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ABSTRACT

This guide is a reprint of published and draft materials from the Federal Civil Defense Guide. This guide is intended to assist the student in planning, developing, implementing and operating a local, county, or state radiological defense (RADEF) system. The state and local radiological defense program objectives are to create an effective and operationally ready radiological monitoring, reporting and evaluating system required to provide accurate and timely information on the extent, intensity and duration of radiological fallout hazards that could result from a nuclear attack. The guide contains the following chapters: (1) RADEF fundamentals (knowledge concerning fallout; (2) RADEF plans and organizations; (3) Implementation of RADEF plans including emergency operating center functions; (4) Monitoring and survey procedures; (5) Radiological reporting procedures; (6) Application of meteorological data to RADEF; (7) Instrumentation, maintenance and calibration; (8) Radiological equipment available to states for civil defense purposes; (9) Handbook for radiological monitors; (10) Peacetime radiological incidents; (11) Fallout Directory; and (12) Decontamination and related countermeasures. (LS)

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REVISED MARCH 1967

RADIOLOGICAL DEFENSE

PLANNING AND OPERATIONS GUIDE

THE USER OF THIS GUIDE IS CAUTIONED TO READ THE PREFACE FIRST.

DEPARTMENT OF DEFENSE

OFFICE OF CIVIL DEFENSE

RADIOLOGICAL DEFENSE

PLANNING AND OPERATIONS GUIDE

SM 11.23.2--MARCH 1967
(Supersedes SM 11.23.2 dated June 1966 which may be used)

DEPARTMENT OF DEFENSE - OFFICE OF CIVIL DEFENSE

P R E F A C E

This Guide is a reprint of published and draft materials from the Federal Civil Defense Guide. The Introduction is a reprint of Part E, Chapter 5. Chapters 1 through 11 are reprints of the corresponding appendices to FG-E-5. Chapter 12 is a reprint of Appendix 1 to Part E, Chapter 7. This Guide is intended to assist the student in planning, developing, implementing, and operating a local, county, or State radiological defense system.

The Introduction and Chapters (FG Appendices) 1, 2, 5, 6, 9, 10, 11 and 12 have been published and are OCD policy. Chapters (FG Appendices) 3, 4, 7, 8, and the Annexes to each Chapter are reprints of draft materials which have been prepared for internal staffing and clearance by OCD. These Chapters may NOT necessarily reflect the final OCD policy in these areas. As the draft Appendices of the Federal Civil Defense Guide are finalized and published, they should be substituted for the corresponding chapters in this Guide.

In order to conserve space, the format used in this Guide varies slightly from that in the Federal Civil Defense Guide. Minor additions and deletions have been made. The material is the most valid available as of March 1, 1967. Updating will be done through instruction, and through the regular Federal Guide distribution channels as new appendices are published.

CONTENTS

I N T R O D U C T I O N

The State and local radiological defense program objectives are to create an effective and operationally ready radiological monitoring, reporting and evaluating system required to provide accurate and timely information on the extent, intensity and duration of radiological fallout hazards that could result from a nuclear attack.

PROBABLE POSTATTACK FALLOUT CONDITIONS

In the event of a nuclear attack on the United States, fallout radiation in varying degrees will be present in many areas of the country. The extent and intensity of the fallout contamination will depend upon the total weight and distribution of the attack; the design of the weapons; the wind and weather; the type of soil and the topography. Under various wind and attack situations, any area of the country could experience a serious fallout situation.

For example, after a rather heavy attack upon counterforce, industrial and population objectives, survivors might require fallout shelter for periods up to 2 days in about 25 percent of the Nation's area. Shelter occupancy for periods of 2 days to 2 weeks might be required in 50 percent of the Nation's area and, in the remaining 25 percent of the national area, 2 weeks of shelter occupancy followed by the application of additional countermeasures such as remedial movement of the populace or extensive decontamination could be required.

