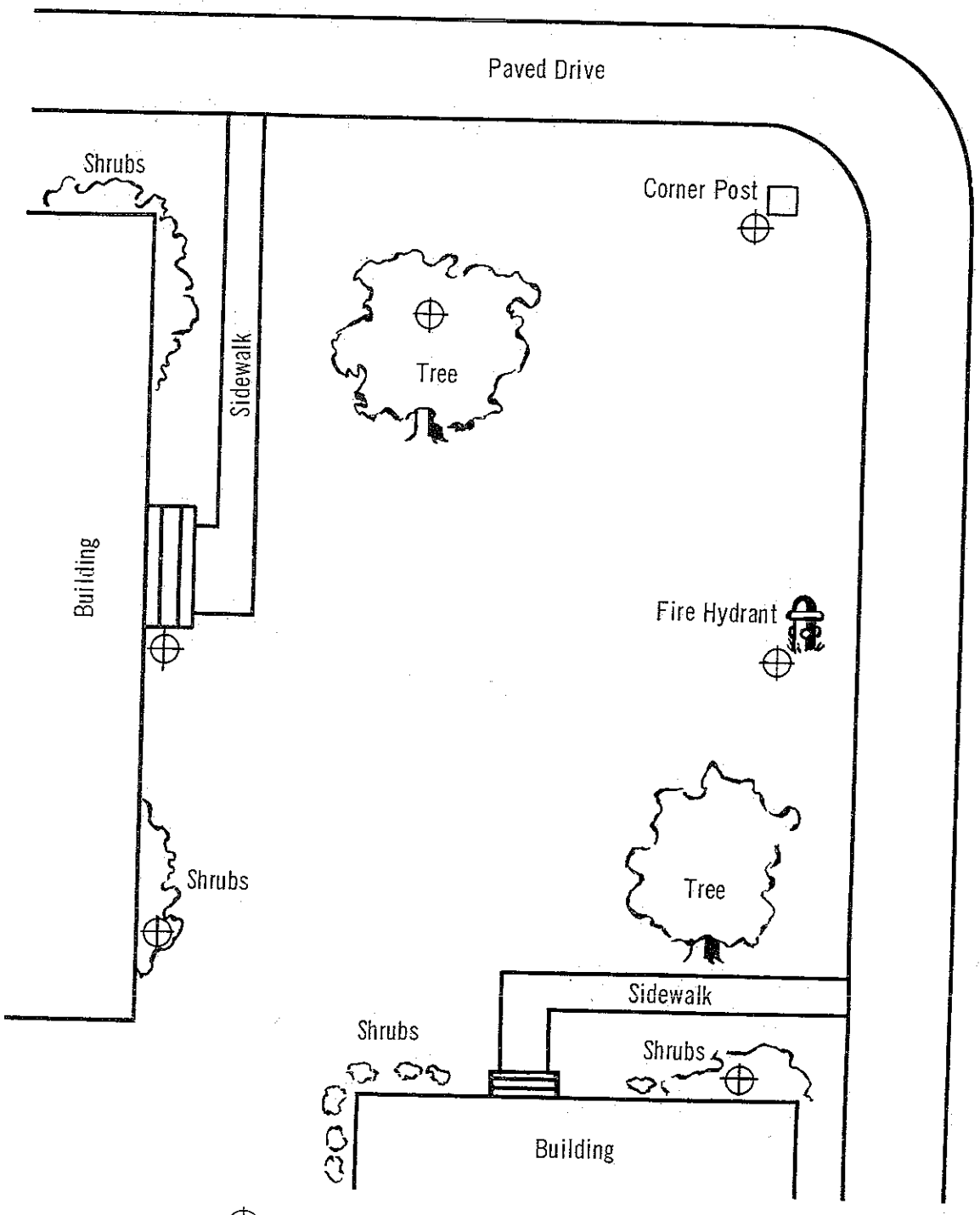
MAIN TOPICS	TEACHING POINTS

6. At the conclusion of the exercise, have the students help recover the sources. This will increase student interest and identify the location of all sources. Place sources in the lead container while making an audible count with the students.

7. If this is the last exercise of the day where sources and instruments are used, have the students remove batteries, repack the instruments in the set, read the dosimeter and record their exposure on the radiation exposure record in the Student Workbook, SM-11.21.1. A partially completed sample is included as Attachment 3.3.

NOTE: Have the students look at the NRC Form 5, Current Occupational External Radiation Exposure. Instruct them to fill in blocks: (1) Name, (2) Social Security Number, (3) Date of birth, (4) Name of licensee (instructor to provide), (8) Period of exposure, (9) Gamma dose (exposure) for the period and (12) Total (exposure).

EXAMPLE "OPERATION PROSPECT" EXERCISE AREA



⊕ Denotes location of hidden radioactive source.

Attachment 3.2

WORKSHEET FOR OPERATION PROSPECT EXERCISE

SOURCE	LOCATION OF SOURCE
0	(Base of fire hydrant)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Attachment 3.3

Form NRC-5
(6-77)
10 CFR 20

U. S. NUCLEAR REGULATORY COMMISSION

Approved by GAO
B-180225 (R0044)
Expires – 4-30-80

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on Back

IDENTIFICATION

1. NAME (PRINT – Last, first, and middle)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (Month, day, year)	4. NAME OF LICENSEE

5. DOSE RECORDED FOR (Specify: Whole body; skin of whole body; or hands and forearms, feet and ankles.)	6. WHOLE BODY DOSE STATUS (rem)	7. METHOD OF MONITORING (e.g., Film Badge – FB; Pocket Chamber – PC; Calculations – Calc.)
Whole Body	N.A.	X OR GAMMA P.C. BETA N.A. NEUTRONS N.A.

8. PERIOD OF EXPOSURE (From – To)	DOSE FOR THE PERIOD (rem) — Daily				13. RUNNING TOTAL FOR CALENDAR QUARTER (rem)
	9. X OR GAMMA	10. N.A.	11. N.A.	12. TOTAL	N.A.

LIFETIME ACCUMULATED DOSE

14. PREVIOUS TOTAL (rem)	15. TOTAL QUARTERLY DOSE (date / rem)	16. TOTAL ACCUMULATED DOSE (rem)	17. PERM. ACC. DOSE 5(N-18) (rem)	18. UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (rem)
N.A.	N.A.	N.A.	N.A.	N.A.

INSTRUCTIONS FOR PREPARATION OF FORM NRC-5

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form is required pursuant to Section 20.401 of "Standards for Protection Against Radiation," 10 CFR 20, as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section 20.202. Note that a separate Form NRC-5 is to be used for recording external exposure to (1) the whole body; (2) skin of whole body; (3) hands and forearms; or (4) feet and ankles, as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

Identification

Item 1. Self-explanatory.
Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.
Item 3. Self-explanatory.
Item 4. Self-explanatory.

Occupational Exposure

Item 5. "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye. Unless the lenses of the eyes are protected with eye shields, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 300 mg/cm^2 or less. When the lenses of the eyes are protected with eye shields having a tissue equivalent thickness of at least 700 mg/cm^2, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 1,000 mg/cm^2 or less.

Dose recorded as dose to the skin of the whole body, hands and forearms, or feet and ankles should include the dose delivered through a tissue equivalent absorber having a thickness of 7 mg/cm^2 or less. The dose to the skin of the whole body, hands and forearms, or feet and ankles should be recorded on separate forms unless the dose to those parts of the body has been included as dose to the whole body on a form maintained for recording whole body exposure.

Item 6. This item need be completed only when the sheet is used to record whole body exposures and the licensee is exposing the individual under the provisions of Paragraph 20.101(b) which allows up to 3 rems per quarter to the whole body. Enter in this item the unused part of permissible accumulated dose taken from previous records of exposure, i.e., Item 18 of the preceding Form AEC-5 or NRC-5 or Item 13 of Form AEC-4 or NRC-4 if the individuals's exposure during employment with the licensee begins with this record.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. Doses received over a period of less than a calendar quarter need not be separately entered on the form provided that the licensee maintains a current record of the doses received by the individual which have not as yet been entered on the form. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, if only quarterly doses are entered, the period of exposure for the first calendar quarter of 1962 might be taken as running from Monday, January 1, 1962, through Friday, March 30, 1962, and would be indicated in this item as Jan. 1, 1962-Mar. 30, 1962. If weekly doses are entered, a film badge issued Monday morning, January 1, 1962, and picked up Friday, January 5, 1962, would be indicated as Jan. 1, 1962-Jan. 5, 1962.

Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known and in accordance with Paragraph 20.4(c). Where calculations are made to determine dose, a copy of such calculations is to be maintained in conjunction with this record. In any case where the dose for a calendar quarter is less than 10% of the value specified in Paragraph 20.101(a), the phrase "less than 10%" may be entered in lieu of a numerical value.

Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters. Paragraph 20.3(a) (4) defines calendar quarter. No entry need be made in this item if only calendar quarter radiation doses are recorded in Items 9, 10, 11 and 12.

Lifetime Accumulated Dose (Whole Body)

NOTE: If the licensee chooses to keep the individual's exposure below that permitted in Paragraph 20.101(a), Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 (or Item 12 if quarterly doses are entered in Item 12) should not exceed 1 1/4 rem.

If an individual is exposed under the provisions of Paragraph 20.101 (b), complete Items 14 through 18 at the end of each calendar quarter and when the sheet is filled. Values in Item 13, when in the middle of a calendar quarter, and values in Item 18, must be brought forward to next sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., from Item 16 of Form AEC-5 or NRC-5 or Item 11 of Form AEC-4 or NRC-4). The total occupational radiation dose received by the individual must be entered in this item, including any occupational dose received from sources of radiation not licensed by the Commission. If the individual was exposed to sources of radiation not licensed by the Commission during any calendar quarter after completing Form AEC-4 or NRC-4 and personnel monitoring equipment was not worn by the individual, it should be assumed that the individual received a dose of 1 1/4 rems during each such calendar quarter.

Item 15. Enter the total calendar quarter dose from Item 13 (or from Item 12 if quarterly doses are entered in Item 12) and the date designating the end of the calendar quarter in which the dose was received (e.g., March 30, 1962).

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (PAD) in rem for the WHOLE BODY. "N" is equal to the number of years of age of the individual on his last birthday. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N = 32, PAD = 5(32-18) = 70 rem.)

Item 18. Determine the unused part of the PAD by subtracting Item 16 from Item 17. The unused part of the PAD is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e) (3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on Form NRC-5. This information is maintained in a system of records designated as NRC-27 and described at 40 Federal Register 45344 (October 1, 1975).

1. AUTHORITY Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(o) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(o)). The authority for soliciting the social security number is 10 CFR Part 20

2. PRINCIPAL PURPOSE(S) The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long-term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon your request.

3. ROUTINE USES The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.

4. WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION It is voluntary that you furnish the requested information, including social security number; however, the licensee must complete Form NRC-5 on each individual for whom personnel monitoring is required under 10 CFR 20.202. Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20.601. The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.

5. SYSTEM MANAGER(S) AND ADDRESS Director, Office of Management Information and Program Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555

LESSON PLAN NO. 4

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Review of HS-3 Home Study Units 1 Thru 4

TIME: .75 Hour

OBJECTIVES: At the conclusion of this unit the student will be able to:

1. Define civil preparedness and list two primary duties of the radiological monitor.
2. Differentiate between radioactivity and nuclear radiation.
3. Explain the terms of radiation measurement, nuclear yield and radiation exposure units.
4. Describe the nature and characteristics of fallout.
5. Compare the effects of time, distance and shielding in reducing radiation exposure.
6. Elaborate on terms of "brief" and "long-term" radiation exposure, radiation sickness symptoms and caring for radiation casualties.
7. Take protective actions against fallout contamination and advise on methods of accomplishing decontamination.
8. Use the general "seven-ten rule" for estimating fallout radiation decay.
9. Know how to properly take measurements of fallout and how to make measurements for computing "outside-inside" radiation level ratios.
10. Maintain a radiological reporting log and make appropriate reports.

SCOPE: Introduction; fallout effects and exposure guidance; protective measures and decontamination procedures; exposure and exposure rates; monitor tasks and procedures; monitor responsibilities and reporting.

