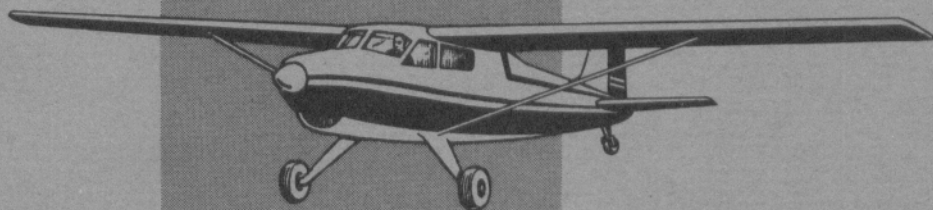
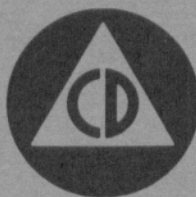


FG-E-5.9.1

JULY 1966



HANDBOOK FOR AERIAL RADIOLOGICAL MONITORS

(Supplement to Handbook for Radiological Monitors, FG-E-5.9)

**DEPARTMENT OF DEFENSE
OFFICE OF CIVIL DEFENSE**

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HANDBOOK FOR AERIAL RADIOLOGICAL MONITORS

I. INTRODUCTION

1.1 This handbook provides technical and operational guidance for aerial radiological surveys. It should be reviewed periodically and used as a reference in emergency exercises.

Scope

1.2 Detailed descriptions of aerial survey techniques, operational procedures, and specialized survey equipment appear in sections III, IV, and V, respectively. These three sections provide the "essentials." However, the planning and execution of aerial surveys are complex; and for most effective operations, an aerial survey team (pilot and monitor) also needs to be familiar with (a) the overall monitoring system, (b) the unique contributions which aerial survey can provide, and (c) the principles affecting the success of aerial survey operations.

1.3 The OCD basic "Handbook for Radiological Monitors" (FG-F-5.9) provides a brief description of the overall radiological monitoring system and the functions required of it. The following paragraphs of this section outline (a) the relationship of aerial survey to the monitoring system, (b) the major contributions to be expected from aerial survey operations, and (c) equipment (aircraft) and personnel requirements. Section II discusses organizational requirements and presents technical principles affecting survey operations.

The Monitoring System—General

1.4 Radiological fallout information obtained by monitoring stations supplemented by surface mobile monitoring will, in most areas, give adequate information for planning for survival, remedial movement, and recovery of fixed facilities. Aerial radiological survey can be of great value when monitoring stations are inoperative or incapable of supplying necessary information, or when high radiation contamination precludes mobile teams from operating. Aerial radiological survey allows flexibility for operating from areas of low contamination to areas of high exposure rates; and allows for survey from a height of several hundred feet, with low exposure to the monitoring personnel. This method of monitoring is of particular value in survey of large areas such as agricultural lands, survey of transportation routes, and early monitoring of areas

surrounding essential facilities. Aerial monitoring done in conjunction with early aerial damage-assessment missions may also be of significant value for indicating general fallout conditions for use in planning operations.

Aerial Radiological Survey Objectives

- 1.5 Aerial radiological survey can supplement surface monitoring by:
- a. Providing radiological information in areas where it cannot be obtained otherwise, because of destruction of monitoring stations, failure of communications, inoperable instruments, or absence of trained monitors to man the stations.
 - b. Monitoring areas of high radiation intensities where surface mobile monitoring would result in excessive exposure of monitors.
 - c. Accomplishing early rapid survey of broad areas and transportation routes for planning remedial movement of personnel and high-priority transport of equipment, supplies, and emergency workers.
 - d. Accomplishing early monitoring at, and in the vicinity of, essential facilities as a basis for planning early recovery.
 - e. Surveying agricultural lands for planning the disposition of livestock, harvesting of crops, and future land utilization.

Equipment and Personnel

1.6 Fixed- or rotary-wing light aircraft capable of flying at low altitudes and slow speeds are suited for aerial survey missions.

1.7 The primary duty of the radiological survey team (normally consisting of a pilot and a monitor) is to provide the most timely and accurate information feasible under existing conditions, for the proper analysis and evaluation of the radiological hazard. Since members of the aerial survey team are required to operate under conditions of varying hazards, they must be thoroughly trained in their functions. Pilots and aerial monitors should be chosen from among the best qualified personnel. In addition to the requirement that aerial monitors be trained as regular monitors, all team members should participate in operational training exercises in aerial survey techniques.

1.8 The pilot should possess a certified pilot's rating commensurate with the mission assignment, and should be familiar with the area in which the team might be required to fly missions. He must have a clear understanding of the "Plan for the Security Control of Air Traffic and Air Navigation Aids" (SCATANA) and FAA Advisory Circular No. 00-7, "State and Regional Defense Airlift Planning" (SARDA). In addition to the normal aircraft pilot proficiency requirements, emphasis should be placed on his ability to maintain a relatively constant (a) ground speed, (b) altitude, and (c) azimuth (direction) while flying at low heights above the terrain.

1.9 The monitor should be able to: (1) follow the survey Standing Operating Procedures (SOP) established by the organization to which he is assigned. This will require an understanding of his function in the plan, the conditions that require monitoring or survey, how and where to report radiation measurements,

and how to maintain required records (If no SOP exists, follow the procedures in Section IV of this handbook.); (2) know the types, use, and operation of all OCD radiological instruments and related equipment discussed in "Handbook for Radiological Monitors," (FG-E-5.9); (3) know the types, use, and operation of the aerial survey equipment; (4) use the survey techniques discussed in this handbook; and (5) promptly advise the pilot on appropriate alterations to flight direction and altitude, when required to assure reliable monitoring information and personnel safety.

1.10 The team should be familiar with the appropriate measures for individual protection, for the protection of aircraft from fallout contamination and for decontamination of aircraft. (Ref.: Section III, FG-E-5.9, and the discussion on aircraft contamination in Section II, below.)

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II. AERIAL MONITORING PRINCIPLES

Emergency Utilization of Aircraft

2.1 All aircraft which are privately or corporately owned are potentially parts of emergency transportation systems. Even for light low-speed aircraft most suitable for aerial monitoring, there may be multiple emergency functions including (a) general damage assessment reconnaissance, (b) aerial radiological survey, (c) airlift of key personnel, and (d) airlift of lightweight critical supplies, such as drugs. During certain phases of attack and defense, there could be unusual hazard associated with flights in these aircraft, and such flights could interfere with defense operations. The States should exercise general direction of aerial survey operations, because they usually would be of broad extent—likely to extend over the boundaries of several political subdivisions. Ideally, survey of heavily contaminated areas would be performed by survey teams based in less contaminated areas.

2.2 For the above reasons, pilots and monitors should recognize the necessity for State aerial survey plans carefully coordinated with all agencies concerned. The development of a plan for aerial radiological survey is primarily the responsibility of the State civil defense director, in coordination as required with the Federal Aviation Agency (General Aviation District Office), State Aviation Administration, State Transportation Agency, and other governmental agencies as appropriate under State regulations. The plan developed should be in consonance with the SCATANA plan and the FAA SARDA planning circular. The capabilities of organized flight groups, including the Civil Air Patrol, should be considered in the development of the plan.

Accuracy of Data

2.3 The intensity (exposure rate) of gamma radiation is decreased by absorption of a part of the radiation as it passes through matter, even air. In describing the radiation situation over a fallout area, stated radiation dose rates apply to locations 3 feet above the surface, unless otherwise specified. Obviously measurements made in an aircraft several hundred feet above the terrain will not be the same as "surface measurements" made at 3 feet above the surface. The reading taken aloft will have to be multiplied by a factor which corrects for the effects of height above the surface. A "Height Correction Factor" (HCF)

chart is supplied as Attachment 1. It does not allow for changed absorption in air at higher altitudes (e.g., over Denver, Colorado), or for changes in radiation absorption resulting from radiation energy changes as fallout radioactivity decays. However, the degree of accuracy is considered adequate for the needs of most aerial surveys.