Protection of the people, early recovery of vital facilities, and recovery and rehabilitation can be accomplished only through an organized capability of detecting, monitoring, reporting and analysis of the fallout situation at each affected locality. Radiation measuring and detection instruments in the hands of trained personnel are the only means of gaining reasonably accurate information of the fallout radiation level at a given time at a geographic location since the levels of radiation will vary geographically, even in small areas. Therefore, an organized capability of detecting, measuring and reporting levels of fallout radiation is needed to furnish information to authorities at all levels of government as a basis for making decisions affecting:

1. The period of shelter occupancy.
2. Restoration of vital facilities and obtaining needed food, water and supplies at the earliest possible time.
3. Firefighting, law enforcement, and other public service operations.
4. Relocation of people from areas of high radiation intensity.
5. Rescue, first aid, medical, and welfare operations.
6. Decontamination, recovery, and rehabilitation operations.
7. Control of radiation exposures of workers assigned to postshelter tasks in fallout areas.

COMPONENTS OF THE RADIOLOGICAL SYSTEM

Because there is no counterpart for the radiological service in normally operating government services, planning and implementing radiological defense services presents new and complex problems. This Guide will provide a comprehensive discussion of the components of radiological defense plans and system necessary for the protection of life and property under the several degrees of radiological hazard that may exist from area to area and from one time period to another.

Plans and Organizations. The basic civil defense plan developed by each element of government should provide for a radiological service and, in broad terms, indicate its organization and the interrelationships between it and the other services responsible for emergency operations. The detailed radiological plan should be an annex to the basic plan, be in accord with its concepts and provisions and show in greater detail the Radef organization, equipment, training and procedures necessary for effective emergency operations.

Shelter Monitoring. At each public community shelter a monitoring capability is necessary to provide (a) the detailed radiological information needed for shelter operations, and (b) radiation exposure dose records for all shelter occupants as a basis for decision concerning their post-shelter assignment to work in radiation areas.

Monitoring and Reporting System. Radiological information is needed at each level of government as a basis for planning and directing survival rescue and recovery operations. Availability of radiological information is dependent upon a network of appropriately dispersed centers with a monitoring and reporting capability called "monitoring stations." From these stations, monitors will perform (a) on-station monitoring during the period when the radiation hazard is great, and (b) detailed mobile monitoring during the period when radiation rates will permit limited field operations on a controlled risk basis. Aerial monitoring cannot replace the detailed monitoring station functions but can effectively supplement it for monitoring of transportation routes, agricultural lands, etc.

At the conclusion of their primary assignments, shelter monitors can be reassigned in support of the basic monitoring station system. Utilization of radiological information requires that there be suitable communication between monitoring stations and government operating centers.

The monitoring stations must be properly distributed geographically in order to provide representative information from all inhabited and habitable areas of the community.

For cities, the total requirement will be related to the population and associated services, business and industry. However, a single "monitoring station" can serve a larger segment of the populace where the population density is high; e.g., apartment or closely built districts, than where the population is more widely dispersed as is typical of suburban areas, small municipalities and villages. Rural areas should have their own monitoring capability as a basis for the protection of personnel, the care of livestock, land utilization in the subsequent production of food, and for measuring the contamination of individually owned crops, both harvestable and stored. Where the average farm size is large, and the population density low, a monitoring station can adequately serve a larger rural area than where the average farm size is small and the population density higher.

Analysis and Evaluation. To provide an effective basis for decisions concerning civil defense operations, it is essential that there be capability at government operating centers to (a) process the raw radiological data into readily usable form, and (b) provide staff support through interpretation of data, provision of technical guidance, and recommendation of possible courses of action.

Federal Capability. By Executive order, some Federal agencies have been assigned specific radiological defense functions for which they have unique capabilities. It is important that State and local officials be aware of these assignments and the mutual support possible through coordinated plans.

PERSONNEL AND TRAINING

There is a requirement for trained monitors, monitor instructors, Radef Officers, and additional operating center personnel such as plotters, analysts, and recorders.

Each emergency operating center, or control center, should have a Radef Officer and a supporting staff, including plotters and analysts. There should be four monitors for each established monitoring station and an average of four monitors for each public community shelter.

Formal instruction is required at three levels: (a) for Radef Officers who, within the broad provisions of their basic civil defense plans, are responsible for planning, implementing, and direction of the radiological service; (b) monitor instructors, necessary to train the large numbers of monitors required for shelters and monitoring stations, and expected to provide high level postattack operational support for Radef Officers; and (c) for monitors. Inservice training is recommended for operating center radiological support personnel.