REFERENCES:

1. Instructor
   Introduction to Radiological Monitoring, HS-3.

2. Student
   Introduction to Radiological Monitoring, HS-3.

REQUIREMENTS:

1. Instructor
   a. Chalkboard, chalk, eraser, pointer.
   b. Introduction to Radiological Monitoring, HS-3.

2. Student
   a. Introduction to Radiological Monitoring, HS-3.
   b. Notebook and pencil as appropriate.

REMARKS: None

MAIN TOPICS	TEACHING POINTS
A. INTRODUCTION	1. Civil preparedness is that activity which is designed to minimize the adverse effects upon our population by man-caused or natural disaster.
	2. The radiation threat to a jurisdiction from a nuclear attack is very different from the events that usually threaten a community; e.g., fire, flood, tornado, or hurricane.
	3. The detection of, and countermeasures for, the radiation hazards from nuclear attack require special instrumentation and specially trained personnel - both of which are normally not available within a jurisdiction and especially in the numbers that would be required.
	4. A Radiological Defense (RADEF) Program is necessary to provide the jurisdiction with the plans, procedures, instrumentation, facilities and trained personnel combined into a complete operational RADEF system that can function to minimize the effects of the radiation hazards in the event of a nuclear attack.
	5. A RADEF system includes an emergency response capability or group of emergency response capabilities with a common mission. Thus, a RADEF system is that part of the total emergency preparedness system that provides for (1) detection, measurement, and exposure control of the radiation hazard, (2) selective reporting of radiological information to higher authorities, (3) evaluation and assessment of the hazard, and (4) application of appropriate countermeasures.
	6. Selected elements of an operational civil preparedness RADEF system - in particular instrument sets - can also be utilized in peacetime radiological emergencies. This use requires coordination with other responsible State and local agencies and significantly more training than is presented in this course.

MAIN TOPICS	TEACHING POINTS
	7. This training will concentrate on the role and duties of the radiological monitor. The primary duties of the radiological monitor (RM) are to obtain, record and report local radiation information needed for self-protection and for analysis and evaluation of the radiological hazard.
	8. The spontaneous, uncontrollable breakdown of unstable atoms, with a resultant release of energy, is called radioactivity. The energy released from the breakdown of the atom is called nuclear radiation.
	9. There are three types of radiation in fallout which are called alpha, beta, and gamma. For civil preparedness purposes, we are primarily concerned with measurement of gamma and detection only of beta.
	10. The unit of measure for gamma radiation exposure is the roentgen or milliroentgen. The unit of measure of the gamma radiation exposure rate is the roentgen-per-hour or milliroentgen-per-hour.
	11. The power of a nuclear explosion is expressed in terms of its relationship to TNT explosive power. The prefix kilo or mega added to the word ton or tons means the nuclear explosion is equivalent in power to 1000 tons or 1,000,000 tons of TNT respectively.
	12. The energy released from a nuclear burst results in a blast wave, thermal radiation and nuclear radiation.
	13. Fallout is the process of the fallback to the earth's surface of particles contaminated with radioactive material from the cloud of a detonated nuclear weapon.
B. FALLOUT EFFECTS & EXPOSURE GUIDANCE	1. Three factors are important in minimizing total radiation exposure from gamma radiation, they are time, distance and shielding. Since

MAIN TOPICS	TEACHING POINTS

it is desirable to keep radiation exposure to a minimum; keep as far as practicable from the source of radiation, have the best shielding possible and be exposed to high levels as briefly as possible.

2. A brief or short-term exposure is defined as the total whole body exposure received within a one week period or less. Long term or protracted exposures are those exposures received during a period of time greater than a week in length.

3. Three radiation sickness symptoms are: (1) nausea, (2) vomiting and (3) fever.

4. There are usually no visible radiation effects with exposures up to 50R (fifty roentgens). Brief periods of nausea may occur on the day of exposure in about 10% of a group exposed to around 75 - 100 R. A short term whole-body exposure of 200 R will not affect the average adult to the extent of being incapable of performing ordinary activities or requiring medical care. When short term exposures exceed 450 R, all will be ill and require medical care; most will die within several weeks.

5. The best care you can give a gamma radiation casualty is to keep the patient quiet and as comfortable as possible. The person should be isolated to protect him from infectious diseases.

6. Radiation exposure must be kept below certain levels if an individual is to avoid illness requiring medical care. The "Penalty" table in CPG 2-6.2.2 provides a simple guide that can be followed. To avoid the need for medical care, total accumulated radiation exposures should not exceed:

   150 R in any one week;
   200 R in any month; and
   300 R in any 4 months.

MAIN TOPICS	TEACHING POINTS

7. If an individual's radiation exposure during the shelter period has been kept below 75 R, then in the absence of other guidance from your local RDO, permissible activities outside the shelter could be as follows:

   a. For exposure rates of less than 0.5 R/hr, no special precautions are necessary for conducting emergency operations. Sleep in the shelter.

   b. For exposure rates of between 0.5 and 2 R/hr, outdoor activity (up to a few hours per day) is acceptable for essential purposes such as: fire fighting, police action, rescue, repair, securing necessary food, water, medicine and blankets, important communication, disposal of waste, exercise and obtaining fresh air. Eat, sleep and carry on all other activities in the best available shelter.

   c. For exposure rates of between 2 R/hr and 10 R/hr, periods of less than an hour per day of outdoor activity are acceptable for only the most essential purposes. Shelter occupants should rotate outdoor tasks to distribute exposures.

   d. For exposure rates greater than 10 R/hr., time outside of the shelter should be held to a few minutes and limited to those few activities that cannot be postponed. All people should remain in the best available shelter no matter how uncomfortable.

NOTE: Instruments are discussed in Lesson Plan No. 2. A review is not needed in this lesson.

MAIN TOPICS	TEACHING POINTS
C. PROTECTIVE MEASURES AND DECONTAMINATION PROCEDURES	1. "Hazard" in RADEF means a definite threat to survival. Radioactive fallout is a definite threat to survival and is therefore a hazard. The two basic hazards of fallout radiation are gamma radiation which can penetrate the body and damage vital internal organs and beta radiation that can cause burns on the skin.
	2. Shielding from gamma radiation requires thick, heavy materials. Compared to gamma, shielding for beta radiation is fairly easy. Just cover the body as much as possible. Wear a hat or cap, long trousers, long sleeve shirt or coat and high top shoes or boots. Fallout must be brushed from uncovered skin as soon as possible. If fallout is significant, it can be seen as particles after it falls back to earth and settles on smooth surfaces.
	3. To keep from carrying fallout into the shelter areas, brush the particles from clothing before entering. If possible, remove outer clothing upon which fallout has been deposited and leave the clothing in a room outside the immediate shelter area. Later the clothing can be decontaminated further by washing after the "brush and shake" procedure.
	4. Fallout contamination on a surface does not make the surface radioactive. If fallout lands on a window ledge, for example, some of the particles of fallout are radioactive but the ledge is not. Remove the fallout and you remove the radioactivity.
	5. Wind can blow fallout particles into the shelter. Vents or openings in the shelter should be closed while fallout is coming down or is being blown around. Mechanical filters can be used to keep radioactive fallout particles from entering the shelter.
	6. The inside of the shelter should be checked by the monitor for the safest areas. This should be done as soon as the radiation level

MAIN TOPICS	TEACHING POINTS
	in the shelter becomes measurable. Continue monitoring until the radiation levels decrease to safe levels.
	7. While on urgent missions outside the shelter, the monitor should wear outer clothing that is tightly woven to minimize contamination getting on the skin. This outer clothing can be removed when re-entering the shelter.
	8. If you drive a vehicle in areas contaminated with fallout, keep windows and vents closed. Upon completing the mission, fallout particles on the vehicle usually can be removed by hosing the outside of the vehicle.
	9. Food and water contamination is not expected to be a significant problem. Water treatment systems normally remove all particulate matter. Food can be washed or peeled before preparing meals. If food or water should become contaminated - don't throw it away. It would be better to eat and drink contaminated food and water than die of starvation or thirst.
D. EXPOSURE AND EXPOSURE RATES	1. As fallout particles fall to earth they accumulate on the ground, roofs of buildings, bushes, ledges and other surfaces. This fallout emits radiation and as the particles of fallout accumulate, the exposure rate increases.
	2. When the unsheltered exposure rate reaches its highest level after all or most of the fallout has been deposited and begins to decay - we say the fallout has "peaked." The decay process results in a gradual decrease in the unsheltered exposure rate.
	3. Radioactive decay is predictable and a rule-of-thumb called the "seven-ten rule" can be used. The seven-ten rule says that for every seven-fold increase in time after detonation, there is a ten-fold decrease in the exposure

MAIN TOPICS	TEACHING POINTS

rate. (Demonstrate on the chalkboard and emphasize that for practical application the rule can only be used after fallout has peaked. Use examples from HS-3, page 131, or from the Radiological Defense Manual, CPG 2-6.2, page 118.)

4. Ionization is the process by which nuclear radiation loses energy. The three types of radiation discussed in this course are alpha, beta, and gamma.

5. Alpha particles are fast moving but lose speed (energy) quickly. They cannot penetrate the walls of a survey meter or even a sheet of paper. They travel only short distances, about an inch in the air. For injury to result from alpha radiation you would have to swallow or inhale the alpha emitting particles.

6. Beta particles move faster than do alpha particles and are lighter. Beta particles can penetrate several sheets of paper or ultra thin sheets of metal, plastic, or glass. They can penetrate the wall of the GM tube if the probe shield is open and the probe is held close to the source of beta radiation. In air, the maximum range of travel of beta particles is 12 to 15 feet.

7. Gamma radiation consists of rays similar to X-rays. It is a form of high frequency electromagnetic radiation. Gamma rays travel at the speed of light, much faster than alpha or beta radiation, and easily penetrate even dense materials. They travel considerable distances in air.

8. This ability to penetrate also makes gamma rays hard to stop and a problem to protect against. Gamma rays easily penetrate the metal covered ionization chambers of the CDV-715 and CDV-717 and the probe shield of the CDV-700.

MAIN TOPICS	TEACHING POINTS
E. MONITOR TASKS & PROCEDURES	1. Radiological monitoring is performed to obtain nuclear radiation hazard information for the area of concern. This information is used to: a. Determine the severity and location of fallout. b. Help decisionmakers decide upon courses of action which will minimize the radiation hazard for the greatest number of people. 2. Fallout radiation measurements are made outside in clear areas (free of trees, bushes, high grass, away from buildings, etc.) at about three feet above the surface. <u>All</u> exposure rates should be reported as <u>unsheltered</u> exposure rates. 3. For a monitor to avoid unnecessary exposure to radiation (especially when exposure rates are high) it may be necessary to determine the Outside-Inside (O/I) ratio. This is done by measuring both the outside and inside exposure rates. The ratio is then computed by dividing the unsheltered exposure rate by the inside sheltered exposure rate. Thereafter, the outside rate can be computed by multiplying the inside exposure rate by the ratio. (Demonstrate using the chalkboard.) The O/I should be checked daily if possible during the shelter period. 4. There is a way to use the dosimeter to measure the exposure rate. This can be done by placing the dosimeter in an unsheltered location for a specific length of time. For example, suppose the dosimeter remained outside in a field of fallout for one hour. The unsheltered exposure rate would then be the dosimeter reading divided by the number of hours exposed; in this example, the exposure rate would be the dosimeter reading divided by 1. Exposure time of the dosimeter to fallout radiation for periods of time other than one hour can also be used. (Demonstrate on

MAIN TOPICS	TEACHING POINTS
	chalkboard.) This can only be done (from a practicable standpoint) when the decrease in exposure rate during the measurement time due to decay is small compared to the measurement time.
	5. Weapons Effects Reporting Stations (WERS) measure, record and report unsheltered total exposure accumulations daily to their Emergency Operating Center (EOC). If a public fallout shelter is also a fallout monitoring station, it will also report the accumulated unsheltered radiation exposure to the EOC.
	6. An accurate record must be kept of the total exposures accumulated by shelterees, emergency workers, and WERS personnel. If enough dosimeters are available, each person can wear his own at all times. When only a few dosimeters are available, place some at various locations in the shelter or station. Use an average reading of the dosimeters to estimate the accumulated exposure to the people in the area.
	7. All people exposed to radiation should keep a daily record of their accumulated exposure. If radiation exposure record forms are available, these should be used. If forms are not available, anything upon which daily exposures may be written and retained will do.
F. MONITOR RESPONSIBILITIES AND REPORTING	1. A Weapons Effects Reporting Station (WERS) can be set up in almost any location that has adequate communications and provides protection from fallout. The station is usually in a selected location with a protection factor of 40 or better. Many WERS are located in police and fire stations because of their superior communications capability.
	2. The monitor should report as directed by the local standing operating procedure. In a WERS, the monitor reports to the RADEF section in the EOC. In community shelters, the monitor

MAIN TOPICS	TEACHING POINTS

reports to the shelter manager. For self-protection monitoring, the monitor uses the information to avoid excessive exposures to all personnel in his operating unit and reports RADEF data to his headquarters.