2.4 Some radiation is absorbed as it passes through the aircraft structure. This will vary somewhat with the type of aircraft used and the positioning of the instrument in the aircraft. There are no adequate data from measurements over broad areas uniformly contaminated with fallout nor from laboratory simulation of this effect. Calculation based on theory and limited experimental data, indicate that the factor to correct for absorption by light aircraft is typically about 1.25 if the detector unit of the instrument is placed on the floor of the passenger compartment. This aircraft absorption factor is not included in the HCF curve (Attachment 1). The factor for correcting aerial readings to surface dose rates is obtained by multiplying the theoretical HCF by the aircraft absorption factor.

Definition of Contamination Pattern

2.5 A radiation measurement is made at a known height and over a defined point, but correction for height and shielding effects does not necessarily give the "surface" exposure rate (3 feet above the surface) at the point of interest. The nature of the terrain affects the intensities at both the surface and higher levels, and fallout is deposited irregularly. The radiation measured by the instrument in the aircraft comes from contamination over a large area. However, the major portion of it comes from a limited area. The contributing area is greater for increased height of the aircraft above ground. Illustration 2.5 indicates that when flying at a low height—for example 200 feet—the response of the instrument indicates the degree of contamination of a relatively small area. When flying at a greater height—for example 600 feet—the indication is representative of a much larger area. Consequently, monitoring at a lower height will provide more detailed information than would be true when monitoring from a greater height above the terrain.

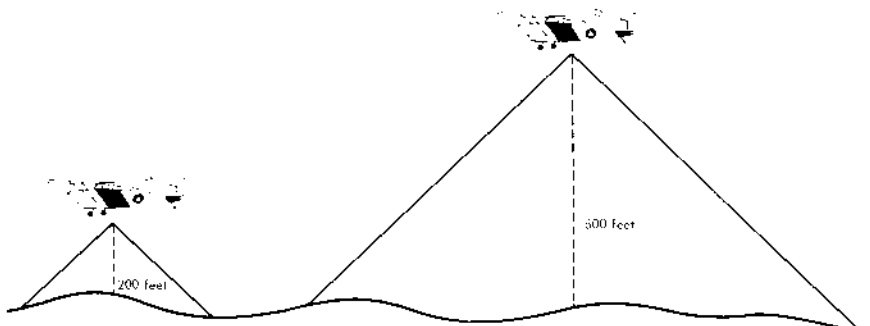


ILLUSTRATION 2.5—Aerial monitoring—effects of height. At low heights the instrument "sees" a relatively small area; and at greater heights, a larger area.

Correction Factor Determination—Field

2.6 In a postattack situation, the RADEF Officer could assign surface monitoring personnel to obtain ground dose-rate readings, and an aerial monitoring team to obtain, almost simultaneously, dose rates at selected altitudes¹ for use in computing actual height correction factors (HCF). These data would be used in developing a height-correction curve for the range of heights planned for the survey mission. The surface selected for this purpose should be large and of such nature that fallout would not be readily moved about by wind or water. It is suggested that an open grassy area, at least 400 by 400 feet in size, be selected. Surface readings (at 3-foot heights) should be taken at a minimum of three equally spaced points, each about 100 feet from the center of the chosen area. Alternatively, the pilot could request similar surface dose-rate readings from an FAA airways station, or from an airport serving as a base for aerial radiological survey operation, all of which have fallout monitoring capability. It is reemphasized that there should be several surface readings at widely dispersed points over an extensive smooth grassy area. The average of these readings should be fairly representative of the field affecting the aerial measurements. However, if there is marked variation in the readings (e.g., plus or minus 50% of the average, or more), the validity of the data for this purpose should be questioned, and use of theoretical height correction factors (Attachment 1) would be preferable.

2.7 Correction factors determined at the time of an aerial survey would correct for the effects of height, nonstandard air density due to altitude, shielding by the specific aircraft structure, and variations in the gamma radiation spectrum. Uncertainties could result from irregular fallout deposit, inaccuracies of the aircraft altimeter, inaccuracies of the instruments used for surface survey, and possible error in determining the aircraft position relative to the monitored field. Close agreement of *two* instruments in the surface survey should reduce the probability of error from instrument inaccuracies.

Optimum Survey Height

2.8 As indicated in paragraph 1.5, aerial survey would be employed chiefly to obtain general radiological information concerning broad areas or extensive transportation routes. For these purposes it is desirable to have individual measurements which are representative of fairly large areas, rather than "point" measurements which might be greatly affected by small-scale irregularities of fallout deposit, and not representative of the general situation. Survey at heights above the terrain of 300 to 500 feet will yield adequate definition, will be relatively safe, and will result in radiation intensities within the aircraft which are about 1/5th to 1/9th the surface intensities. For *extensive* survey over very heavily contaminated areas, greater survey heights may be prescribed to avoid high radiation exposures of survey personnel, but this will result in less definition of the boundaries of high contamination areas.

¹The RADEF Officer is responsible for calculating the aircraft altitudes which will result in the desired heights above the ground.

2.9 To obtain relatively fine definition of the fallout situation at and surrounding an important isolated facility or small area, survey at a low altitude (perhaps 200 feet) with measurement at short intervals will be required. Data would be adequate for planning occupancy or decontamination, but surface monitoring would still be required upon occupancy to identify any small but intense radiation hazard area.

Optimum Survey Speed

2.10 Optimum speed is related to the nature of the survey. Very low speed is desirable for a detailed small area survey (paragraph 2.9). Speeds up to the maximum cruising speeds of light aircraft available for this purpose are suitable for broad area surveys of a general nature. The somewhat lower speeds of slow aircraft would be appropriate for a fairly detailed survey of a transportation route. Where feasible, the characteristic of the aircraft should be matched to the mission requirements.

2.11 The characteristics of the radiation survey instruments are related to allowable speed. For example, it takes a CD V-715 instrument up to 9 seconds to indicate 95 percent of a sudden change in the radiation field. At 150 mph an aircraft would travel a little more than one third of a mile during that time interval. This lag in instrument response would not be tolerable if great detail is required. One of the characteristics of the special aerial survey meter is more rapid response to changes in radiation rates.

Data Requirements

2.12 The purpose of the survey should dictate the quantity and nature of the data gathered. If an aerial radiological survey is accomplished in conjunction with early damage assessment of an exploratory nature, and with little preflight direction, a running account is required describing locations, point by point, and associated radiation monitoring; extent of blast and fire damage; and the extent of fires still burning. These data would be voluminous and difficult to record in written form while in flight. The use of a tape recorder would permit a far more comprehensive record. Where a survey is over a prescribed area and is to serve a specific purpose, the minimum data requirements should be determined by the authority requiring the data. To avoid confusion, and to conserve communications time and the time and effort for processing data, the survey team should record the specified data in prescribed format, if feasible. Additional recorded information should be limited to observation of situations or happenings likely to have significant value in survival or recovery operations.

Aircraft Contamination

2.13 Even in areas experiencing considerable fallout, it is unlikely that aircraft in hangars or under covers will be significantly contaminated. It should be feasible to use them for aerial monitoring. As an aircraft is taxied into position for takeoff, the wheels may pick up some fallout particles. However,

experience at weapons tests indicates that, in general, the amount of fallout adhering to tires is small and can be ignored.

2.14 If the only aircraft available are ones which have been unprotected during fallout, the extent of contamination might be high enough to interfere seriously with their use for aerial survey. Where aircraft have been dry during the deposit of fallout, it can be expected that even gentle breezes would dislodge most particles from clean surfaces, and increased air speed in taxiing, takeoff, and flight would dislodge remaining loose particles. However, if surfaces were greasy or wet from rain or dew, a significant amount might adhere. The resultant gamma radiation dose rate in the fuselage is not expected to be high enough to be dangerous to personnel, but it could be high enough to interfere with aerial radiological survey.

2.15 The extent of the aircraft radiation background can be readily evaluated, provided necessary flight authorization can be obtained. If an extensive body of water is available (lake, bay, broad river), perhaps a mile or more across, a measurement in excess of 0.01 R/hr at a few hundred feet above the water and about half a mile from the nearest shore would be almost entirely due to aircraft background radiation. (This assumes measurement after there has been time for fallout particles to sink well below the surface). Alternatively, the aircraft might be flown to increasingly high altitudes over a given land area until there was no longer material decrease in the survey meter reading. The continuing radiation reading would be the background due to aircraft contamination.