INSTRUMENTS

The basic radiological instruments necessary for measuring dose rates (survey meters) and accumulated dosages (dosimeters) are provided by the Federal government to the States and through them to local community shelters and State and local monitoring stations. From time to time additional equipment will become part of the total instrumentation relating to civil defense. Examples are aerial monitoring instruments, training sets, calibrators, etc. To insure operational readiness, a system to control, maintain, repair and calibrate equipment is required with Federal, State, and local participation.

Dosimeters are being provided for use by workers assigned to tasks in fallout radiation areas. These instruments are for measurement of the workers' accumulated radiation exposure doses as a basis for exposure control. Generally, their use will be directed by monitors attached to the services directing the emergency work. Formal training of workers wearing these dosimeters is not required.

RADIOLOGICAL OPERATIONS

Monitoring and Survey. Chapter 9 describes (a) the monitoring techniques for radiological monitoring and survey; (b) protective measures to be observed by monitors; and (c) guidance concerning monitoring and reporting operations required at their level.

Reporting. Details are provided in Chapter 5 for the transmission of fallout information from monitors to operating centers and between operating centers at the same and higher and lower levels of government.

Government Operating Centers. Methods for evaluating the radiological hazard and providing the technical guidance to civil defense directors and their emergency operating services are contained in Chapter 3.

CHAPTER I

RADEF FUNDAMENTALS

The development of an effective radiological service is dependent upon knowledge concerning fallout - what it is, how it is formed and distributed - nuclear radiations, and their effects upon man and his possessions. The objectives of this chapter are to present in abbreviated form the basic information needed for an understanding of the radiological hazards associated with nuclear war, and to present an overview of nationwide Radef requirements.

FORMATION AND SPREAD OF FALLOUT

Formation of Crater. When a nuclear weapon is detonated at or near the surface of the earth, the removal of material from the earth, due to the blast effect and the vaporization of dirt and other materials due to the heat effect, result in the formation of a crater. The dimensions of the crater will vary with the yield of weapons, height of burst, and the type of soil. However, the crater may be about a half mile across and about 600 feet deep at its center for the surface burst of a 10 megaton weapon. In addition, the mound of material forming the lip of the crater may extend another one-fourth mile all around.

Formation of Fallout Particles. With a multimegaton size detonation, thousands of tons of the crater material are pulverized and/or vaporized. Because of the tremendous heat-induced convective action, the pulverized and gaseous materials from the crater are drawn into the ascending nuclear cloud. The earth particles are mixed with the radioactive materials formed by the fission process in the weapon's detonation. Upon recondensation, many of the earth particles merge with the radioactive fission fragments, becoming contaminated. Neutron capture may make other materials radioactive, such as earth, bomb casing, and the part of the atmosphere in the immediate vicinity of the point of detonation. Much of the induced radioactive material will also be drawn into the ascending nuclear cloud, adding to the radioactivity resulting from the fission process.

Spread of Fallout Particles. The particles continue to rise in the atmosphere until the mushroom cloud reaches stabilization - about 10 minutes after detonation for a megaton weapon. The smaller particles may be lifted 15 to 20 miles above the earth's surface. While the cloud is rising and as it reaches stabilization, these particles begin to settle slowly under the influence of gravity, and they are scattered by the winds as they fall gradually back to the surface of the earth. The heavier particles begin to settle back to the earth in about 30 minutes, landing around and downwind of ground zero. The less heavy particles land a little farther downwind, and the lighter ones a greater distance.

The fallout particles, with which most of the radioactivity is associated, are quite small - generally about one-half to one-tenth the size of an average grain of salt or sugar. However, because of their abundance, these particles may be visible as they settle through the air, or as they accumulate on the ground and other surfaces in the zones of heavier fallout.

The net result is a pattern of fallout particles along the surface of the earth. Not all of these particles are radioactive or contaminated. However, with a multimegaton burst and average wind conditions, there is sufficient radioactivity to cause an irregular pattern of lethal levels of radiation extending from about 3 to 4 miles upwind to 200 or more miles downwind of ground zero. The amount of close-in radioactivity and the extent of its spread will depend upon many things such as the total yield and design of the weapon, the type of soil over which it is detonated, the prevailing wind and weather, and the topography. The lethal pattern, oriented generally in the downwind direction, will vary with the wind shear, and the pattern may have numerous hotspots.