3. Monitors have some peacetime duties. Most of these duties involve keeping in touch with the local civil preparedness organization. The monitor also has the responsibility to keep proficient in his ability to detect, measure, record and report radiation levels. Each monitor should perform periodic operational instrument checks, recharge or zero dosimeters, and review using the seven-ten rule, the exposure and exposure rate nomogram and calculating O/I ratios.

4. When attack or warning of an impending attack occurs, the monitor should move to the assigned shelter or WERS as quickly as possible. Upon reaching the shelter or station, the monitor should operationally check his instruments and report to the shelter manager or the RADEF section in the EOC.

5. When fallout arrives and accumulates to the measurable level of 0.5 R/hr, this should be recorded and a flash report sent to the EOC from the WERS. The term, "flash" is a communications message priority and in the RADEF circles it is understood that the reporting location has received its first hazardous fallout condition.

6. The arrival of fallout requires the monitor to keep a record of exposure rates and exposure. The main reporting form is the Radiological Recording Log shown in HS-3 and CPG 2-6.2.2. (Have students look at the form. Go over the form block by block.)

7. Emergency outside missions may be required while the radiation levels are still high. When the monitor is directed to perform such a mission, the EOC will exercise control and

MAIN TOPICS	TEACHING POINTS
	provide the monitor with the time the mission is to be performed, the entry time into the mission area, the stay time allowable, and the anticipated exposure rate for the area. The EOC will also provide an allowable exposure to the monitor - but it is the responsibility of the monitor to keep close check on his actual exposure while on the mission. If the dosimeter he is wearing indicates that he will exceed the allowable exposure before completing the mission -- the monitor may have to abort the mission.
	8. As outside radiation levels decrease, the demand for in-shelter monitoring decreases. Monitors will become more involved in the support of operational recovery missions. However, until the end of the shelter period, each shelter should retain a monitoring capability. All WERS will remain activated until closed by the direction of the EOC RADEF section.
	NOTE: Do not refer to nomograms at this time. They are covered in detail in Lesson Plan No. 9.
G. SUMMARY	1. The monitor's duty in civil preparedness.
	2. Fallout effects and exposure guidance.
	3. Protection measures and decontamination procedures.
	4. Responsibilities and reporting procedures.
	5. Purpose of determining Outside/Inside ratio.
	6. Using the seven-ten rule.
	7. Exposure and exposure rate guidance.

LESSON PLAN NO. 5

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Instrument Familiarization (Exercise) TIME: .50 Hour

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OBJECTIVES: At the conclusion of this exercise the student should be able to:

1. Measure nuclear radiation exposure rates at specific distances from a point source.
2. Change instrument ranges and convert meter readings to measured exposure rates.
3. Relate to the effects of exposure rates versus distance.

SCOPE: Practical exercise in measuring radiation exposure rates at specific distances from a point source with the CDV-700 survey meter.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, HS-3.
   b. Handbook for Radiological Monitors, CPG 2-6.2.2.
   c. Radiological Monitoring Student Workbook, SM-11.21.1.
2. Student
   a. Radiological Monitoring Student Workbook, SM-11.21.1.
   b. Handbook for Radiological Monitors, CPG 2-6.2.2.

REQUIREMENTS:

1. Instructor
   a. Chalkboard, chalk, eraser, pointer.
   b. Training Source Set, CDV-778.
   c. RADEF Instrument Set, CDV-777A.
   d. Space suitable for the instrument exercise.
   e. Tape measure, masking tape, grease pencil.
2. Student
   a. RADEF Instrument Set, CDV-777A. (One set per each two students.)
   b. One CDV-138 dosimeter per student.
   c. Radiological Monitoring Student Workbook, SM-11.21.1.

REMARKS:

1. The exercise area should be readied prior to the class period. The layout should have a spiral measured and marked on the floor with grease pencil, chalk or masking tape. (See Attachment 5.1.)

2. The sources may be hung from a hook on a bent coat hanger or dropped in a styrofoam coffee cup. Using the 18" tongs, place the sources in the center of the spiral at point "X." Placement of the sources should not be made until the students are ready to begin the exercise.

3. A licensed user must be present when sources are in exercise use. Hazard signs must be posted at entrances to the area.

4. The Training Source Sets are many years old and have experienced several half-life decays. If desired, the sources from two Training Sets may be combined to produce a higher exposure rate level.

CAUTION - Do not intermix the sources. They must be returned to their respective lead containers. A count should be made and recorded of the number of source capsules (1) present in every lead storage container immediately after unlocking and before starting to distribute them for use in the exercise and (2) returned to the lead container after the completion of each exercise.

MAIN TOPICS	TEACHING POINTS
A. INSTRUMENT FAMILIARIZATION (EXERCISE)	1. If this is the first exercise of the day by the class using the training sources, have the students zero the training dosimeters and record the initial readings. Also the CDV-700 survey meters should be prepared for use and operationally checked by the student. 2. Explain the layout of the instrument familiarization exercise area. Inform the students that this exercise provides the practical experience in the operational use of the range selector switch, and conversion of meter readings to measured exposure rates. 3. Caution the students to work on the outside of the spiral so that an unobstructed path is maintained between the measured location on the spiral and the sealed sources. 4. Each student should use the worksheet for Instrument Familiarization in the Radiological Monitoring Student Workbook, SM-11.21.1. (Attachment 5.2.) 5. During the exercise one student should record meter readings and the other student should operate the instrument. When one-half of the prescribed measurements have been made, the students should switch activities. 6. Demonstrate placing the CDV-700 on one of the spiral floor markings with the probe shield closed and the probe seated in the holder. Center the probe over the floor marking. 7. Demonstrate adjusting the selector switch to obtain readings in the center portion of the meter scale. Have one of the students determine the measured exposure rate by multiplying the range times the meter reading. 8. After demonstrating how to use the instrument and the exercise spiral - have the students take instrument readings to enable them to determine the exposure rate at each of the

MAIN TOPICS	TEACHING POINTS

marked distances on the spiral. Allow 10 to 15 seconds for the meter response and average maximum and minimum deflections of the meter needle to determine the meter reading.

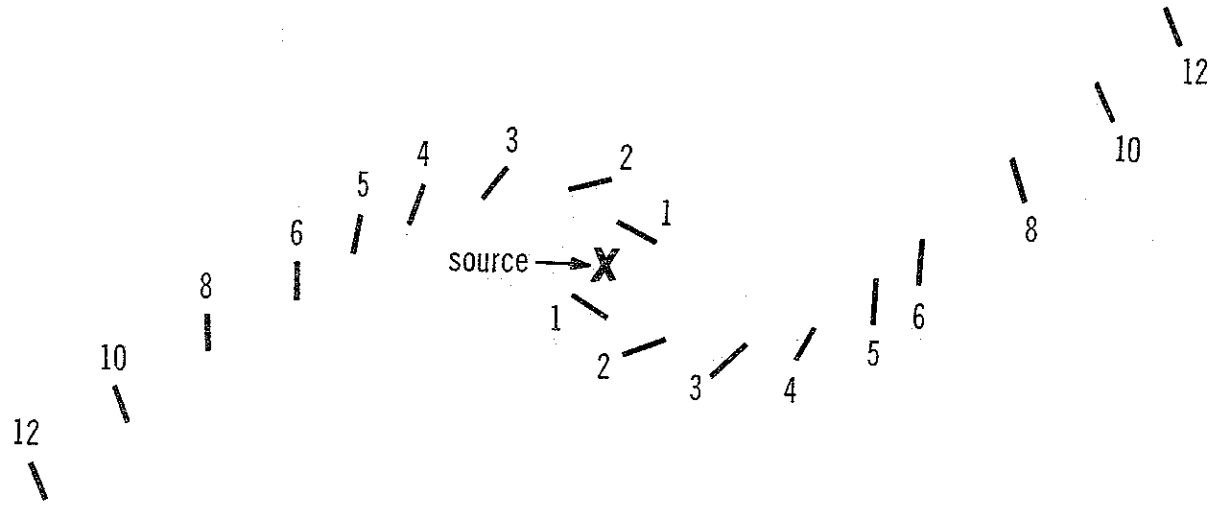
9. Stay in the exercise area and spot check the students worksheets to insure that the readings and conversions are correct.

10. Call attention to the effect of the distance and the rough approximation of the inverse square law, (i.e., doubling the distance decreases the exposure rate by a factor of 4; increasing the distance by a factor 10 decreases the exposure rate by a factor of 100.)

11. If this should be the last exercise of the day - have the students read their dosimeter and record their exposure on their radiation exposure record, remove batteries from the instruments, and repack the instrument sets.

INSTRUMENT FAMILIARIZATION EXERCISE SPIRAL

Numbers and bars represent measuring locations and distance in feet from point source.



WORKSHEET FOR INSTRUMENT FAMILIARIZATION EXERCISE

DISTANCE (FEET)	RANGE	×	METER READING	=	MEASURED EXPOSURE RATE (mR/hr)
1		×		=	
2		×		=	
3		×		=	
4		×		=	
5		×		=	
6		×		=	
8		×		=	
10		×		=	
12		×		=	
14		×		=	
16		×		=	
18		×		=	
20		×		=	
		×		=	
		×		=	
		×		=	
		×		=	
		×		=	

LESSON PLAN NO. 6

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Area Monitoring (Exercise) TIME: .75 Hour

OBJECTIVES: At the conclusion of this unit the student will be able to:

1. Perform an area monitoring survey.
2. Chart areas of varying exposure rates.
3. Draw selected exposure rate contours on a chart of the surveyed area.

SCOPE: Survey of an exercise area with the CDV-700; construction of selected exposure rate contours on the exercise area map.

REFERENCES:

1. Instructor
   a. Handbook for Radiological Monitors, CPG 2-6.2.2.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.
2. Student
   a. Handbook for Radiological Monitors, CPG 2-6.2.2.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.