2.16 If the background reading is no greater than the lowest significant reading expected in the survey, it can be used as a correction to be subtracted from each reading. If background levels are too high to permit use of the aircraft for aerial survey, or if flight restrictions prevent the above evaluative procedures, the aircraft might be monitored, and decontamination attempted.

2.17 Detection of aircraft contamination is accomplished with a beta-discriminating instrument. Since the range of the beta particles in air would not exceed about 10 feet, monitoring for the source of beta radiation would locate major areas of contamination responsible for the gamma radiation background. If a smooth paved area a little larger than the aircraft were thoroughly washed, or brushed, interfering beta and gamma radiation would be reduced. Then, if the aircraft were spotted centrally in the area, beta indications of contamination could be determined with the CD V-720 or a modified CD V-700 with a high-range tube. Quick scanning (monitoring) of a given area of the aircraft surface with the beta shield closed to determine the general gamma radiation levels, followed by monitoring at a distance of 4 to 6 inches with the beta shield open should readily delineate contaminated areas. Marked increase of the beta plus gamma reading, over the initial gamma measurement, indicates surface contamination.

2.18 For outer surfaces of the aircraft, flushing with water, scrubbing greasy areas with soap or detergent and water, or wiping greasy areas with a cloth dampened with an organic solvent such as kerosene could be expected to ma-

terially reduce the contamination. If significant amounts of fallout have penetrated inside engine housings or other openings, decontamination procedures are more difficult, and simple procedures may be less effective. If available, steam-cleaning might reduce the contamination. The effectiveness of such procedures could be evaluated as outlined in paragraph 2.15.

2.19 Contamination of the aircraft with airborne fallout could occur while a survey mission is being performed. Low concentrations of air-borne fallout are difficult to detect but over a period of time in flight may be "collected" in significant amounts—chiefly in air ducts, engine cooling systems, and on engine surfaces. This slow buildup of contamination is difficult to detect or remove. While in flight it can be suspected if there is less variation in readings with change of height than would be expected; that is, when the altitude of the terrain varies abruptly or when there is relatively rapid change in altitude of the aircraft. A *gradual* increase of the dose rate would also be reason to suspect this.

2.20 If contamination with airborne fallout is suspected, evaluation of any resultant background might be accomplished as indicated in paragraph 2.15. If significant contamination is indicated, the advice of the responsible Radef officer should be requested when communications capability will permit. The degree of contamination might warrant discontinuing the mission. However, if the buildup has not been rapid, and if the aircraft background does not significantly exceed the lowest expected readings from fallout on the terrain, the survey might be continued. A record of contamination evaluation and results is an essential addition to the survey record.

III. SURVEY TECHNIQUES

3.1 For several purposes, radiological data which would otherwise be unobtainable or require prohibitive amounts of time and radiation exposures to monitors can be obtained through aerial survey. (See par. 1.5.) The nature of the data needed to satisfy the several types of requirements varies. In turn, several types of aerial survey or combinations of survey techniques are available, each having particular advantages or disadvantages for accomplishing a given purpose under various circumstances. For convenience, aerial survey is discussed under the subheadings (a) Course Leg Technique, (b) Route Technique, and (c) Point Technique. Visual Flight Rules (VFR) are followed in the execution of all these techniques. The application of these techniques to survey missions of varied nature is described in Section IV, Survey Operations. Basic elements of the techniques are outlined below.

Course Leg Technique

3.2 This technique is applicable to systematic survey of large areas. Radiation exposure rates are measured at prescribed intervals along a straight line between two selected points. These "legs" are usually laid out in a zigzag pattern.

3.3 In preparation for a "Course Leg Technique" mission, a number of readily identifiable checkpoints are selected in the area of concern and designated by sequence lettering. The points are connected by lines which are referred to as course legs. The topography of the terrain is examined and the altitude(s) prescribed for flying the entire pattern, or each course leg. In some instances, change in altitude may be specified for even a portion of a course leg. The prescribed altitudes are selected to reflect requirements for clearance of natural terrain and manmade objects, and to satisfy the data requirements of the survey.

3.4 The application of this technique is illustrated in paragraphs 4.23 and 4.24. Types of maps suitable for aerial survey, and their availability, are discussed in Section V.

Route Technique

3.5 The route technique is generally similar to that for a single leg of the course leg technique. However, there is an increased need for specifying inter-

mediate checkpoints because ground speed is likely to be more variable as direction is changed in following the route. There may be more frequent requirements for change in altitude at specified checkpoints during the survey of the route. The application of this technique is shown in Illustrations 4.24 and 4.26.

3.6 In the route technique, a course is flown between two points along a distinct terrain feature such as a highway, railroad, or powerline, taking dose rate readings at equal intervals, or over specific landmarks. The pilot must fly the route at the designated altitudes, maintaining the most practicable constant ground speed as the monitor records the dose rate at prescribed intervals. Maintaining a constant ground speed is not required if readings are taken over landmarks only.

3.7 There may be a specified requirement for measuring the radiation exposure dose with a dosimeter while in flight over the route. These data could be used in making a rough estimate of expected radiation exposures while traversing the route in surface vehicles. However, this dose-estimating method is scarcely practicable except when ground speed and height above terrain can be maintained at fairly constant values.

3.8 Difficulty may be experienced in maintaining a relatively constant ground speed while monitoring a transportation route under windy or turbulent air conditions, and when significant changes in direction are necessary to follow the route. Unfavorable conditions of this nature may require that dose rate be recorded only at designated points rather than at prescribed intervals.

Point Technique

3.9 In the point technique survey, prescribed point locations in the area of concern are selected, using a monitoring sequence numbering system. These points are usually prominent landmarks or manmade structures easily identified from the air and somewhat evenly dispersed throughout the area to be surveyed. This type survey is appropriate only when good landmarks exist, and for somewhat smaller and more densely populated areas than those for which the course leg technique would be more appropriate. Employment of the point technique can provide fairly detailed radiological information concerning points and small subareas of interest, and also delineate the general radiological situation of the area. The entire survey may be conducted at a specified constant altitude above sea level; or altitudes may be specified for each point, which will result in all radiation measurements being made from approximately the same height above the terrain. Application of this technique is shown in Illustration 4.21.

Exploratory Survey

3.10 In this general or exploratory type survey, sometimes called a "hasty" survey, a combination of the above techniques would be used. The most likely area of employment would be near ground zero in the early postattack period, when (a) radiation dose rates might be high and could vary greatly over short distances, (b) blast damage might be extensive, obliterating many landmarks,

and (c) fire damage might be great and smoke from continuing fires could obscure many landmarks. For such areas, so little might be known that detailed planning of the survey by higher authority would be unrealistic. However, a survey team might be given instructions as to the area for which information was needed and the nature of the data required. The survey team would necessarily have major responsibility for deciding the techniques to be used to acquire these data. Since the conditions encountered might require the application of a number of techniques chosen to fit the particular need, the monitoring team would be expected to use its best judgment in obtaining the most pertinent data. It is evident that a greater degree of skill and understanding of radiological fallout operations is required for this type of mission. The monitor and pilot should understand and be able to apply the basic principles outlined in Section II.

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IV. SURVEY OPERATIONS

Maps

4.1 Maps appropriate to the mission are essential to the most effective survey operations. See Section V, Equipment.

Protective Measures

4.2 Although major responsibilities for planning and directing aerial survey rest at State level (par. 2.2), the members of the survey team and ground support personnel are directly responsible for knowing and observing radiological protective measures. Section III of the basic Handbook for Radiological Monitors, FG-E-5.9, provides guidance for surface operations. These are also directly applicable during preparations for an aerial mission.

4.3 For the performance of an aerial survey, a maximum permissible mission dose will be indicated by the responsible Radef officer. The dosimeters provided are to be worn and checked frequently during flight over fallout areas to assure that the radiation exposure dose up to the time, plus probable exposure for completion of the survey, will not exceed the allowable dose. Also a CD V-715 or CD V-710 is to be carried for measurement of dose rates exceeding the range of the aerial survey instrument. The dose rate indicated by the aerial survey instrument, or by the CD V-715 or CD V-710, can be useful in estimating potential additional exposure. The dose rate (R/hr) times the estimated remaining mission duration (hours) would provide an estimate of the additional exposure if the dose rate remained unchanged. This rough estimate would indicate whether the higher intensity might reasonably be tolerated for the duration of the survey, or evasive action should be employed.