Worldwide Fallout. In addition to the early or close-in fallout, about 10 to 25 percent of the total radioactivity formed by a surface nuclear detonation is associated with extremely fine particles that are injected and suspended in the stratosphere. The portion of the fallout that remains in the stratosphere for periods of months to possibly a year or longer will be deposited in the hemisphere in which the weapon is detonated. For this reason, the worldwide fallout is widely dispersed and the amount of radioactivity deposited in a specific area is extremely small, usually measured in terms of micro-microcuries per unit measure of sample. Worldwide fallout remains in the stratosphere for protracted periods and most short-lived isotopes, normally associated with nuclear fallout, decay to negligible levels while still airborne. Strontium 90 and cesium 137, which have half lives of approximately 30 years, persist to become a long term hazard.

The possible hazard of fallout from weapons tests does not constitute a significant external hazard to the people of the United States, but may constitute an internal one resulting from the ingestion of radioactive isotopes that may become a part of our food supply. Therefore, the long term hazard is not one requiring shelter protection. Rather, it is a type of hazard that conceivably may result in recommendations of selected food items in relatively small areas. The Public Health Service has the responsibility for evaluating the health hazards in the United States that are associated with fallout from weapons testing.

In cooperation with State health agencies, the Public Health Service is operating a network of air, water, milk and food sampling stations and, if a significant hazard develops, the general public will be advised of any countermeasures that should be applied. The Public Health Service determines the amount of specific isotopes in water and milk, while the Food and Drug Administration is responsible for radiochemical analyses in other foods and food products, with the exception of meat and poultry which are the responsibility of the U. S. Department of Agriculture.

EFFECTS OF NUCLEAR RADIATION

Radiation Emitted by Fallout. Each radioactive fallout particle will give off alpha, beta, or gamma radiation, or a combination of these three. Alpha particles have limited penetration power and pose no external hazard. Beta particles from early fallout may cause serious radiation burns on the skin, but this can be prevented by wearing ordinary heavy clothing to keep the major part of the fallout material from coming in direct contact with the skin, or by brushing or washing after exposure to remove the fallout material.

The most damaging form of radiation from fallout during the first two weeks to months after attack is gamma radiation from sources outside the body. Clothing, even special sealed plastic suits, provides no shielding against gamma radiation. Like X-rays, gamma rays penetrate deeply and massive barriers (shelters) are required to absorb the major part of the energy. All forms of nuclear radiation can cause damage to cellular tissue, seriously affecting the cells' capability to perform their specialized functions.

The radioactivity associated with fallout decays quite rapidly during the early postattack period. However, during the first few days and upwards to two weeks after attack, fallout can be an extremely serious threat to survival unless countermeasures such as shelter or remedial evacuation are employed. Radiation, associated with fallout, cannot be detected by any of the senses. It can only be detected by means of monitoring instruments.

Radiological and Medical Considerations. NOTE - The following discussion of the effects of radiation on humans was adapted from recommendations of the National Committee on Radiation Protection and Measurements (NCRP).[1] The NCRP report states, "The recommendations must be regarded as reflecting the committee's best effort to evaluate information presently available; the ideas may be extensively modified as our knowledge increases."

Radiation Injury. The effects of small amounts of radiation can be detected only by statistical methods applied many years after the onset of exposure. It is important to appreciate the distinction between this subtle nonclinical type of injury and acute radiation sickness or damage to skin, which is apparent soon after the beginning of exposure to large amounts of radiation. Radiation injury is termed immediate when manifestations occur within a few months after the onset of overexposure. Late somatic effects occur many months or years after the onset of overexposure and include leukemia, cataracts, cancer, etc. A late effect can develop in a person who has recovered from immediate radiation injury, or in a person who has never been sick in spite of protracted exposure. Radiation sickness or skin damage is described as acute when clinical manifestations occur within a few hours to a few days and do not last longer than 6 months. When symptoms and signs persist beyond 6 months, the condition is chronic.

Genetic injury by radiation can affect survivors capable of procreation who may, or may not, have experienced observable immediate or late effects.

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1 Exposure to Radiation in An Emergency, National Committee on Radiation Protection and Measurements, Report No. 29, issued January 1962. The report is available only from the Section on Nuclear Medicine, Department of Pharmacology, the University of Chicago, Chicago 37, Illinois, price 50 cents per copy.