REQUIREMENTS:

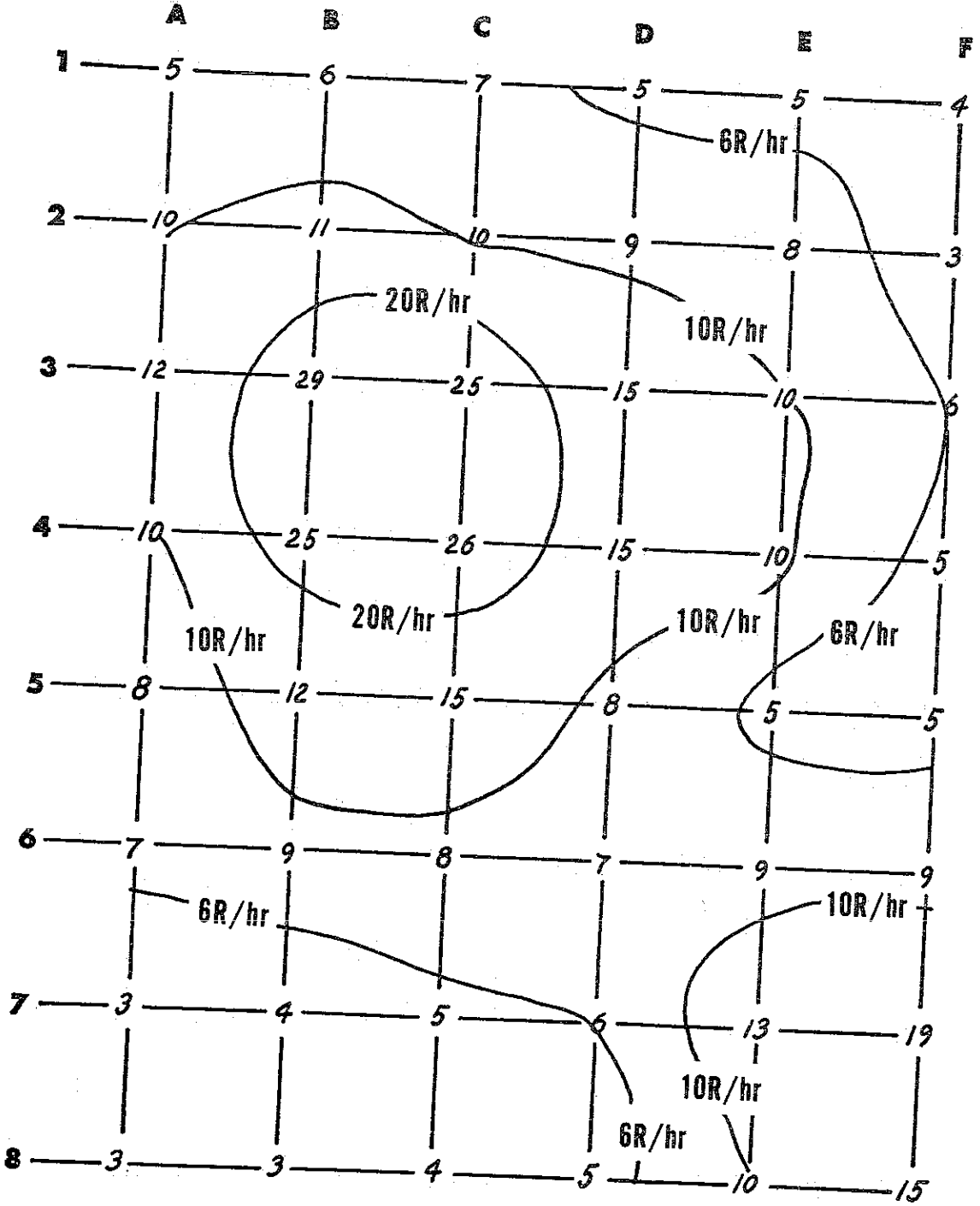
1. Instructor
   a. Training Source Set, CDV-778.
   b. Exercise area of at least 12 x 16 feet.
   c. Forty-eight (48) styrofoam or paper coffee cups.
   d. Marking pen or grease pencil.
   e. CDV-777A RADEF Instrument Set.
2. Student
   a. CDV-777A RADEF Instrument Set.(One set per each two students.)
   b. One CDV-138 dosimeter per student.
   c. Worksheet for area monitoring exercise, SM-11.21.1.

REMARKS: Prior to the exercise the instructor should prepare the area in a grid-like pattern similar to the pattern shown on the worksheet for the area monitoring exercise in SM-11.21.1 (Attachment 6.1). At the intersection, i.e, A-1, B-1, C-1, A-2, B-2, C-2, etc. the instructor should place a cup upside down with the intersection number marked on the bottom so it is visible to the monitors. The instructor can then hide the sources under selected cups to give the desired exposure rate contour. For example, if the instructor wanted to establish a hot spot in the middle of the survey area, he would place all the sources under cups C-4, D-4, C-5 and D-5. The number of cups used in the grid will depend upon the size of the room. Cups should be about 3 feet apart.

Prepare radiation hazard signs for placement to area entry. Count and record the number of sources placed under the cups at the beginning of the exercise. At the end of the exercise, count and record the number of sources replaced in the lead container. A licensed user must stay in the area when the sources are not secured in the lead containers.

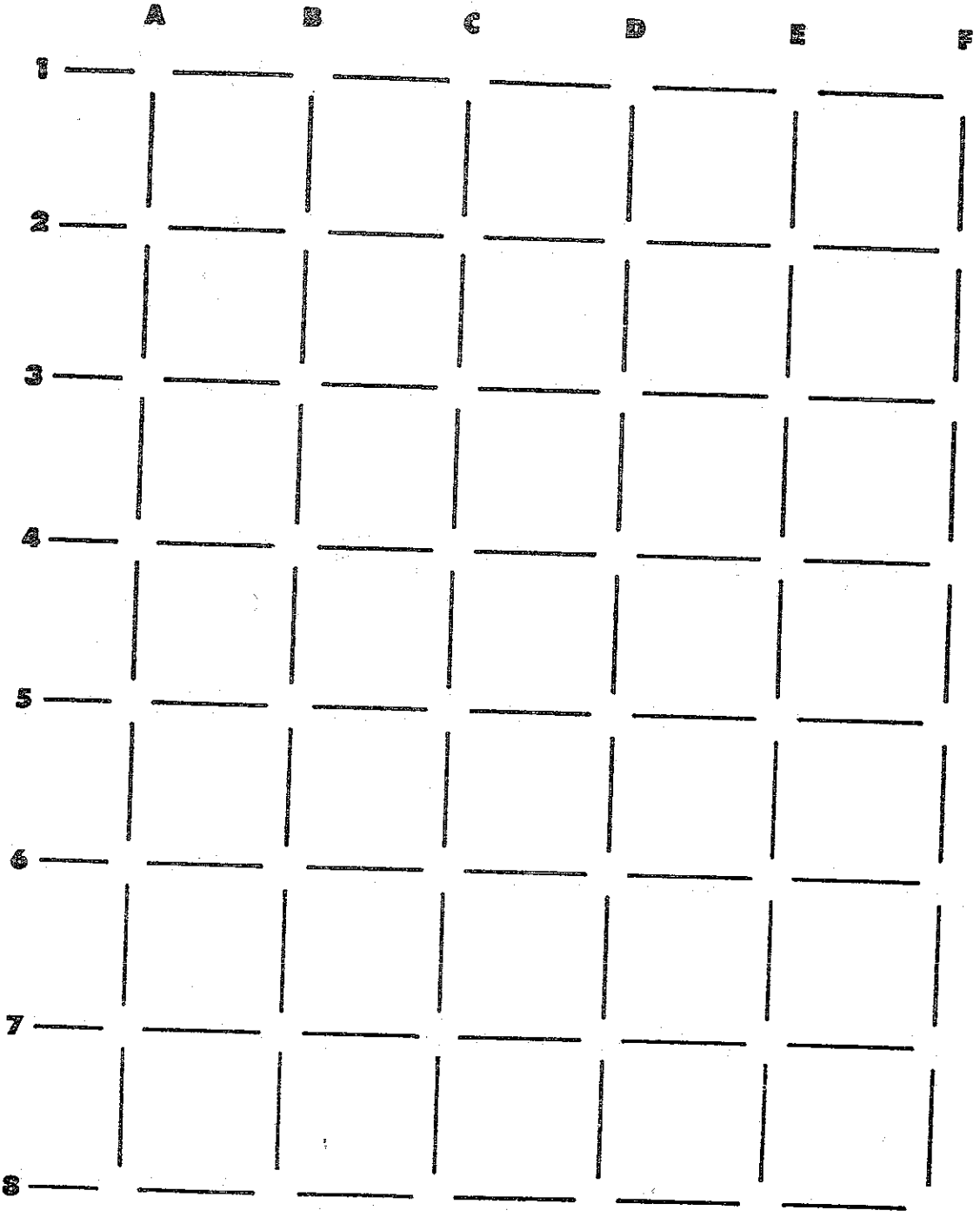
MAIN TOPICS	TEACHING POINTS
A. AREA MONITORING (EXERCISE)	1. This exercise provides additional experience in using radiological instruments in a radiation area and in collecting and recording radiological data. Each location in the exercise area could represent a WERS from which information would be furnished to an EOC.
Sample Worksheet (from SM-11.21.1 with contours) Attachment 6.1	2. To familiarize the student with a possible use of the radiological data he will collect - exposure rate contours will be constructed from the exercise readings. These contours are a visual analysis of radiological data that a RADEF Officer could use to provide guidance to a civil preparedness director regarding the hazard in performance of emergency operations.
Sample Worksheet (without markings from SM-11.21.1) Attachment 6.2	3. Explain the layout of the exercise area, using the worksheet or chalkboard. Again the shield on the instrument probe should be closed and the probe in the holder on the instrument. Work should be done in groups of two students - one student to operate the instrument and the other to record the instrument readings. Half way through the exercise the students should switch activities.
	4. The CDV-700 should be held at belt height over the grid coordinates (upside down paper cups) while the exposure rate at that location is being measured and recorded. Students should not be concerned about the shielding of other students in the area.
	5. When all measurements and their recordings have been completed, each student pair should return to the classroom and draw in one or two contour lines as directed by the instructor. The finished drawings can then be compared with those of other groups.
	NOTE: <u>The exercise exposure rate will be in mR/hr.</u>

SAMPLE WORKSHEET FOR AREA MONITORING EXERCISE



Attachment 6.2

WORK SHEET
FOR
AREA MONITORING EXERCISE



LESSON PLAN NO. 7

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Radiation Protection (Exercise) TIME: 1.0 Hour

OBJECTIVES: At the conclusion of this unit the student will be able to:

1. Demonstrate how time, distance and shielding offer protection from nuclear radiation.
2. Calculate exposure and exposure rate from a point source using the CDV-138 dosimeter and the CDV-700 Survey meter.
3. Explain the relative effectiveness of wood, earth and concrete or common clay bricks as a shielding material.
4. Calculate the percentage of shielding reduction for the above materials.

SCOPE: Practical exercise demonstrating the relationship of time, distance and shielding as radiation protection measures using radioactive sources, dosimeters, distances, wood, earth and concrete or common clay brick; calculation of reduction percentages for the above shielding materials.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, HS-3.
   b. Radiological Defense Manual, CPG 2-6.2.
   c. Radiological Monitoring Student Workbook, SM-11.21.1.
2. Student
   Radiological Monitoring Student Workbook, SM-11.21.1.

REQUIREMENTS:

1. Instructor
   a. Training Source Set, CDV-778.
   b. Shielding materials such as solid common clay or concrete bricks, earth and wood.
   c. Radiation Protection Exercise Layout.
   d. CDV-777A RADEF Instrument Sets.
   e. Thirty CDV-138 dosimeters.
   f. Chalkboard, chalk, eraser and pointer.

2. Student
   a. CDV-777A RADEF Instrument Set, one set per each two students.
   b. One CDV-138 dosimeter per student.
   c. Worksheet for Radiation Protection Exercise, SM-11.21.1.

REMARKS:

The Radiation Protection Exercise Layout (Attachment 7.1) should be made prior to class. The layout circles can be made on thin sheets of plywood or heavy cardboard. The sheets may be hinged to permit compactness when folded. This will permit easy carrying.

A center point should be designated where all 6 capsules from the CDV-778 Training Source Set are placed in a small paper cup. The sources should be put out after all the dosimeters and shielding material are in place. Because the existing training source sets have decayed to a total of 5 to 7 millicuries for all six capsules, radiation exposures with the CDV-138 dosimeters must be made close to the center point of sources and for long time periods.

The inner circle should be drawn with a radius of 6 inches. A second circle should be drawn with a radius of 12 inches. The third circle should be drawn with a radius of 24 inches so that exposure rate measurements can be taken with the CDV-700. The circles should be divided into four 90° quadrants. One of the 90° quadrants should be subdivided in half as illustrated in Attachment 7.1.

For shielding material wood, earth, and either clay or concrete bricks can be used. The wood may be two pieces of pine 2 x 4" about 8" in length. The earth can be tamped into an empty cardboard half-gallon milk carton. The bricks should be solid and equal in thickness to the wood and earth shielding.

The shielding materials should be placed in positions A, B and C for the exercise so that three CDV-138 dosimeters can be placed on the 6" radius circle behind each of the shielding materials. In the non-shielded quadrant, dosimeters should be placed on the 6" and the 12" radius circles so that no dosimeter is shielded from the source of radiation by another dosimeter.

Because there is quite a bit of arithmetic involved, the instructor may wish to have one of the students use a calculator (if available) to sum the measurements recorded and to average the readings. The averaged readings may be used by the class in their calculations. The results will be more uniform when this procedure is used.

REMINDER - A licensed user must be present when the training sources are not locked in the lead container. Hazard signs should be posted at the entrances to the exercise area. The instructor should count and record the number of sources placed in the cup at the center of the circles. At the end of the exercise he should again count and record the number of sources replaced in the lead container.