4.4 If necessary, the potential radiation exposure of the survey team can be reduced by increasing the altitude. For example, reference to the Height Correction Factor chart (Attachment 1) indicates an aircraft-to-surface (3 feet above) dose-rate ratio of 1 to 4 at 200 feet above the surface, versus about 1 to 12 when the height of the aircraft is 600 feet. This drop in exposure rate is by a factor of 3. Unplanned or unauthorized changes in altitude complicate the processing of survey data, increase the possibility of error, and reduce the definition of hot spots and small-scale variations. The altitudes should not be changed unless the high dose rate continues for several minutes, indicating possible broad

extent of the high contamination. Changes in altitudes should be clearly noted in the survey record.

Protection of Aircraft

4.5 In a period of marked world tension, special consideration should be given to the hangaring or covering of aircraft likely to be required for aerial survey. It is unlikely that the fallout that would adhere to an aircraft tied down in the open would cause significant emergency hazard to flight personnel. However, as indicated in Section II, a small amount of fallout contamination nearby can cause high enough radiation background to interfere with measurement of radiation from large amounts of fallout far below on the ground. As a minimum, the closing of major openings to cabin and engine(s), and covering engine(s), can help prevent deposit of fallout in locations where it is hard to remove. If it is necessary to use aircraft which have been unprotected in a fallout area, the degree of contamination should be evaluated by application of the principles outlined in paragraphs 2.15 and 2.16. If necessary, simple decontamination procedures might be employed (par. 2.17), followed by reevaluation of the contamination level.

Equipment Mounting

4.6 The major components of the aerial survey equipment are (a) the detector unit, (b) the metering unit, (c) the tape recorder, and (d) the simulator unit, used in training. The "Instruction and Maintenance" manuals supplied with the instruments include sections on mounting and operation. Only one set of mounting brackets is furnished with each aerial survey meter. The suggested mounting arrangements are not suitable for some aircraft. Further, there can be little assurance that a specific aircraft would always be available at a given airport. Therefore, simple and versatile mounting equipment and procedures must be available to provide needed flexibility.

4.7 Each locality can fabricate a mounting device best adapted to the particular aircraft being used. Illustrations 4.7A and 4.7B show the metering unit mounted on a lapboard and attached to aluminum straps bent to support the unit on a seat back. Other locally fabricated devices or methods can be devised to provide suitable mounting. These include use of woven nylon cord, tape, brackets with suction cups, etc., so long as the meters are not viewed at an angle, resulting in erroneous readings.

4.8 The detector unit can be placed on a 3/8- to 1/2-inch sponge rubber mat on the floor, and secured by the monitor's feet, or attached to seat mountings, floor rings, etc., by cord or tape. In positioning the unit, avoid shielding from below by massive structural members of the aircraft, gasoline tanks, etc.

4.9 The aerial survey meter can be operated for many hours on low-cost, self-contained batteries; or with installation of a special connector in a 12-volt aircraft electrical system, power may be obtained from that source. Alternatively, an adapter could be used for connecting into a cigarette lighter receptacle. Connection of aircraft power permits use of optional indicator lights, but

dependence upon it decreases options in aircraft utilization. A supply of fresh batteries must be maintained to permit use in any available aircraft.

4.10 Excerpts from the instruction manuals dealing with operational checks and operation of the equipment are included in Section V. This provides ready availability of operational instructions to all aerial monitors.

The Survey Briefing

4.11 The planning, direction, and execution of survey missions are complex and interrelated. For example, the type of aircraft available, its cruising speed, and its useful range will affect the prescribed time interval between readings along a route, and the extent of the survey mission. Where several aircraft are available, the one best suited for the mission should be specified— or if only one type aircraft is available, the survey plans should be adapted to its capabilities. Further, if the pilot and monitor are made aware of the specific objectives of the survey mission, they will be in a better position to achieve those objectives even when some variation from the survey plans is dictated by field or flight conditions.

4.12 Ideally the presurvey briefing would be a face-to-face conference between the mission planner and potential survey team. Distance or potential radiation exposures, however, may require use of telephone or radio communication. In some instances, there may even be need for written request and instructions for the mission. The pilot and monitor should analyze the survey requirement and review the step-by-step flight course and monitoring procedures. If there appears to be any question or conflict in the information or instructions presented by the Emergency Operating Center (EOC) Officer, these should be resolved before commencing the mission. The pilot makes all appropriate flight arrangements.

Survey Data Sheet

4.13 A sample Aerial Radiological Survey Data Sheet is included as Attachment 2. It is designed for use both at the EOC and in performance of the mission. Items in the heading are to be supplied by the Radef Officer who plans the mission, subject to revision or completion in the survey briefing. Data for the first two columns are also supplied by the planning officer for most kinds of missions. The next three columns are for in-flight recording of observed data, and the last four are for use at the EOC for reduction of aerial observations to corresponding ground exposure rates. When several sheets are required for a single mission, the heading (items a-f incl.) will be filled out on the first sheet only.

4.14 The data sheet serves as a checklist of essential information items both for the planner and the survey team. An additional checklist of equipment and operational actions appears on the reverse side of the data sheet. The use of the single form also assures that information is assembled in the same format, both at the EOC and by the monitor. This will facilitate the orderly transmission of instructions to the survey team, and reports of survey data to the EOC.

ILLUSTRATION 4.7A
METERING UNIT MOUNTED ON LAP BOARD

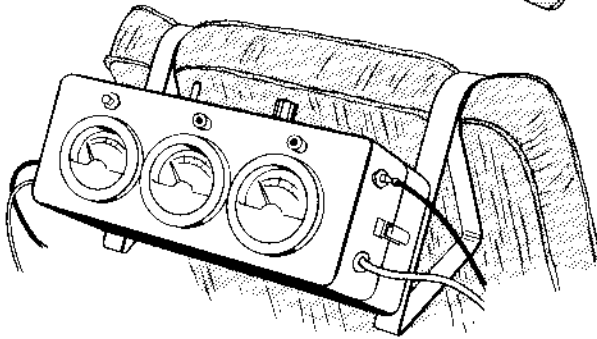
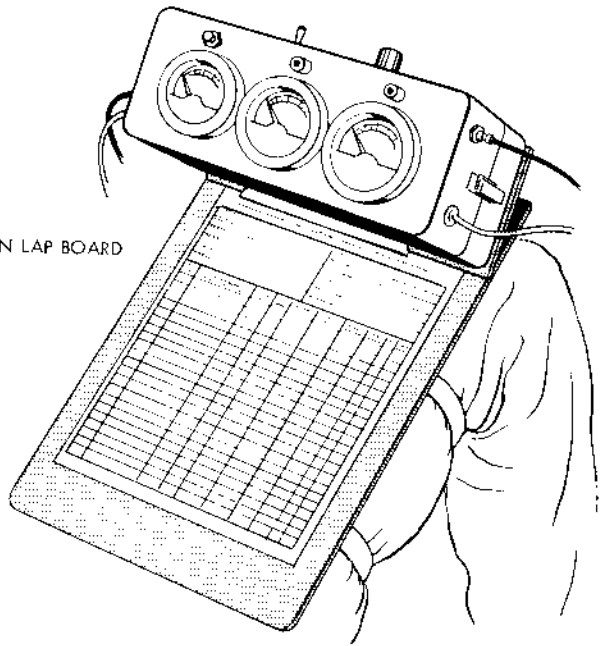


ILLUSTRATION 4.7B METERING UNIT MOUNTED ON BACK OF SEAT
(TWO PLACE INLINE AIRCRAFT)

Recording and Reporting Data

4.15 Data may be recorded directly on the data sheet as suggested above or on tape. Operation of the tape recorder is described in Section V. A monitor expecting to record survey data on a recorder should practice its use until he has a high degree of proficiency, and complete confidence that the reproduction of recorded data can be readily understood. If the remote-control switch is to be used, the recorder and remote switch should be assembled before positioning in the aircraft, and a brief test recording should be made while observing the "RECORD" level in the VU meter. Changes in the VU meter response with the volume of sound indicate that the recorder is adjusted to "RECORD" rather than "PLAY." All on-off control of the recorder should then be with the remote-control switch until the conclusion of the mission or the tape on

the supply reel is used up. When a tape recorder is used, information called for in the heading of the data sheet is to be recorded before monitoring operations are begun. This will assure that pertinent data concerning the mission are directly associated with the observed data.