The genetic injury can become manifested in their decendants by an increased rate of infant mortality and by an increased incidence of hereditary disorders.

Operation Considerations. The principal justification for a civil defense organization is to insure the survival of the people in a nuclear war. Survival, therefore, is paramount, for without it there is no need to be concerned about late somatic and genetic effects of radiation. In the event of a nationwide attack, there may be a tendency to think only of survival and disregard entirely the possibility that late somatic and genetic effects could impair the health of the people. Such an attitude, if allowed to dominate decisionmaking, may be shortsighted, although it should be realized that measures adopted to insure survival with the fewest possible casualties will be the same as measures effective in reducing late effects. Consequently, early command decisions based on survival alone are not likely, in general, to be in serious conflict with more leisurely made judgments in which late effects are carefully considered. When circumstances permit, it is desirable to give preferential consideration to children and adults still capable of procreation, since these are the ones through whom the genetic effects of radiation would have influence on the future population.

Symptoms of Acute Radiation Sickness. The symptoms of acute radiation sickness with increasing radiation exposures over a short period of time are nausea; epilation; moderately severe fever and illness due primarily to secondary and complicating infections because of damage to the blood-forming organs; internal hemorrhaging; damage to the gastrointestinal tract manifested by intractable diarrhea which soon becomes bloody; emaciation; coma; convulsions, and death within a few days after exposure.

Relationship of Radiation Injury to Total Whole-Body Dose of Gamma Radiation. Large brief doses cause serious sickness or death, depending on the size of the dose and on individual susceptibility, except that very large doses are invariably lethal. Frequent small doses can be tolerated over a long period of time. The total amount received in this fashion may be many times greater than the size of the single lethal dose. Combinations of large single doses and repeated small doses have intermediate effects.

Thus, the clinical outcome of any particular radiation dose is significantly affected by the time span during which the exposure occurred. For example, a whole-body dose of 600 roentgen (r) may be lethal when received as a single exposure dose, but protracted over a period of 20 years and delivered in equal daily amounts (that is, less than 0.1 r/day) it may not cause any recognizable clinical effect, although there may be signs that can be demonstrated by sensitive laboratory tests. When a portion of the total 600 r dose - one-half, for example - is received as a brief dose and the remainder is received as a protracted dose at the rate of 1.0 r/week, the following result can be expected. The person will become sick and vomit during, or shortly after, the onset of the brief exposure (the chances are about 9 out of 10). Approximately 3-4 weeks later, he will develop symptoms of moderately severe radiation sickness. The chances are about equal that medical care and, in some cases, hospitalization will be necessary.

In an otherwise healthy adult, the likelihood of death following a brief dose of 300 r is probably less than 1 in 10, and recovery from acute radiation sickness can be expected. Protracted exposure to 1 r/week for six years should not cause any clinical symptoms, although it may be possible to demonstrate some effects of radiation by means of laboratory methods.

Equivalent Residual Dose (ERD). Since a major portion of the injury resulting from exposure to radiation may be repaired, the total dose (r) is not by itself a reliable basis for predicting the clinical outcome. The concept of the equivalent residual dose (ERD) has been developed to permit a more reliable prediction of the biological and medical consequences of exposure to radiation than is possible on the basis of accumulated dose alone. The ERD, expressed in roentgens, is the accumulated dose corrected from the recovery assumed to have occurred at a specific time. The ERD concept assumes that, given an opportunity, the body can repair 90 percent of the total injury. It is further assumed that, starting with the 5th day after exposure, radiation injury is repaired at the rate of 2-1/2 percent per day of the remaining repairable injury. At this rate of recovery, half of the repairable injury would be repaired in about a month. It is presumed that a person's ERD would manifest itself in approximately the same symptoms of radiation injury as would be anticipated following a brief dose of the same size. Chapter 3 provides the details for computing the ERD.

Correlation of ERD to Severity of Acute Radiation Sickness. Five clinical groups of acute radiation sickness can be distinguished on the basis of severity which can be correlated with the size of a short term exposure or with the ERD.

Group I Symptoms. Less than half of this group will vomit within 24 hours after the onset of exposure. There are either no subsequent symptoms or, at most, weakness and easy fatigue. There is a decrease in the blood cell counts. Less than 5 percent will require medical care. All others can perform their customary tasks. Any deaths that occur are caused by complications. Correlated Exposure. Sickness of this type has been seen after brief, whole-body doses of gamma and X-radiation in the range of 50-200 r. An ERD of external gamma radiation of 50-200 r may have a similar effect.