MAIN TOPICS	TEACHING POINTS
A. INTRODUCTION	This exercise demonstrates the effectiveness of time, distance and shielding as radiation protective measures. The inverse square law will be used to relate the exposure rates at varying distances from a point source. It should be understood that the inverse square law applies only to point sources and does not apply to a fallout area.
B. PREPARATION	Divide the students into groups of four. If there are not enough students to form seven groups, have selected groups do more than one part of the exercise. The students should zero all thirty dosimeters and perform an operation check of the CDV-700s used. Because the students will be using the dosimeters during the exercise, they will not be able to wear them to measure body exposure. Therefore, select one student from the first 5 groups to wear a CDV-138 for the exercise. The instructor should also wear a dosimeter during the exercise. At the end of the exercise, average the 5 dosimeter readings and have the students enter this figure in their own radiation exposure record.
C. EXERCISE AREA PROCEDURE (Attachment 7.1)	1. Explain how the exercise area and the Radiation Protection Exercise Layout will be used. 2. Have group A place three dosimeters on the 6" radius circle behind the wood (shield A). 3. Have group B place three dosimeters on the 6" radius circle behind the earth (shield B). 4. Have group C place three dosimeters on the 6" radius circle behind the solid concrete or clay bricks (shield C). 5. Have group D place three dosimeters on the 6" radius circle in the area marked D. 6. Have group E place three dosimeters on the 6" radius circle in the area marked E.

MAIN TOPICS	TEACHING POINTS

7. Have group F place 4 dosimeters on the 12" radius circle in the area marked F.

8. Have group G place 4 dosimeters on the 12" radius circle in the area marked G.

9. Any additional dosimeters may be placed at locations designated by the instructor.

10. Place the six sealed sources in a paper or styrofoam cup and position at the center point of the Exercise Layout.

11. Appoint a student to act as "official timer" so that group D and group F dosimeters are removed after 10 minutes of exposure to the sources. At the end of twenty minutes the cup containing the six sources should be removed. The students can then pick up the dosimeters remaining and read all dosimeters.

12. List on the chalkboard the dosimeter readings for the appropriate time, distance and shield-materials. Average the readings and have the students enter the average readings in the appropriate blanks on the Worksheet for Radiation Protection Exercise (Attachment 7.2).

13. While the dosimeters are being exposed, have each group take a CDV-700 survey meter reading in each of the quadrants at the "X" locations. In the quadrants with the shielding material, be sure the probe of the instrument is well behind the shielding material, and record the lowest readings.

14. While the dosimeters are being exposed, explain how to calculate the exposure rate for the 6", 12" and 24" distances and the expected exposure for each time interval (10 and 20 minutes) at the 6" and 12" distances.

    a. For example, what exposure should a dosimeter measure at 1' from 5 millicuries of Cobalt 60 if it was exposed for 10 minutes?

MAIN TOPICS	TEACHING POINTS

b. Exposure rate in mR/hr.

$$= \frac{(14.2)\ (\text{Number of mCi } Co^{60})}{(\text{distance in feet squared})}$$

$$= \frac{(14.2)\ (5)}{(1)^2} = \frac{71.0}{1} = 71 \text{ mR/hr}$$

c. Exposure at 1 foot = $\frac{10 \text{ min.}}{60 \text{ min.}} \times 71$ mR/hr

= 11.8 mR

d. Exposure at 1 foot for 20 minutes =

$\frac{20 \text{ min.}}{60 \text{ min.}} \times 71$ mR/hr = 23.6 mR

e. Exposure rate in mR/hr at 2 feet =

$$\frac{71 \text{ mR/hr}}{(2 \text{ ft.})^2} = \frac{71}{4} = 17.75 \text{ mR/hr}$$

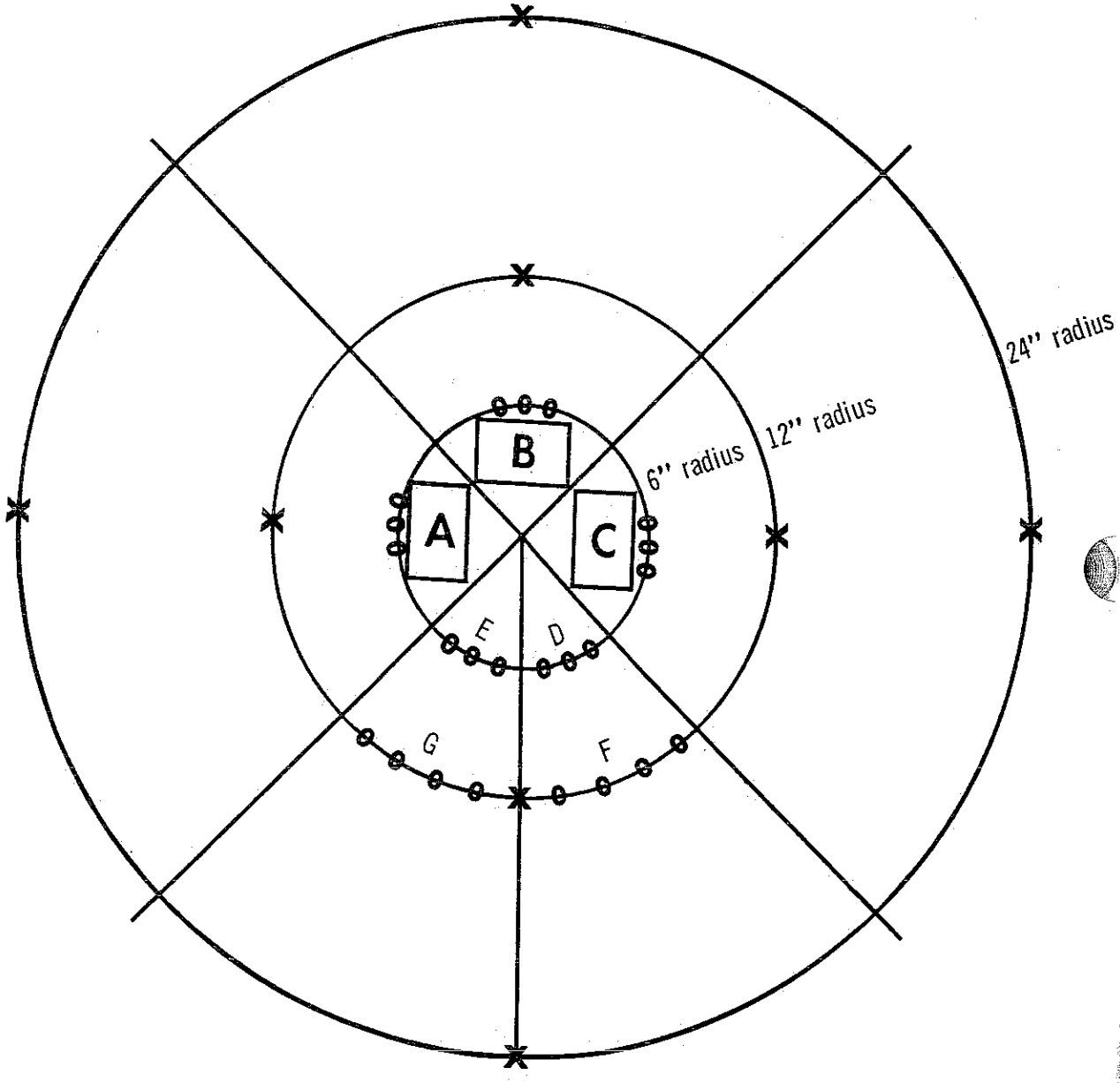
NOTE: The sources used in the exercise are considered to be an "equivalent point source."

15. Have each group of students calculate the expected exposure for each of the four situations and record these values on the Worksheet for Radiation Protection Exercise.

16. Discuss the results of the rate meter measurements while the dosimeters are being exposed. Discuss how time and distance can be used as protective measures. Emphasize that the exposure rate in a fallout field will not decrease according to the inverse square law.

MAIN TOPICS	TEACHING POINTS
D. PERCENTAGE OF REDUCTION	1. Demonstrate on the chalkboard how to calculate the percentage of reduction. a. Put the average unshielded reading for 20 minutes on the chalkboard and subtract the average reading of the clay bricks (or concrete bricks) from the average unshielded reading and obtain the difference. b. Divide the unshielded reading into the difference, multiply by 100, and get the percentage of reduction. Record under the percentage reduction column. Example problem: (1) The unshielded exposure of a dosimeter for 20 minutes was 96 mR. A shielded exposure for 20 minutes behind a solid common clay brick produced an exposure of 36 mR. What is the percentage of reduction? (2) Unshielded reading = 96 mR Shielded reading = 36 mR Difference = 60 mR (3) $\frac{\text{Difference}}{\text{Unshielding reading}} = \frac{60}{96} = .625$ (4) Answer: .625 x 100 = 62.5% reduction.
E. CONCLUSION & SUMMARY	1. Average the dosimeter readings from the five students who wore dosimeters during the exercise and have all students record this average exposure in their radiation exposure record. 2. Review and discuss each part of the exercise and the objectives of the exercise.

RADIATION PROTECTION EXERCISE LAYOUT



0 CDV–138 Dosimeter Exposure Positions
X Locations of CDV–700 Survey Meter Readings
A Shielding Material – Wood
B Shielding Material – Earth
C Shielding Material – Brick

Attachment 7.2

WORKSHEET FOR RADIATION PROTECTION EXERCISE

4" radius

UNSHIELDED QUADRANT

TIME (Min.)	DISTANCE (inches)	DOSIMETER READINGS	AVERAGE READING	CALCULATED READING	SURVEY METER READING
10	6				
10	12				
20	6				
20	12				
	24				

WOOD SHIELDED QUADRANT

TIME (Min.)	DISTANCE (inches)	DOSIMETER READINGS	AVERAGE READING	CALCULATED READING	SURVEY METER READING
20	6				
	12				

EARTH SHIELDED QUADRANT

TIME (Min.)	DISTANCE (inches)	DOSIMETER READINGS	AVERAGE READING	CALCULATED READING	SURVEY METER READING
20	6				
	12				

BRICK SHIELDED QUADRANT

TIME (Min.)	DISTANCE (inches)	DOSIMETER READINGS	AVERAGE READING	CALCULATED READING	SURVEY METER READING
20	6				
	12				

COMPUTING PERCENT REDUCTION

SHIELDING MATERIAL	UNSHIELDED DOSIMETER AVERAGE	SHIELDED DOSIMETER AVERAGE	DIFFERENCE	PERCENT REDUCTION
WOOD				
EARTH				
BRICK				

LESSON PLAN NO. 8

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Radiological Monitoring, Reporting and Assessment

TIME: .75 Hour

OBJECTIVE: At the conclusion of this lesson the student will be able to:

1. Describe the four basic types of radiological monitoring operations that are required and what the monitor is expected to do in each type.

2. Explain in general terms the difference between shelter monitoring, self-protection monitoring and Weapons Effects Reporting Station monitoring.

3. Describe the importance of a RADEF system network and the reporting channels.

4. Work effectively with the local RADEF reporting procedures or the procedures as given in the Handbook for Radiological Monitors, CPG 2-6.2.2 and the Civil Defense Emergency Operations Reporting Systems, CPG 2-10.

SCOPE: The RADEF system; shelter monitoring; self-protection monitoring; radiological monitoring for reporting and assessment; and radiological monitoring support for postattack recovery; the WERS network and reporting channels; local reporting procedures.

REFERENCES:

1. Instructor
   a. Radiological Defense Preparedness, CPG 2-6.1.
   b. Local radiological defense plan and annex with WERS procedures.
   c. State radiological defense plan with monitoring and reporting procedures.
   d. Handbook for Radiological Monitors, CPG 2-6.2.2.
   e. Radiological Defense Manual, CPG 2-6.2.
   f. Civil Defense Emergency Operations Reporting Systems, CPG 2-10

2. Student
   a. Handbook for Radiological Monitors, CPG 2-6.2.2.
   b. Local WERS procedures.

REQUIREMENTS: 1. Instructor

a. Chalkboard, chalk, eraser, pointer.
b. Local radiological defense plan and annex with WERS procedures.
c. Any local reporting forms that may be applicable.

2. Student

Any handout material that might be available concerning local reporting procedures such as flow charts, WERS locations, telephone numbers, recording forms, etc.