4.16 For most missions it is likely that the requirement for data will not be sufficiently urgent to require data reporting by radio as measurements are made. When data are reported by telephone or in writing through a communications center, the report must be kept as brief as is consistent with clarity. The mission number and dose received (Item i of the heading) will be stated in the body of the message. To the extent feasible, each entry in the column will be keyed to the point number. Place names or other lengthy location identification will be used only when essential for clarity. Only the essential altimeter and time readings will be reported. The examples beginning with paragraph 4.18, and accompanying illustrations, clarify the flexible requirements for readings and the times at which radiation measurements were made.

Air-Drop Report

4.17 In some instances it may be expedient to air-drop the survey report to an EOC which has served as the local intermediary between the State Radef service and the survey team. That could be advantageous in bypassing a potentially overloaded communications link. If such procedure is intended, there should be preflight preparation for the airdrops. The receiving EOC should be expecting the drops. If aircraft-to-ground-to-EOC communications links are feasible, the EOC should be alerted a short time before the anticipated drop, particularly if radiation would make a continuing "air-watch" at the EOC hazardous. The dropped package should be conspicuously addressed. If a taped record is to be air-dropped, there should be assurance that the EOC possesses capability for play-back at the tape-speed used in recording.

Survey Examples

4.18 The general procedures to be followed in performance of an aerial survey have been presented above in paragraphs 4.11 through 4.17. The examples below illustrate the application of the several techniques described in Section III and should serve as guides in the preparation of SOP's and the execution of survey missions.

4.19 *Pre-Flight preparations.*—Generally applicable for all survey techniques. It is assumed that the following steps have been taken: Availability of suitable aircraft determined; verification of flight clearance received from the appropriate air route traffic control center (ARTC); and required communications capabilities checked.

- a. Participate in survey briefing (par. 4.9).
- b. Prepare survey mission data sheets (par. 4.11).
- c. Prepare appropriate maps (par. 5.1 and Illustrations 4.21 and 4.24).
- d. Check the list of equipment (reverse side of data sheet).
- e. Perform instrument operational checks (Sec. V).

- f. Zero dosimeters and position on survey team personnel.
- g. Check tape recorder. (If scheduled for use, record the preliminary information from the survey data sheet, par. 4.13).
- h. Position equipment in aircraft (par. 4.6).
- i. Set altimeter. Set the latest barometric data in the Kollsman window of the altimeter and correct for nonstandard surface pressure. Note: the validity of aerial radiological survey data is directly related to the accuracy of altitude determinations.
- j. Proceed with survey.

4.20 *Point Technique*.—This survey technique is described in general terms in paragraph 3.7. Illustration 4.20 is an "exploded" view of a survey data sheet

DEPARTMENT OF THE ARMY OFFICE OF THE SECRETARY OF THE ARMY OFFICE OF CIVIL DEFENSE		SECTION NUMBER S-5
AERIAL RADIOLOGICAL SURVEY DATA SHEET		DATE January 18, 1966
1. RECEIVED BY State of Virginia EOC	4. SURVEY POINT LOCATION AND SPACING Geological Survey Falls Church 1.24, 0.00	Completed during briefing by RADEF Officer (Excerpt Item #1)
2. REPORT TO Alexandria Va. Radef Officer	5. TIME OF DAY OF USE 15 R	
3. CONTINUED BY	6. WIND DIRECTION RECEIVED 8 R	
7. NAME OF ORGANIZATION Maj. AN Able, Dulles Camp Sq Sterling (CAP)	8. CORRECTIVE CORRECTION FACTOR 1.2	
9. OPERATOR'S NAME AND GRADE Capt Ben Rodgers	10. INSTRUMENT USED CD V-781 Model 1	
11. AIRCRAFT TYPE Biper PA18 NZ418 A	12. CHANGE OF ALTITUDE OR SOUP' TIME INTERVAL NR	

READ- ING OR POINT NO	LOCATION OR OTHER IDENTIFICATION	DESIGNATED ALTITUDE ABOVE SEA LEVEL (ft)	ALT. METER READING	INSTR.- MENT READING H. R.	TIME OF READING (if required)	ELEVATION OF GROUND ABOVE SEA LEVEL (ft)	HEIGHT OF READING ABOVE GROUND (ft)	HEIGHT OF CF	GROUND EXPO- SURE RATE
1	Chain Bldg + Garget Falls Rd	615	"	7.0	10:10 am	367	250	5	35
2	On Chain Bldg Rd	595	"	5.0		345	"	"	25
3	Tysons Corner Chain Bldg +	735	"	4.2		483	"	"	21
4	Courty House Rds w/inter	725	"	5.3		476	"	"	26.5
5	Woodford Rds	720	"	4.7		469	"	"	23.5
6	Freedom Hill Sch	730	"	7.5		485	"	"	37.5
7	Leesburg Loring Rd	725	"	6.5		476	"	"	32.5
8	Pinnit Hill Sch Sewage Disposal Pl	745	"	7.2		496	"	"	36
9	E Pinnit Dr	550	"	5.4		300	"	"	27
10	Leman Rd Sch Water Pt. N Leesburg	615	"	5.6		365	"	"	28
11	Pk + Pinnit Dr Water Pt. va. m.	650	"	6.0		400	"	"	30
12	N Leesburg Pk Loring Rd. N	645	"	5.8		495	"	"	29
13	Shreve Ln Woodford Rd	735	"	6.7		483	"	"	33.5
14	Electric Ave	700	"	7.0		449	"	"	35
15	R.R. + Shreve Ln	670	"	5.4		417	"	"	27
16	Duan Loring Sch	720	"	6.8		467	"	"	34
17	Irwin Manor Ch	720	"	7.2		472	"	"	36
18	George Mason Sch (End of Survey)	660	"	7.0	11:25 am	410	"	"	35
19	Map attached								

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Section - 1 Section - 2 Section - 3
Provided by RADEF Chief Recorded in Flight Data processed by EOC RADEF Staff

ILLUSTRATION 4.20—Point Technique Survey—Example Data Sheet
(Prescribed altitudes to result in readings at 250' above designated locations)

for an example point-technique survey. The information in the heading is completed jointly by the Radef Officer and the survey team during the briefing. The data in Section 1 is provided by the Radef Officer, with the altitudes prescribed resulting in all readings being taken 250 feet above the designated locations. Section 2 represents the in-flight survey record. Section 3 represents the results of computation at the FOC on the basis of reported data.

4.21 *Map Preparation.*—The prescribed survey point locations are indicated on a suitable map by the column 1 survey sequence point numbers as shown in Illustration 4.21. A map scale of 1:24000 was selected for this example because the objective was to provide detail concerning the more densely populated portions of a small area.