Group II Symptoms. More than half of this group will vomit soon after the onset of exposure and are sick for a few days. This is followed by a period of 1-3 weeks when there are few or no symptoms. During the latent period, typical changes occur in the blood count and can be used for diagnosis. At the end of the latent period, epilation (loss of hair) is seen in more than half, and this is followed by a moderately severe illness due primarily to the damage to the blood-forming organs. Most of the people in this group require medical care and more than half survive. Correlated Exposure. Sickness of this type has been seen after brief, whole-body doses of gamma or X-radiation on the order of 200-450 r. An ERD of external gamma radiation of the same size will probably cause a similar illness.

Group III Symptoms. This is a more serious version of the sickness described as Group II. The initial period of illness is longer, the latent period is shorter, and the main episode of illness is characterized by extensive hemorrhages and complicating infections. People in this group need medical care and hospitalization. Less than half survive. Correlated Exposure. Sickness of this type has been seen after brief whole-body gamma radiation with doses in excess of 450 r.

Group IV Symptoms. This is an accelerated version of the sickness described as Group III. All in this group begin to vomit soon after the onset of exposure, and this continues for several days or until death. Damage to the gastrointestinal tract predominates, manifested by uncontrollable diarrhea, which becomes bloody. Changes in the blood count occur early. Death occurs before the appearance of hemorrhages or epilation. All in this group need care, and it is unlikely that many will survive. Correlated Exposure. Sickness of this type has been seen after brief, whole-body exposure to gamma radiation in excess of 600 r. During protracted exposure to external gamma radiation, it is not probable that an illness of this type would be the first evidence of injury.

Group V Symptoms. This is an extremely severe injury in which damage to the brain and nervous system predominates. Symptoms, signs, and rapid prostration come on almost as soon as the dose has been received. Death occurs within a few hours or a few days. Correlated Exposure. Sickness of this type has been seen after brief, whole-body exposure to gamma rays in excess of several thousand r, and to equivalent doses from neutrons.

Chronic Radiation Sickness. There is almost no information about the effects of protracted external exposure to man. Some radium chemists and radiologists who worked with radiation before the hazards were recognized frequently developed a progressive refractory anemia and died either from the anemia or from complicating infections. Animal experiments provide little additional information concerning the patterns of chronic radiation sickness that may occur in man. At present, we cannot tell the size of the ERD that will be lethal, when exposure is protracted over a period of years.

Radiation Injury to the Skin. Epilation, or loss of hair, is caused by exposure to gamma radiation, beta radiation, a mixture of gamma and beta, or to X-rays. Regardless of the dose, epilation is unusual before the second week after the onset of exposure. Among people exposed only to mixed radiation (gamma rays plus neutrons), epilation is a reliable indicator of the existence of radiation injury. It seldom occurs when the brief dose is less than 200 r. Beta-ray injury due to contamination of the scalp by radioactive fallout particles is additive to gamma-ray (and neutron) injury, so that epilation is more frequent and more extreme in individuals exposed to both forms of radiation. A single "hot" particle of fallout stuck in the hair can cause a bald spot approximately one-half inch in diameter. The hair grows back if the dose has not exceeded 600 r.

Radiation dermatitis is caused by exposure to beta radiation or gamma radiation. Beta burns can result from radioactive fallout retained on the skin, or from exposure to beta radiation from a fallout field. The skin of the hands may be damaged by handling objects heavily contaminated by fresh fallout. The reactions of the skin depend on the size of the dose absorbed and the energy of the radiation.

Internal Radiation Injury. There is limited human experience, to date, with internal deposits of radioisotopes large enough to cause acute radiation sickness. Nevertheless, the following effects are anticipated chiefly on the basis of animal experiments. Isotopes of iodine are selectively deposited in the thyroid gland, and the dosimetry of this reaction is well known because of the clinical use of iodine 131. Radioisotopes of strontium and of several other elements are selectively deposited in the bones.

Genetic Effects of Radiation. Most authorities believe that the extent of genetic injury is approximately proportional to the total dose of radiation accumulated up to the time of procreation, although there may be some recovery, as in the case of ordinary radiation injury.