REMARKS: The instructor will have to secure and study local and State plans for guidance in reporting procedures and policy. The local RADEF officer should be asked to make this presentation or serve as a resource person.

MAIN TOPICS	TEACHING POINTS
A. RADEF SYSTEM	1. To have a fully operational RADEF system, a sufficient number of people must be trained as radiological monitors for weapons effects reporting stations and for the self protection of emergency services personnel such as fire, police, hospitals, public works, industries and vital facilities.
	2. The RADEF training will normally be accomplished by the RDO or someone enlisted to conduct the training courses. In the RADEF annexes of the emergency plan there should be provisions for crisis training of shelter monitors, additional radiological monitors for weapons effects reporting, self-protection and added personnel to assist in the EOC. Training during a period of international tension is the primary means of training shelter monitors.
	3. The RDO must not only assist in planning for the development and deployment of a RADEF system, but must assist in maintaining and exercising the system. To this end, persons who are trained as radiological monitors should continue to familiarize themselves with their instruments and procedures.
B. SHELTER MONITORING	In a complete and operationally ready RADEF system a shelter monitoring capability is needed for monitoring and assessing the radiation environment for shelterees. It is the duty of the shelter monitor to: (a) find the best protected locations in the shelter where the exposure rate is lowest; (b) determine if the best protected areas need improvement; (c) evaluate any shielding improvements made in the shelter; (d) measure and limit or control the radiation exposure to the shelterees; (e) determine when short excursions can be made outside the shelter for essential items such as food, water, and medical aid; (f) determine when areas within the structure other than the best protected areas may be utilized by shelterees and for how long; and (g) in the absence of other guidance, make decisions on when the shelterees may leave the shelter for at least a limited time period.

MAIN TOPICS	TEACHING POINTS
C. SELF-PROTECTION MONITORING	The monitoring and assessing of the radiation environment to control or limit the radiation exposure by personnel who must conduct emergency operations under fallout conditions is termed self-protection monitoring. This is performed by personnel in emergency services organizations; at vital facilities, including hospitals, utilities, and essential industries and for the large number of additional emergency workers who would be required for postattack recovery operations. A self-protection monitor would: (a) measure actual exposure rates at the location where emergency operations are being conducted to confirm or revise radiation exposure rate estimates; (b) evaluate, if necessary, how long people can work at the location without exceeding established exposure limits; and (c) measure, control and limit the actual radiation exposure to persons performing the emergency operations. Radiation exposure rates would not be routinely reported to an EOC. However, radiological and operational information should be received from the EOC in conjunction with the emergency assignment, and the EOC may request radiological data on certain areas during the course of conducting emergency operations. If the levels measured vary significantly from the estimates provided by the EOC, then the EOC should be advised immediately.
D. MONITORING, REPORTING AND ASSESSMENT	1. A monitoring, reporting and assessment capability for determining the extent and magnitude of the radiological hazard is possible by using the data furnished by the on-scene monitor. This capability is needed to determine: (a) if and when emergency operations can be initiated; (b) when lower grade shelters may be used; (c) when people - emergency workers, or any others being sheltered - may go outside of shelters; (d) when restrictions in shelter living may be relaxed; and (e) when radiological countermeasures can be undertaken. 2. The radiological monitor performing in a self-protection capacity will: (a) Measure

MAIN TOPICS	TEACHING POINTS
	actual exposure rates at locations where emergency operations are underway; (b) control or limit his exposure and the exposure of other emergency workers in his organization; and (c) report the measured exposure rates to his headquarters.
	3. The radiological monitor at a WERS will report nuclear detonation effects in addition to measured exposure rates to a central location (EOC).
	4. The RDO at the EOC will collect, process and analyze the data from the monitor's reports. The RDO may request WERS monitors or self protection monitors to provide supplemental data from nearby locations. The RDO can then provide for a display of the radiological hazard in the EOC for the officials in charge to see. The RDO can also expect to be asked to provide the officials with summaries of the situation for their issuing to the general public and to higher echelons in accordance with agreed procedures.
E. RADIOLOGICAL MONITORING FOR POSTATTACK RECOVERY	1. Radiological monitoring for postattack recovery operations is needed to: a. Measure actual exposure rates at each location where decontamination is being considered; b. evaluate the effectiveness of various methods of removing or covering the radioactive fallout; c. minimize the radiation exposure of decontamination personnel; and d. measure exposure rates during and following decontamination operations. Decontamination can allow earlier use of essential facilities and reduce exposure to the people sheltered or working in the facilities.

MAIN TOPICS	TEACHING POINTS
	2. The decontamination support monitor will measure actual exposure rates at the site before decontamination operations are initiated. The monitor's data will permit the RDO to evaluate the various methods of removing or covering the radioactive fallout. The RDO and the civil preparedness coordinator can then arrange for manpower and machines necessary to do the decontamination.
	3. At the scene of the decontamination operations the radiological monitor will: (a) measure exposure rates during and after the decon operation; and (b) see that workers do not exceed the control limits of exposure.
F. OPERATIONS IN AN EMERGENCY	1. Direction and control functions are best centered in an emergency operating center where the decisionmakers can be provided with all of the relevant information on attack effects and the condition of emergency resources and of the population in general.
	2. Operations in fallout contaminated areas, for example, require information on radiation exposure rates that can only be obtained by special monitoring equipment used by specially trained personnel.
	3. The monitor is the key person who provides the basic radiological information from which analyses and decisions are made. If the monitor provides erroneous data -- serious errors in decisions may be made. As you can see -- the monitor is an important link in the system. He must be most competent in the use of his instruments and in the reporting of radiological and other weapons effects data.
G. WEAPONS EFFECTS REPORTING SYSTEM	1. The radiological reporting channel starts with the monitor in a Weapons Effects Reporting Station (WERS). From there data is reported to a local emergency operating center. At the emergency operating center the data is

MAIN TOPICS	TEACHING POINTS
	summarized and forwarded to the next higher reporting level. This level may be the county or sub-State district level. The data is reduced and summarized and forwarded to the State EOC. The State in turn relays the weapons effects information to the appropriate Regional Center from which it is finally sent to National Headquarters.
	2. The radiological data needed at the local community for operational purposes would be much more detailed than that needed by the higher levels of government.
H. LOCAL REPORTING PROCEDURES	NOTE: At this point the instructor should teach the appropriate local reporting procedures. If there are none - then the instructor may use the procedures suggested in the Handbook for Radiological Monitors, CPG 2-6.2.2 and Civil Defense Emergency Operations Reporting Systems, CPG 2-10.

LESSON PLAN NO. 9

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Exposure and Exposure Rate Nomograms (Exercise) TIME: 1.0 Hour

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OBJECTIVE: At the conclusion of this exercise the student will be able to:

1. Forecast future exposure rates when provided with the time after burst and the exposure rate.

2. Compute total exposure, entry, and stay time for unsheltered emergency missions.

SCOPE: Use of the Exposure Rate Nomogram to forecast exposure rates; use of the Entry-Stay Time-Total Exposure Nomogram for arriving at solutions to total exposure, stay and entry time problems.

REFERENCES:

1. Instructor
   a. Introduction to Radiological Monitoring, HS-3.
   b. Radiological Monitoring Student Workbook, SM-11.21.1.

2. Student
   Same as above listed references.

REQUIREMENTS:

1. Instructor
   a. Exposure and exposure rate problems listed in SM-11.21.1.
   b. Answers to exposure rate problems in SM-11.21.1.
   c. Chalkboard, chalk and eraser, pointer.

2. Student
   a. Radiological Monitoring Student Workbook, SM-11.21.1.
   b. Straightedge or ruler.
   c. Sharp pencil and stick pin.

REMARKS:

1. The number of problems worked will depend upon the remaining time in the class period. There may not be enough time to work all the problems. However, students should practice until they become proficient.

2. It is suggested that the instructor begin the class by assigning a sampling of each of the three types of

problems in the Student Workbook, SM-11.21.1 (for example the first five problems in each group.)

3. When working the exercise problems, encourage students to help each other.

MAIN TOPICS	TEACHING POINTS
A. EXPOSURE AND EXPOSURE RATE NOMOGRAM	1. The exposure rate nomogram helps the monitor (if such information is not available from the EOC) to estimate future exposure rates due to radioactive decay. 2. To use the exposure rate nomogram to project future exposure rates, you need to know what the exposure rate is at the time of computation and how long it has been since the nuclear burst occurred. (The instructor can demonstrate a problem from the HS-3 textbook.) 3. After determining what the exposure rate would have been at H plus 1, the future exposure rate may be calculated. (Again, the instructor can demonstrate from HS-3.) NOTE: <u>It is important that the instructor emphasize that all calculations are based upon knowing what the exposure rates would have been at H plus 1.</u> 4. The entry-stay time part of the nomogram can be used to calculate total exposure. (The instructor should again demonstrate an example problem from HS-3.) 5. The nomogram can also be used to determine entry time or time of stay for a given mission when it is wanted to hold the mission exposure to a limited amount. (The instructor should demonstrate from HS-3.) 6. One fact to keep in mind - nomograms are based on standard decay. Other than standard decay or other factors - such as additional fallout or weathering - can affect the actual readings so all calculations should be confirmed with actual instrument measurements.

MAIN TOPICS	TEACHING POINTS
B. ASSIGNED PROBLEMS	To be selected by the instructor to fit available class time. Exercise problems and answers are listed in Attachment 9.1.

EXPOSURE AND EXPOSURE RATE PROBLEMS

Exposure Rate Problems

1. If the exposure rate at one hour after burst is 40 R/hr, what will be the exposure rate at 2, 4, 6, 8, and 10 hours?

   Answer: 18, 7.6, 4.7, 3.4, 2.6 R/hr.

2. If the exposure rate at H+1 is 100 R/hr, what will be the exposure rate at 2, 4, and 10 hours?

   Answer: 44, 19 and 6.5 R/hr.

3. If the exposure rate at H+1 is 350 R/hr, what will be the exposure rate at 5, 8, and 12 hours?

   Answer: 51, 30 and 18 R/hr.

4. If the exposure rate at H+6 was 45 R/hr, what would be the exposure rate at 1, 9, 12, and 15 hours?

   Answer: 380, 28, 20 and 15 R/hr.

5. If the exposure rate at H+12 was 80 R/hr, what would be the exposure rate at 1, 16, and 24 hours?

   Answer: 1600, 58 and 35 R/hr.

6. If the exposure rate at H+20 was 10 R/hr, what would be the exposure rate at 1, 20, 25, and 32 hours?

   Answer: 370, 10, 8 and 6 R/hr.

7. If the exposure rate at H+30 is 10 R/hr, when would the exposure rate be 7 R/hr?

   Answer: H+40

8. At H+20 days the exposure rate in an area is 3 R/hr. What will be the exposure rate at H+25 days?

   Answer: 2.5 R/hr.

9. In a sheltered area with an outside/inside rate of 100, the exposure rate is 10 R/hr at H+10. What will be the unsheltered exposure rate at H+18?

   Answer: 500 R/hr.

10. In a sheltered area with an outside/inside ratio of 1,000, the exposure rate at H+24 is 15 R/hr. What will be the exposure rate in the shelter at H+40?

Answer: 8 R/hr.

Exposure Problems

11. If the exposure rate at H+1 was 200 R/hr, what would be the exposure of a monitor if he entered the area at H+12 and stayed 4 hours?

Answer: 35 R

12. If the exposure rate at H+1 was 50 R/hr, what would be the exposure of a monitor if he stayed in this area from H+5 to H+8?

Answer: 15 R

13. If the exposure rate at H+1 was 500 R/hr, what would be the total exposure of a monitor who remained in this area for a 1.5 hour period beginning at H+12?

Answer: 36 R

14. What would be a monitor's exposure if he entered an area at H+6 and left at H+8? At the time of entry, the exposure rate was 15 R/hr.

Answer: 25 R

15. Firemen must put out a fire in an area where the exposure rate was 50 R/hr at H+7. What will be their mission exposure if it takes 6 hours to fight the fire and they start their mission at H+12?

Answer: 120R

16. Vital medical supplies must be moved to a shelter area. The task will require 30 minutes. If the worker enters the area at H+6 when the exposure rate is 200 R/hr, what exposure will he receive?