AERIAL SURVEY EXAMPLE: POINT TECHNIQUE

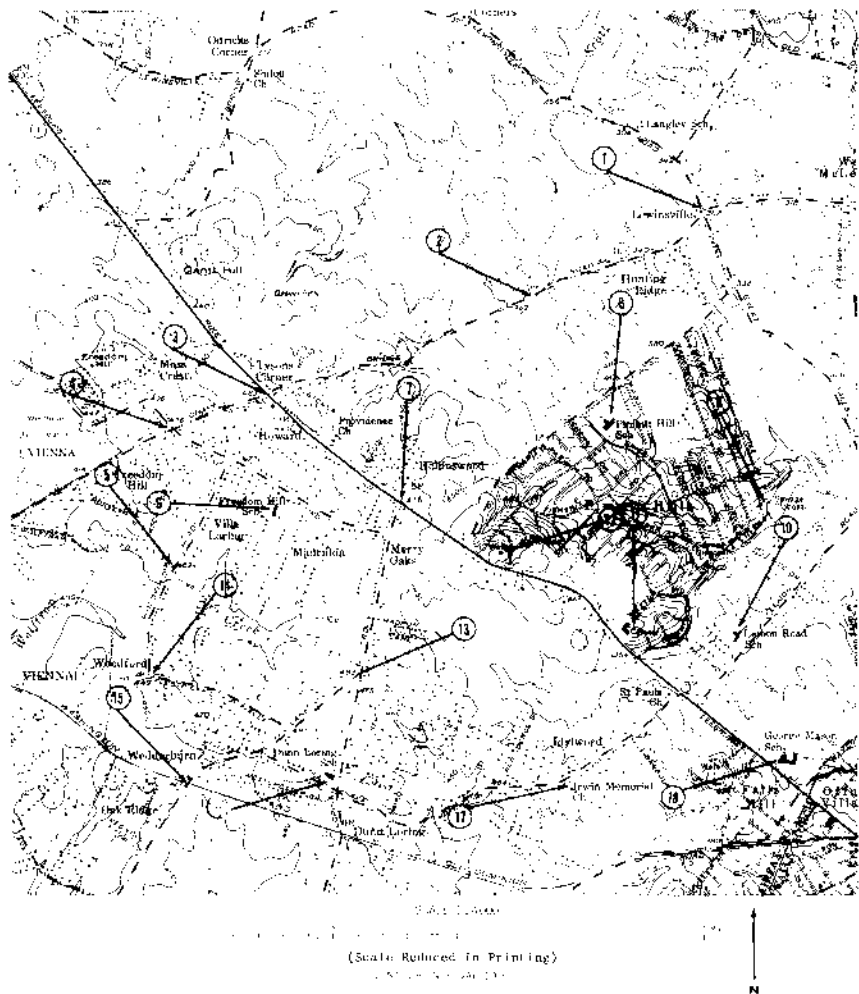


ILLUSTRATION 4.21—Point Technique—Prepared Map

4.22 *In-Flight Operations*.—The following procedure is used to conduct the example point survey, as illustrated:

- a. The pilot locates point No. 1 which is at the intersection of Chain Bridge and Great Falls Roads and heads the aircraft over the point at the prescribed altitude of 615 feet.
- b. Just prior to reaching the point, the pilot alerts the monitor; and when directly over the point, signals "Record." He follows with the altimeter reading if it varies from the prescribed altitude.
- c. At the signal "Record," the monitor records the observed dose rate of 7.0 under the column "Instrument Reading, R/hr.," and if required by b., above, the altimeter reading.
- d. The monitor records the time, 10:10 a.m., under the heading "Time of Reading."
- e. The above procedure is continued until all points have been monitored.
- f. For the last point in this example, No. 18, George Mason School, the time is again recorded.

Note: Intermediate time readings are not recorded. By the time most aerial surveys would be feasible, radioactive decay would be insignificant over this short time span.

- g. Upon completion of the mission, personal dosimeters are read and the radiation exposure recorded under Item i.
- h. Reporting requirements were discussed in paragraph 4.14.

4.23 *Course Leg Technique*.—The general nature and applications of this technique are discussed in paragraphs 3.2 through 3.4. The basic principles for determining and recording data on the survey data sheet are the same as for the point technique, but the nature of some data is different. In the example, Illustration 4.23, the prescribed time interval of 30 seconds between radiation measurements was selected to provide data at approximately 1½-mile intervals at the cruising speed of a Cessna 180. The Radef Officer supplies the description of the course legs to be flown; including the landmarks which identify the beginning and end of each course leg, the letters by which they are to be identified, specified intermediate checkpoints, and the prescribed constant altitude for each leg. A separate data sheet is used for each course leg. In the heading of the additional sheets, only the mission number is repeated.

4.24 *Map Preparation*.—The prescribed course legs are laid out on a suitable map and lettered in the prescribed sequence, as shown in Illustration 4.24. The true north azimuth for each course leg is measured and the magnetic declination (7° in this example) is applied to obtain the magnetic azimuth, which is marked on each course leg for course leg navigation.

4.25 *In-Flight Operations*.—The following procedure is used to conduct the course leg survey illustrated in paragraphs 4.23 and 4.24:

- a. The pilot locates the starting point "A" of the first leg, which is indicated on the map at the intersection of Highways U.S. 1 and U.S. 350, about 12 miles south of Alexandria. At the prescribed altitude of 650 feet, he heads the aircraft on the magnetic azimuth of 299° and visually locates the designated checkpoint, Manassas.

DEPARTMENT OF THE ARMY OFFICE OF THE SECRETARY OF THE ARMY OFFICE OF CIVIL DEFENSE AERIAL RADIOLOGICAL SURVEY DATA SHEET							MISSION NUMBER S-7 DATE January 18, 1966		
1. REQUESTED BY State EOC, Richmond, Virginia				6. MAP IDENTIFICATION AND SCALE Army Map Sv. E. U.S. Wash. 1:250,000					
2. REPORT TO F.V. Evans, Radef. O., Front Royal, Va.				7. ALTITUDE DOSE RECEIVED 20 R					
3. CONTROL LED BY Front Royal EOC				8. AIRCRAFT CORRECTION FACTOR					
4. PILOT'S NAME AND ORGANIZATION Capt. Dan Deat, Front Royal Camp Sp. (CAF)				9. MONITOR'S NAME AND ORGANIZATION Sgt. Al Boyd					
5. AIRCRAFT TYPE AND NO. Cessna 180, N203811				10. RADIO INSTRUMENT USED CDV-781 Model 1					
				11. COURSE LEG OR ROUTE TIME INTERVAL 30 Seconds (Course Leg + Route)					
READING OR POINT NO.	LOCATION OR OTHER IDENTIFICATION	PRESCRIBED ALTITUDE ABOVE SEA LEVEL (ft)	ALTIMETER READING	INSTRUMENT READING R/HR	TIME OF READING (If Required)	ELEVATION OF GROUND ABOVE SEA LEVEL (ft)	HEIGHT OF READING ABOVE GROUND (ft)	HEIGHT OF GROUND	GROUND EXPOSURE RATE
1	A (to B)	650	650	5.0	9:47 a.m.				
2	"	"	"	4.6					
3	"	"	"	3.3					
4	"	"	"	3.0					
5	"	"	"	3.5					
6	"	"	"	3.1					
7	"	"	600	4.2					
8	"	"	650	4.0					
9	"	"	"	3.7					
10	"	"	"	4.0					
11	"	"	"	3.8					
12	"	"	"	3.0					
13	"	"	"	3.1					
14	"	"	"	3.1	9:54 a.m.				
15					A to B + 20 Sec.				
16									
17									
18									
19									
20									

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ILLUSTRATION 4.23—Course Leg Technique

- The pilot flies the aircraft on the proper course to pass over point "A" on a straight path toward Manassas.
- When on course, the pilot alerts the monitor.
- As the aircraft passes directly over point "A," the pilot signals "Record," followed by the altitude reading if it varies from the prescribed altitude.
- At the signal "Record," the monitor records the observed dose rate of 5.0 under the column "Instrument Reading, R/hr.; and if required by d., above, the altitude reading.
- Upon passing over the checkpoint, Manassas, 20 seconds had elapsed since reading "9" was taken. This is indicated on the data sheet by the special notation "+ 20 sec. C.P."