Late Somatic Effects of Radiation. Late effects can occur many months or years after the onset of overexposure and include leukemia, life-shortening, cataracts, sterility, cancer of any site, and, in the case of fetal irradiation, a variety of development defects. A late effect can - but may not necessarily - develop in a person who has recovered from acute radiation sickness, or in a person who has never been sick in spite of protracted overexposure. None of these conditions is caused uniquely by radiation - they can afflict people who have never been exposed to more than the natural background plus the X-rays used in ordinary medical and dental examinations. What the additional radiation does, apparently, is to increase the probability of these troubles (e.g., leukemia, etc.) above the standard rate for persons of their age.

Summary: Dose - Injury Relationships. It is reemphasized that the most damaging form of radiation from fallout during the first weeks to months after attack is gamma radiation. There are significant relationships between the different kinds of radiation injury, which may be more readily appreciated from the tabular summary than from reading the text. See Table 1.

The Problem of Protracted Exposure. In the case of peacetime radiation emergencies, there is little reason to anticipate the need to regulate protracted exposure for weeks or months, if relocation of the exposed population is possible. In the case of a large-scale attack with nuclear weapons, relocation may be impossible either for the entire population or for certain segments of it (e.g., defense plant workers, security forces, etc.). Under these circumstances, decisions will be required with respect to the daily dose that may be authorized for periods of time as long as 1 year after the beginning of exposure. In such a case, the adoption of the ERD provides a reasonable basis for decisionmaking. The responsible authority will have to deal with two related problems; first, when to allow able-bodied survivors to leave shelter to participate in clean up, maintenance of the economy, and reconstruction; and second, how to control the exposure of those

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TABLE 1.—*Summary of relationship between dose and injury*

Type of exposure	Type of injury	Probable condition of majority during emergency		Probable mortality rate during emergency [1]	Comments
		Medical care required	Able to work		
A. Brief, whole-body, gamma-rays; 12–50 r.	Asymptomatic	No	Yes	0	Similar effect from ERD of 12–50 r.
50–200 r.	Acute radiation sickness, group I.	No	Yes	Less than 5 percent	Similar effect from ERD of 50–200 r.
200–450 r.	Acute radiation sickness, group II.	Yes	No	Less than 50 percent	Probably similar effect from ERD of 200–450 r.
450–600 r.	Acute radiation sickness, group III.	Yes	No	More than 50 percent	Uncertain effect of ERD in excess of 450 r.
More than	Acute radiation sickness, groups IV and V.	Yes	No	100 percent	Uncertain effect of ERD in excess of 450 r.
B. Internal deposit	Acute radiation sickness with severity proportional to internal dose.	Varies	Varies	Varies	No reliable data on relation between internal dose and whole-body brief external dose.
C. Beta-irradiation of skin less than 1,000 r.[2]	Radiation dermatitis, mild	No	Yes	0	Associated with whole-body radiation dose of variable size.
1,000–5,000 r.	Radiation dermatitis, moderate.	Yes	No	Less than 50 percent	Mortality related to area of burn.
More than 5,000 r.	Radiation dermatitis, severe.	Yes	No	More than 50 percent	Mortality related to area of burn.

[1] This refers to acute mortality: death during first 6 months after onset of exposure.
[2] Beta-ray dose is usually stated in rads.

survivors so that they will not develop acute radiation sickness severe enough to require medical care, hospitalization, and removal from the labor force. The nomograms and tables in Chapter 3 can be used for ERD calculations.

Using the ERD as a guide, it should be possible to regulate the daily dose in such a fashion that an established limit (on ERD, that is) can be adhered to. The daily dose can be controlled - in theory at least - by regulating the length of time authorized out of shelter or at a particular job in the radiation field. In order to do this, reliable personal dosimeters and competent radiological personnel are necessary.

Examination of the Nomogram in Chapter 3 demonstrates that, during the first three months, recovery from a brief dose of 200 r more than offsets the buildup of ERD when the protracted exposure is less than 3 r/day. At the end of the third month, all possible recovery from the brief dose will have occurred, and the ERD will be about 160 r. Continued exposure at 3 r/day for a few more months will lead to an ERD in excess of 200 r. There is little confidence in the usefulness of ERD when the brief dose is in excess of about 300 r, or when the ERD itself is much in excess of about 250 r.