Answer: 90 R

17. An individual left a shelter at H+6 on a mission to a nearby shelter but never arrived at the other shelter. At H+30 a rescue team found him unconscious in the contaminated area outside the original shelter. At that time, the exposure rate was 14 R/hr. What exposure was received by the unconscious individual?

Answer: 800 R

18. A rescue team entered a contaminated area at H+12 and accomplished a task in 4 hours. What was their exposure if the exposure rate at time of exit was 12 R/hr?

Answer: 60 R

19. No water is available in a shelter. There is a safe supply nearby. It is a 45-minute walk to the water and the mission will begin at H+10. If the exposure rate at H+7 was 30 R/hr, what exposure will be received in obtaining the water for the shelter?

Answer: 27 R

20. What is the exposure received in a shelter from H+18 to H+24, if the unsheltered exposure rate at H+16 is 120 R/hr and the shelter outside/inside ratio is 200?

Answer: 2.7 R

Entry Time Problems

21. If the exposure rate in an area was 300 R/hr at H+1, when can a monitor enter the area for a 3-hour stay and receive less than 50 R?

Answer: H+11

22. A monitor must stay in an area for 1 hour. The exposure rate in this area at H+1 was 150 R/hr. He must limit his dose to 15 R. When can he enter?

Answer: H+6

23. In order to keep a monitor's exposure below 20R for a stay time of 2 hours, what is the earliest possible entry time into an area where the exposure rate was 120 R/hr at H+1?

Answer: H+7

24. If the exposure rate in an area is 5 R/hr at H+20 and an individual must stay there 3 hours, what is the earliest time he can enter and not exceed an exposure of 10 R?

Answer: H+27

25. A mission exposure is set at 35 R. The exposure rate in the area was 18 R/hr at H+15. When can workers enter this area for a 3-hour period?

Answer: H+21

26. The task of removing valuable equipment which is located in a contaminated area will require 3 hours. The mission exposure is set at 50 R and the exposure rate at H+9 was 50 R/hr. When can the salvage crew enter the area?

Answer: H+22

27. A monitor must make a survey of an area which will require 2 hours. The mission exposure is set at 35 R and the exposure rate in the area was 18 R/hr at H+1 day. When will the monitor be able to enter the area?

Answer: H+23

28. People want to move from an improvised shelter to a community shelter. At H+6 the route to be traveled had an average exposure rate of 85 R/hr. The trip will take 2 hours and the mission exposure is 50 R. When can they leave?

Answer: H+17

29. A supply of drugs must be delivered as soon as possible to a shelter. The drive takes 3 hours. The average exposure rate along the route to be followed was 125 R/hr at H+4. The mission exposure is 75 R. What is the earliest time that the drugs can arrive at the shelter?

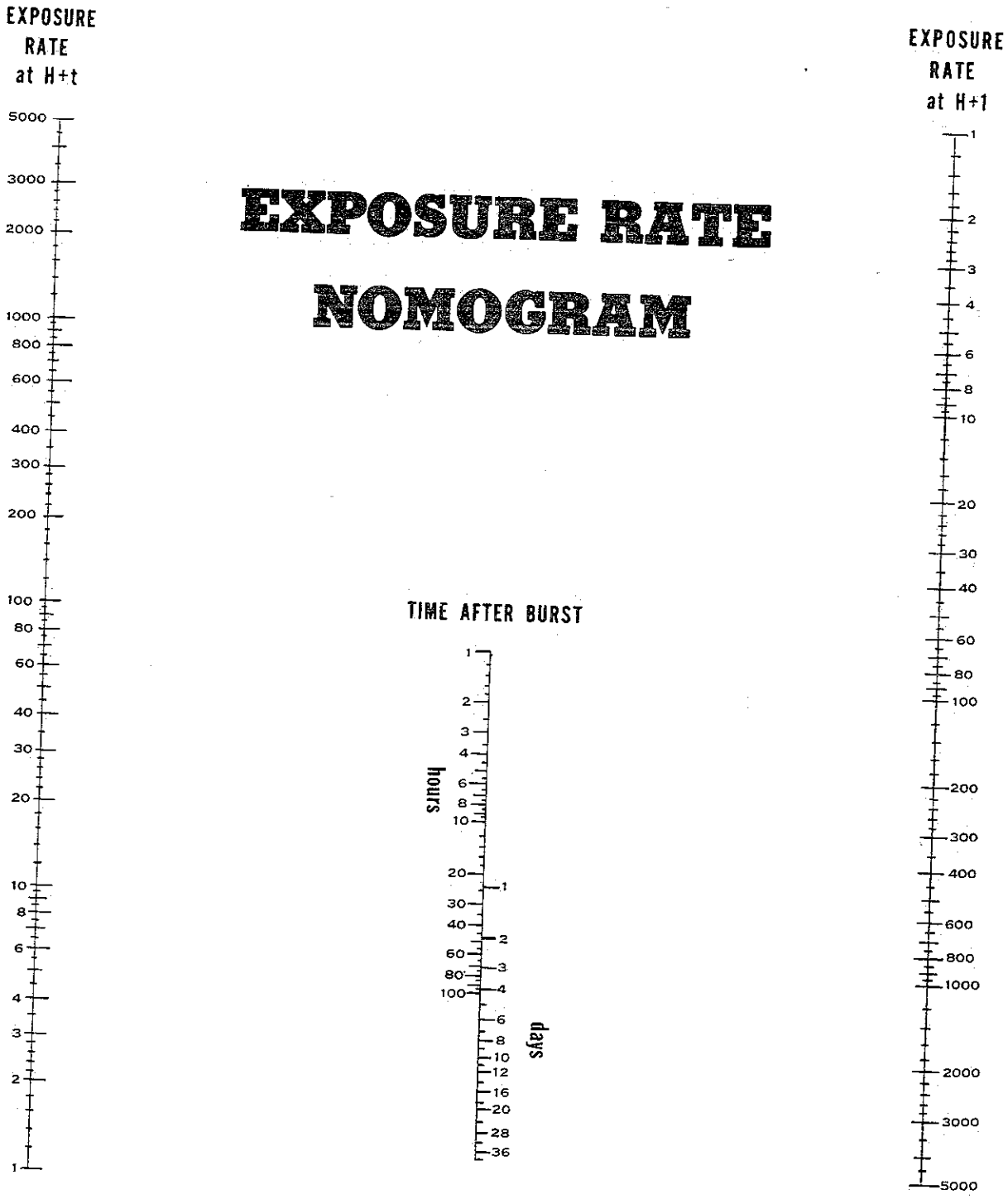
Answer: (H+15) + 3 = H+18

30. A shelter with an outside/inside ratio of 500 is running low on food. The nearest supply would require 1 hour round trip travel to obtain it. The average exposure rate over the route to be traveled was 60 R/hr at H+7. The mission exposure is set at 50 R. When can the mission be started to obtain the food?

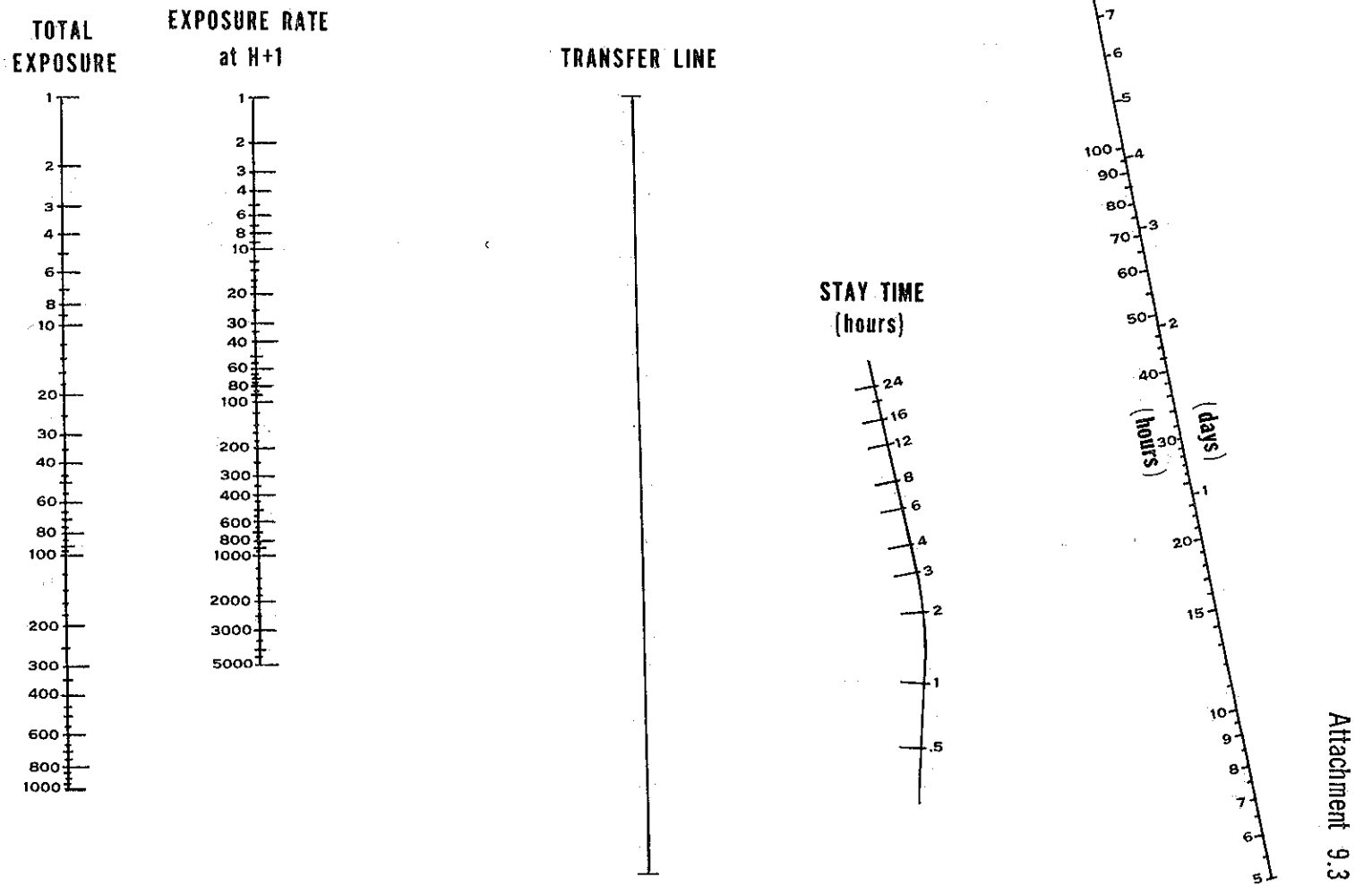
Answer: H+8

Attachment 9.2

EXPOSURE RATE NOMOGRAM



ENTRY TIME - STAY TIME
TOTAL EXPOSURE NOMOGRAM



Attachment 9.3

LESSON PLAN NO. 10

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: COURSE EXAMINATION TIME: .50 Hour

OBJECTIVE: At the conclusion of this examination the student will:

1. Have the opportunity to review how well he understands the effects of nuclear weapons; the operation of the monitor's instruments; radiological monitoring; the nature of fallout; protection measures; weapons effects reporting and decontamination.

2. Demonstrate by formal examination the degree of proficiency attained in his course of training to become a qualified radiological monitor.

SCOPE: Thirty-three written multiple choice questions.

REFERENCES: None

REQUIREMENTS: 1. Instructor

For quick and easy grading the instructor may wish to make an answer or score card upon which the students can record their selected answer. A plastic template can be made to overlay the score card to speed the grading process.

2. Student
   a. Course examination in the back of the Radiological Monitoring Student Workbook, SM-11.21.1.
   b. Nomogram.
   c. Answer or score card.

REMARKS: Attachment 10.1 is a copy of the course examination with correct answers marked with an asterisk.

Attachment 10.2 is a sample score card for the instructor with the correct answers provided. These may be used as reference by the instructor or as a model in constructing a score card and scoring template.

COURSE EXAMINATION

Multiple Choice Questions

TIME: 25 Minutes

DIRECTIONS: Each question is followed by four possible responses. Circle the letter before the response which best answers the question.

1. The chronological order of events accompanying a nuclear detonation are:

   a. Fireball, fallout, thermal wave, blast wave.
   *b. Fireball, thermal wave, blast wave, fallout.
   c. Fallout, blast wave, thermal wave, fireball.
   d. Blast wave, thermal wave, fallout, fireball.