**AERIAL SURVEY
EXAMPLE: COURSE LEG AND ROUTE TECHNIQUES**

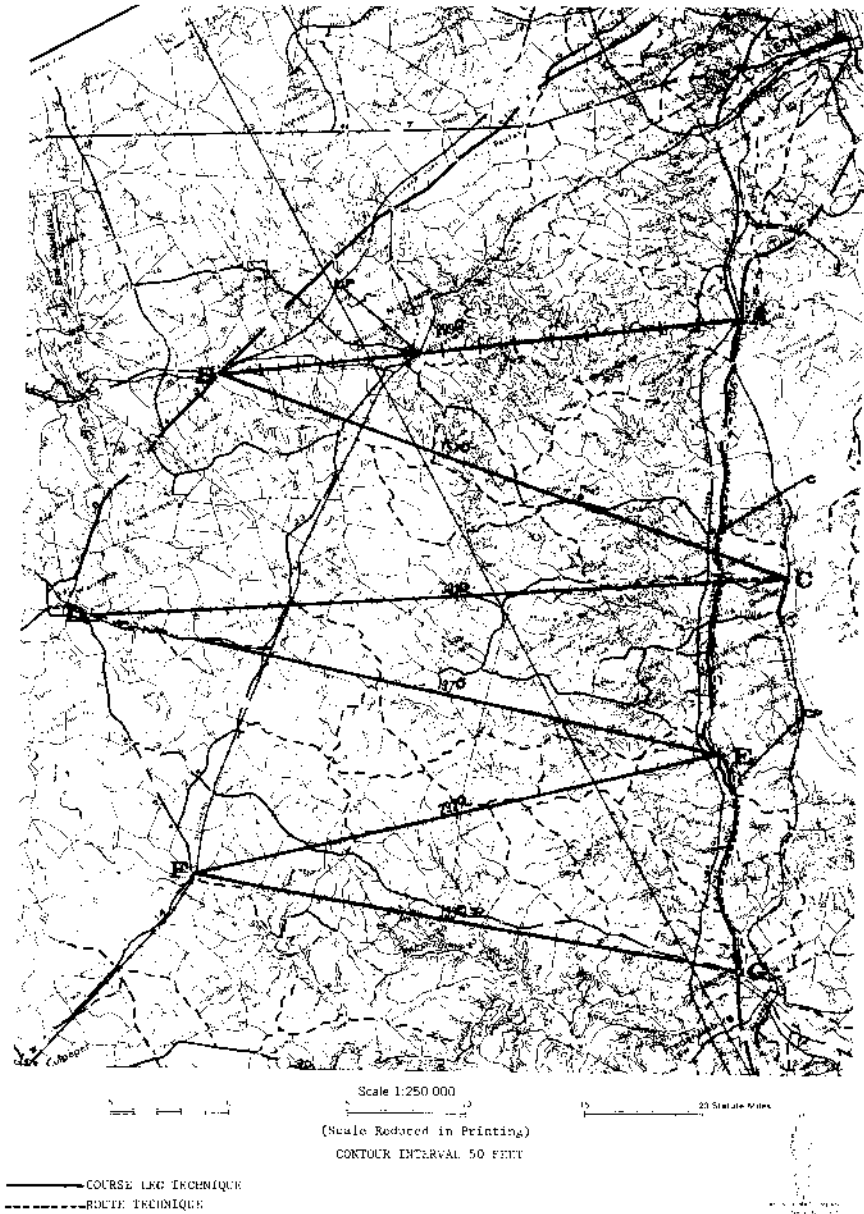


ILLUSTRATION 4.24—Course Leg and Route Techniques

g. On the same heading, the pilot identifies point "B," and the above procedure is continued. Upon signaling "Record" for the last reading prior to crossing over point "B," the pilot indicates to the monitor that they are approaching the end of the course leg.

- h. The monitor records the time of the last reading and indicates the elapse of time since reading "14" was taken.
- i. Similarly, the above procedures are employed in surveying the remaining course legs.

Note: The intermediate marks on course leg A-B are provided to illustrate how these data would be plotted at the EOC. Assuming constant ground speed, the course leg is divided into 13 equal segments, corresponding to the 14 evenly spaced readings. In some instances, minor adjustment may be required when the last time interval is materially less than the standard.

4.26 *Route Technique*.—This technique is similar to that for a single course leg, described above. Illustration 4.24 includes a map layout of an example

DEPARTMENT OF THE ARMY OFFICE OF THE SECRETARY OF THE ARMY OFFICE OF CIVIL DEFENSE AERIAL RADIOLOGICAL SURVEY DATA SHEET						MISSION NUMBER S-7 (Continued) DATE January 18, 1966			
a. REQUESTED BY				b. MAP IDENTIFICATION AND SCALE					
c. REPORT TO				d. AUTHORIZED MISSION CODE					
e. CONTROLLED BY				f. MISSION DOSE RECEIVED					
g. PILOT'S NAME AND ORGANIZATION				i. AIRCRAFT CORRECTION FACTOR 9R					
h. MONITOR'S NAME AND ORGANIZATION				j. WADEF INSTRUMENT USED					
k. AIRCRAFT TYPE AND NO.				l. COURSE LEG OR ROUTE TIME INTERVAL 30 Seconds (Route)					
READING OR POINT NO.	LOCATION OR OTHER IDENTIFICATION	PRESCRIBED ALTITUDE ABOVE SEA LEVEL (ft)	ALTIMETER READING	INSTRUMENT READING R/HR	TIME OF READING (if required)	ELEVATION OF GROUND ABOVE SEA LEVEL (ft)	HEIGHT OF READING ABOVE GROUND (ft)	HEIGHT CF	GROUND EXPOSURE RATE
1	G (to A)	600	600	3.1	11:02 a.m.				
2		"	"	3.4					
3		"	"	3.5					
4		"	"	3.4					
5		"	"	3.6					
6		"	"	3.7	CP #1 +6 Sec				
7		"	"	3.6					
8		"	"	3.7					
9		"	"	3.8					
10		"	"	4.0					
11		"	"	4.2					
12		"	"	4.2					
13		"	"	4.4					
14		"	"	4.1					
15		"	"	4.8					
16		"	"	4.7					
17		"	"	5.1					
18		"	"	5.3	11:20 a.m.				
19		"	"	5.5	CP #2 25 Sec				
20									

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ILLUSTRATION 4.26—Route Survey Technique

route survey. The accompanying Aerial Radiological Survey Data Sheet, Illustration 4.26, is self-explanatory.

4.27 *Exploratory Survey.*---In this kind of aerial survey (par. 3.9), the team may employ any of the above techniques, or a combination of them. Because they will be observing and reporting what they encounter within a generally described area, precise instructions for recording data are impossible. Recording observations on tape will permit the inclusion of much detail which may prove to be important, or unimportant, as the survey progresses. At the conclusion of the survey the team should play back the recording and select and condense the pertinent data for transmission to the requesting EOC.

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V. EQUIPMENT

Maps

5.1 As stated in paragraph 3.1, Visual Flight Rules (VFR) are followed in the execution of aerial radiological surveys. Therefore, it is imperative that topographic maps depicting readily recognized natural and manmade landmarks be employed. The amount of detail to be presented will influence the scale of the map to be used. For the example shown in Illustration 4.21, the scale (reduced for printing) is 1:24000, about 2½ inches per mile, and the contour interval is 10 feet. In Illustration 4.24, the map scale selected is 1:250,000, about 4 miles per inch, and the contour interval is 50 feet. The latter illustration relates to a general survey over a broad area. The illustrated map scales will meet the requirement for most survey missions. However, intermediate scales may be more appropriate for some missions.

5.2 The series illustrated are mapped by the Army Map Service (AMS) and published for civilian use by the U.S. Geological Survey. AMS catalog indexes describing AMS maps are available in each OCD Regional Office and at the OCD Staff College. The AMS indexes should be consulted before ordering maps. Certain maps may be obtained by State and local civil defense organizations for aerial monitoring training and operational use, through the OCD Regions.

The Aerial Survey Meter, CD V-781, Model 1

5.3 The major components of the CD V-781 Aerial Survey Meter are the detector unit, the metering unit, the tape recorder, and the simulator unit (Illustration 5.3). A comprehensive instruction and maintenance manual is supplied with the instrument. For ready availability to all monitors, operational procedures are outlined below:

- a. *Metering Unit*.—Prior to mounting the *metering unit* into the aircraft, the instrument should be checked with the use of the *simulator unit*. The following procedure should be followed:
 - (1) Attach the cable of the *metering unit* to the connector provided on the *simulator unit*.
 - (2) Position the power switch on the *metering unit* to "Battery" power position and allow the instrument a warmup period of at least 2 minutes.

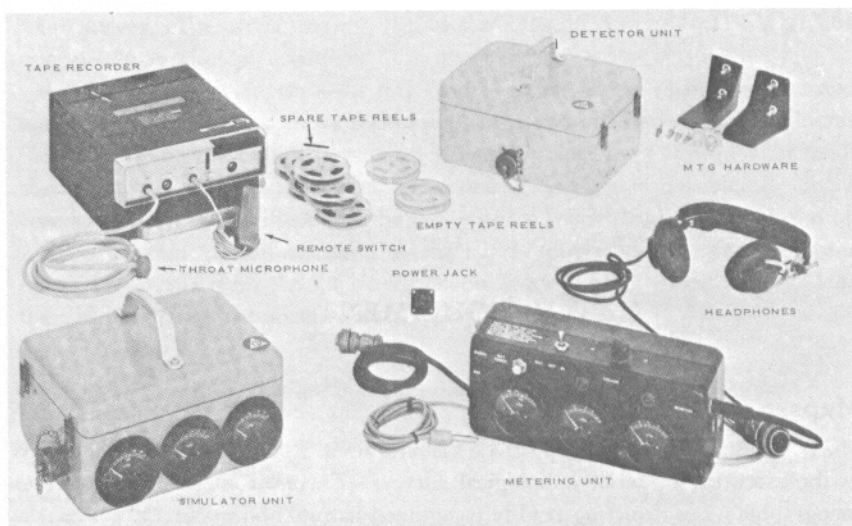
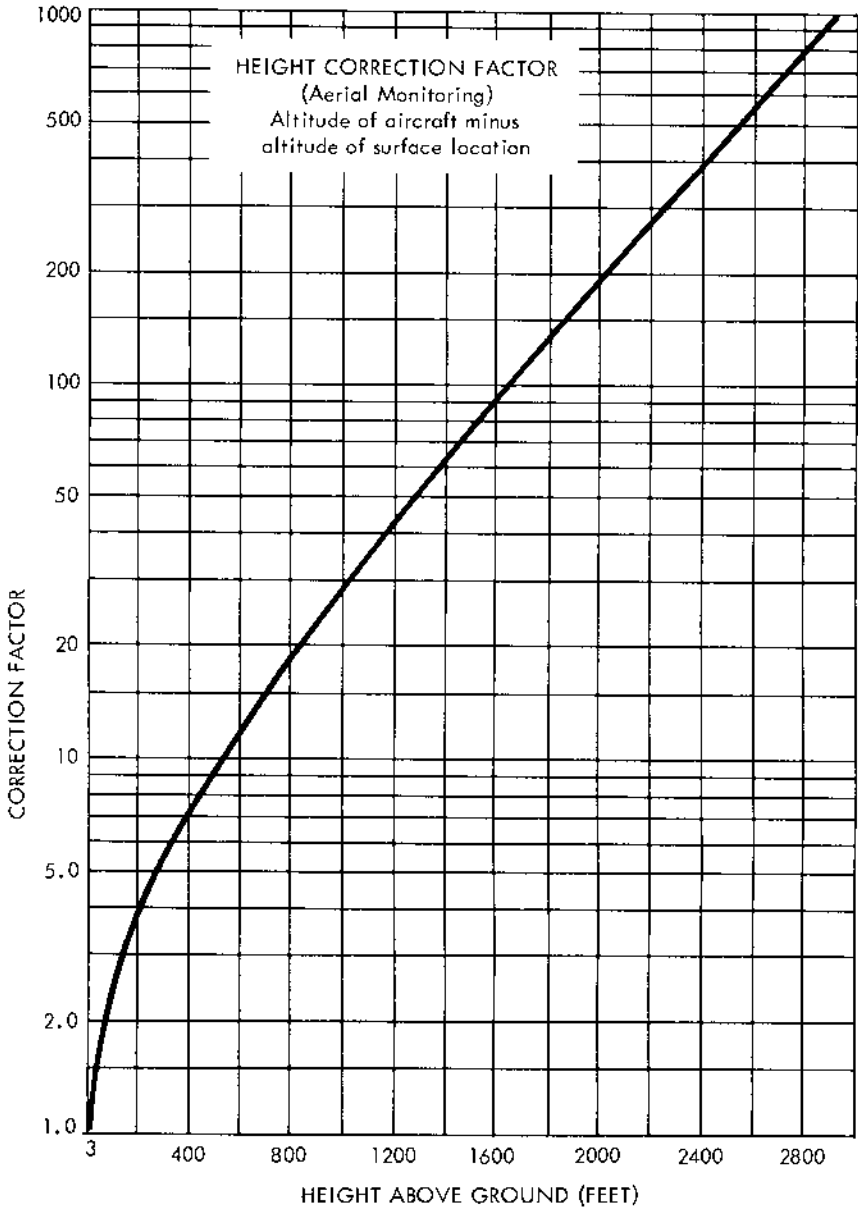


ILLUSTRATION 5.3—Aerial Survey Meter, CD V-781, Model 1

- (3) By rotation of the meter-reading control knob on the *simulator unit*, check each of the three meters at half scale.
 - (4) Starting with the metering control knob in the extreme counter-clockwise position, slowly rotate the knob clockwise. The tracking error between the meters of the *simulator unit* and corresponding meters on the *metering unit* should be no more than 10 percent at any simulated dose rate.
- b. The audio output may be checked by plugging in the headset to the *metering unit*. The audio output should be from 225 to 275 cycles per second (within one or two notes of middle C) for normal radiation background. The audio output can be operated with the *simulator unit*.
- c. After installation of the CD V-781 Aerial Survey Meter into the aircraft, the operational check is performed as follows:
- (1) Instrument Battery Supply
 - (a) Observe meters prior to turning on instrument. Meters should indicate zero within one scale division (the instrument has no zero adjustment).
 - (b) Position the power switch on the *metering unit* to the "Battery" power switch position and allow the instrument a warmup period of at least 2 minutes.
 - (c) Observe the meters after warmup period. Meters should continue to indicate zero within one scale division when only normal background radiation is present. In the event external radiation from fallout prohibits this check, it should be assumed the instrument is operating properly if it indicates radiation levels above normal background.
 - (d) Press the "Battery Check" switch. The 0-0.1 R/hr. meter should read at, or slightly above, the battery check point.



(2) Aircraft Power Supply

- (a) When the aircraft electrical power source is used, position the power switch on the *metering unit* to the "Plane" power position.
- (b) Repeat steps (c) and (d) above.

The Tape Recorder

5.4 The manufacturer's manual supplied with the recorder indicates precautions to be observed and provides detailed instructions for operation. A monitor expecting to use the recorder should practice using it until he is proficient. The recording and playback of preliminary survey information will provide a check of the recorder's operability. Prior to a mission, the "Battery Voltage Indication" should be observed and batteries replaced, if required.

DEPARTMENT OF THE ARMY OFFICE OF THE SECRETARY OF THE ARMY OFFICE OF CIVIL DEFENSE AERIAL RADIOLOGICAL SURVEY DATA SHEET								MISSION NUMBER	
								DATE	
A. REQUESTED BY				B. MAP IDENTIFICATION AND SCALE					
D. REPORT TO				B. AUTHORIZED MISSION DOSE					
C. CONTROLLED BY				F. MISSION DOSE RECEIVED					
G. PILOT'S NAME AND ORGANIZATION				J. AIRCRAFT CORRECTION FACTOR					
E. MONITOR'S NAME AND ORGANIZATION				K. RADEF INSTRUMENT USED					
I. AIRCRAFT TYPE AND NO.				L. COURSE LEG OR ROUTE TIME INTERVAL					
READING OR POINT NO.	LOCATION OR OTHER IDENTIFICATION	PRESCRIBED ALTITUDE ABOVE SEA LEVEL (ft)	ALTIMETER READING	INSTRUMENT READING R HR	TIME OF READING (If Required)	ELEVATION OF GROUND ABOVE SEA LEVEL (ft)	HEIGHT OF READING ABOVE GROUND (ft)	HEIGHT CF	GROUND EXPOSURE RATE
1									
2									
3									
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Front of Aerial Radiological Survey Data Sheet (OCD form 843). (See reverse side of form on following page.)

(OCD Form 843—reverse side)

Equipment for Aerial Monitoring Mission

- CD V-781 aerial survey meter (less simulator unit)
- CD V-715 survey meter
- CD V-138 dosimeter (2 ea.)
- CD V-730 dosimeter (2 ea.)
- CD V-740 dosimeter (2 ea.)

ATTACHMENT 2 (Continued)

Tape recorder

Watch with sweep "second" hand

Aerial Radiological Survey Data Sheet (Containing appropriate presurvey information plus additional sheets)

Maps (appropriate for mission assignment)

Recording tape

Clipboard

Equipment for airdrop

Pencils

Other items as required

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