2. What type of nuclear burst would cause the most severe fallout situation?

   a. Air burst.
   b. Space burst.
   *c. Surface burst.
   d. Subsurface burst.

3. A nuclear weapon differs from a conventional weapon in that part of the energy is released as:

   a. Thermal radiation.
   b. Blast.
   c. Firestorm.
   *d. Nuclear radiation.

4. The nuclear weapon effect that covers the largest geographical area is:

   *a. Fallout.
   b. Thermal.
   c. Blast.
   d. Initial nuclear radiation.

5. Fallout monitoring stations will make a FLASH REPORT of fallout arrival when the exposure rate reaches, or exceeds:

   a. 1.5 R/hr.
   *b. .5 R/hr.
   c. 50 mR/hr.
   d. A measurable level.

6. Fallout shelters are primarily for the purpose of protecting people from:

a. Blast.
b. Thermal radiation.
*c. Gamma radiation.
d. Beta radiation.

7. Assuming equal thicknesses, which of the following materials provides the best shielding against gamma radiation?

a. Wood.
b. Earth.
c. Concrete.
*d. Steel.

8. The CDV-700, 0-50 mR/hr survey meter, will detect:

a. Alpha and beta radiation.
b. Beta radiation only.
*c. Beta and gamma radiation.
d. Gamma radiation only.

9. The instrument designed to measure exposure to gamma radiation is a:

*a. Dosimeter.
b. Survey meter.
c. Geiger counter.
d. Charger.

10. The civil defense instrument designed to measure the rate of exposure to nuclear radiation is a/an:

a. Dosimeter.
*b. Survey meter.
c. Ion chamber.
d. Charger.

11. The CDV-700, 0-50 mR/hr survey meter, will:

a. Produce off-scale readings for dose rates of 50 mR/hr to 1 R/hr.
b. Jam and read zero at some exposure rates in excess of 1 R/hr.
c. Measure gamma exposure rates from 0-50 mR/hr.
*d. All of the above.

12. How many seconds should a monitor allow for meter response to stabilize before recording an exposure rate?

a. 5 seconds.
*b. 15 seconds.
c. 30 seconds.
d. 60 seconds.

13. The exposure rate inside a shelter was .5 R/hr at the same time the outside exposure rate was 60 R/hr. What is the outside/inside ratio of the shelter?

*a. 120
b. 60
c. 30
d. 5

14. The dosimeters in Shelter A could not be charged. At H+24 the exposure rate in the shelter was 5 R/hr. Recorded exposure rates at the end of the next three hours were: 7 R/hr, 5 R/hr, and 3 R/hr. What would be the approximate shelter exposure for the three hour period from H+24 to H+27?

a. 20 R
*b. 16 R
c. 6.6 R
d. None of the above.

15. Outside exposure rate readings should be taken at:

a. Chest height.
b. Ground level.
*c. Belt height.
d. Knee height.

16. When using the CDV-715, 0-500 R/hr survey meter, it is important that the instrument be:

*a. Operationally checked.
b. Warmed up for at least 10 minutes.
c. Used with the probe shield open.
d. Oriented level with the ground.

17. Daily exposure of all shelterees should be determined by:

a. The shelter manager.
b. Each shelteree.
*c. The radiological monitor.
d. The radiological defense officer.

18. A shelter has an outside/inside ratio of 100. If the inside exposure rate is 2.4 R/hr, the outside exposure rate would be:

a. 41.6 R/hr.
b. .024 R/hr.
*c. 240 R/hr.
d. 2400 R/hr.

19. How does fallout affect the air through which it passes and the surfaces on which it settles?

a. The air and the surfaces become radioactive.
b. The air becomes radioactive but not the surfaces.
*c. Neither the air nor the surfaces become radioactive.
d. Neither the air nor the surfaces become hazardous unless moisture is present.

20. Radiological monitors, whether assigned to community shelters or fallout monitoring stations, generally:

a. Follow the procedures and techniques developed by the shelter manager.
*b. Follow the procedures and techniques outlined in the Handbook for Radiological Monitors and/or the local SOP.
c. Develop and follow their own procedures and techniques.
d. Follow instructions given by the Nuclear Regulatory Commission.

21. The primary problem associated with an approved temporary emergence from a shelter is that of:

a. Radiation sickness.
b. Fallout contamination.
c. Initial radiation.
*d. Gamma radiation exposure.

22. The primary duty of radiological monitors assigned to fallout monitoring stations will be:

a. Analyzing radiological reports.
b. Personnel decontamination.
*c. Measuring, recording and reporting radiological information.
d. Briefing shelterees on the radiological situation.

23. The <u>first</u> and possibly the only necessary personnel decontamination procedure(s) which need to be used is (are):

a. Vacuum cleaning clothing.
b. Dry cleaning clothing.
*c. Brushing and shaking clothing.
d. Change of clothing and use of soap and water.

24. Almost 100% of the exposed people will die within 1 to 3 weeks if they are exposed to a short-term fallout radiation exposure of:

*a. 600 roentgens.
b. 400 roentgens.
c. 200 roentgens.
d. 100 roentgens.

25. If the exposure rate 1 hour after burst is 80 R/hr, what would be the approximate exposure at H+8?

a. 5 R/hr.
*b. 7 R/hr.
c. 9 R/hr.
d. 11 R/hr.

26. At H+3 the exposure rate is 30 R/hr. If 4 hours is required to accomplish a mission, when can the operational crew enter the area and not exceed an exposure of 25 R?

a. H+14
b. H+11
*c. H+9
d. H+7

27. Additional food must be obtained from a nearby warehouse. The exposure rate in the area at H+12 was 25 R/hr. What is the estimated exposure to be received by each individual on the mission if it requires 1 hour to secure the food and they begin work at H+24?

a. 5 R
*b. 10 R
c. 15 R
d. 20 R

28. When can a monitor leave shelter to perform a 2 hour mission, if the exposure rate was 26 R/hr at H+10 and his exposure is not to exceed 25 R?

a. H+15
*b. H+18
c. H+21
d. H+24

29. Upon returning from a survey mission, a monitor noted a reading of 14 R on his CDV-742 dosimeter. The reading before the mission was 5 R. What exposure did the monitor receive during the mission?

a. 19 R
b. 14 R
*c. 9 R
d. 5 R

30. A monitor on a survey mission observes a reading of 2.8 on the 0.1 range of his CDV-715, 0-500 R/hr survey meter. The measured exposure rate is:

a. .028 R/hr.
*b. .28 R/hr.
c. 2.8 R/hr.
d. 28 R/hr.

31. In decontaminating a bushel of potatoes, the best method(s) would be to:

a. Store the potatoes until the radioactive fallout decays to tolerable levels.
b. Brush the potatoes.
*c. Wash, peel and wash potatoes.
d. Vacuum the potatoes.

32. After the need for frequent reports of monitored data from fallout monitoring stations becomes less urgent, there may be a continuing requirement for the monitoring of:

a. Production plants.
b. Roads and streets.
c. Sleeping areas.
*d. All of the above.

33. It is expected that all monitors will receive technical direction and supervision from:

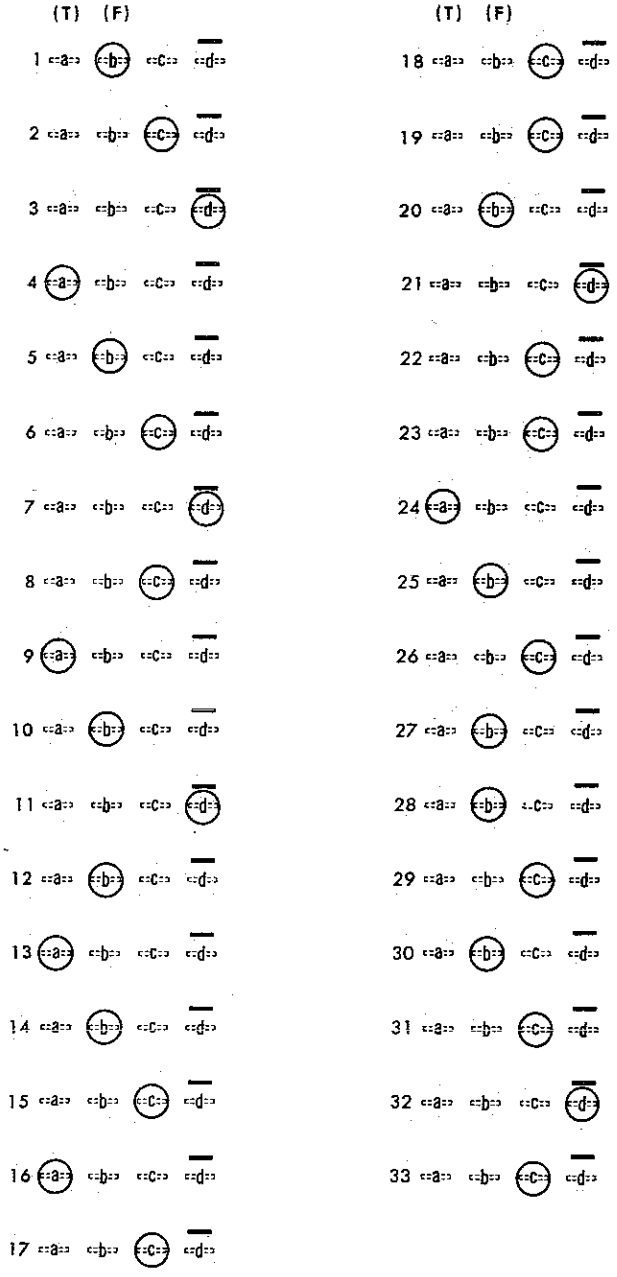
a. The Civil Preparedness Coordinator.
b. The shelter manager.
*c. The organizational RADEF Officer.
d. All of the above.

Attachment 10.2

ANSWERS TO RM PRACTICAL FINAL EXAMINATION

1. b	18. c
2. c	19. c
3. d	20. b
4. a	21. d
5. b	22. c
6. c	23. c
7. d	24. a
8. c	25. b
9. a	26. c
10. b	27. b
11. d	28. b
12. b	29. c
13. a	30. b
14. b	31. c
15. c	32. d
16. a	33. c
17. c	

NAME _____



NUMBER RIGHT

LESSON PLAN NO. 11

COURSE TITLE: RM-PRACTICAL

LESSON TITLE: Summary and Presentation of Certificates TIME: .25 Hour

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OBJECTIVE: At the conclusion of this unit the student should have:

1. Received a certificate indicating that the student has satisfactorily completed a course of instruction that qualifies the individual as a fully trained radiological monitor.

2. Had the opportunity to critique, orally or in writing, the monitor training which the student has received.

SCOPE: Importance of the radiological monitor; issuance of certificate; oral or written evaluation of monitor training.

REFERENCE: None

REQUIREMENTS:

1. Instructor
   Signed certificates.

2. Student - None

REMARKS: If possible, the local civil defense coordinator should be invited to present, "The Importance of the Monitor" speech, award the certificates, and assign the students as monitors.

SM-11.21.1 contains a certificate that can be used by those local organizations which do not have their own certificates.

NUMBER RIGHT

MAIN TOPICS	TEACHING POINTS
A. IMPORTANCE OF THE MONITOR	1. Key individual. 2. Uses specialized instruments. 3. Is part of the nationwide RADEF system. 4. People's lives depend upon the radiological data provided.
B. AWARDING OF CERTIFICATES	1. Hand certificate to individual - do not pass down the aisle. 2. Be certain individual's name on certificate is spelled correctly.
C. EVALUATION	1. Evaluation may be either oral or written or a combination of both. 2. Suggested items for evaluation are: a. Objectives - clearly stated? Met? b. Organization of material - any changes that will make it better? c. Materials content - relevant? Not relevant? d. Length of sessions - just right? too short? too long? e. Presentation of instructor - easily understood? How to improve? f. The most valuable learning experience was ..... g. Are there any unanswered questions?
D. COURSE CLOSE	Officially close the course. Provide any announcements that will help the participants leave the area -- such as traffic directions through a tricky intersection or a road that has been blocked off for repairs. Wish the students well in their future endeavors, and that they may never have to make use of the instruments or the information they have just received except in practice or refresher courses.

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