It should be understood that the concept of ERD is compatible with what is known about the effects of radiation on man, but no experiments have been performed to test its validity. Until experience has been gained with the application of ERD in an emergency, its use should not be extended beyond about one year. In spite of all these uncertainties, there does not appear to be any better way to deal with the protracted exposure of some persons that will inevitably occur following an attack with nuclear weapons.

Emergency External Gamma Radiation Exposure Criteria. There is not one "acceptable" radiation exposure criteria for segments of the general public that would be in fallout areas resulting from a nuclear attack on this country, or for the emergency services that would be required to carry out high priority operations in fallout areas. Rather, the principle that must be applied is that any exposure to radiation is to be considered harmful and the hazard is greater when the exposure increases. To the extent that gamma radiation exposure can be controlled in postattack situations, the radiation exposure of the general public and the emergency operating services in each area must be held to as low a level as practicable.

In making command decisions concerning shelter, remedial movement, individual and group protective measures, decontamination, and use of emergency personnel, the civil defense director should obtain the assistance and advice of his Radef Officer, medical officer, or other qualified personnel. However, the following condensed table may be used by civil defense personnel for estimating the consequences to be expected from a short term external gamma radiation dose or an ERD which has not greatly exceeded 200 r.

	Consequences or Effects	Short term dose ERD
(1)	Smallest effect detectable by statistical study of blood counts of a large group of people	15 r
(2)	Smallest effect detectable in an individual by laboratory methods	50 r
(3)	Smallest dose that causes vomiting on day of exposure in at least 10 percent of people	75 r
(4)	Smallest dose that causes epilation (loss of hair) in at least 10 percent	100 r
(5)	Largest dose that does not cause illness severe enough to require medical care in majority of people (more than 9 out of 10)	200 r
(6)	Dose that would be fatal to about 50 percent of the people	450 r
(7)	Dose that would be fatal to almost everyone	600 r

Reference to the above table indicates that there would, in general, be no injury severe enough to require medical attention and the incidence of nausea would be held to low levels where the ERD of the general public is kept below 100 r. In most areas, after nuclear attack, the ERD of the general public can be controlled to less than 100 r by the application of countermeasures such as optimum utilization of shelter, remedial movement, and decontamination.

Although everyone may be exposed to some radiation hazards, the postattack fallout situation will require that emergency workers (such as firemen, policemen, doctors, monitors, and decontamination personnel) accept additional exposure to radiation on a calculated risk basis. The above table indicates that the majority of personnel, where required, could continue essential functions and that there would be a relatively low incidence of serious radiation sickness in cases where the ERD was not allowed to exceed 200 r. In the accomplishment of essential functions the exposure of emergency personnel should be kept as low as practicable, but in no instance should the ERD of emergency personnel exceed 200 r, except on a command decision basis where such exposure of a few individuals might be instrumental in the saving of hundreds of lives or in the saving of a highly essential facility.

Effects of Fallout on Agriculture. The U. S. Department of Agriculture has been assigned major responsibilities for developing plans and furnishing technical guidance concerning the protection of agriculture against the effects of radioactive fallout. To effectively accomplish this, close coordination will be required between State and local Radef personnel and representatives of USDA. The following brief summaries of effects on agriculture are intended only as a brief indoctrination. Key Radef personnel should coordinate their programs with those of USDA at their levels of government, and become familiar with USDA publications providing guidance for the protection of agriculture.

Livestock, similar to humans, may be injured or killed by radiation from fallout. The medium lethal dose for farm ~~animals~~ has been determined experimentally and is much more certain than the median lethal dose for man. All domestic animals have a similar response to total body irradiation. Few if any die after exposure to 250 roentgens. And few if any survive an acute dose as high as 1,000. Smaller doses or slower dose rates are tolerated better than faster delivered large doses. Some animals, like swine, have a much faster recovery rate than others, like the burro, although there is little difference in response of the species to acute exposure. The body size of the animal has little to do with survival, although the very young or the very old may be more radiosensitive.

The following table indicates the percentage of mortality of unsheltered animals after 24 hours exposure to various radiation doses:

Species	Mortality—Exposure dose (roentgens)[1]				
	100 percent	80 percent	50 percent	20 percent	0
Cattle	650	600	550	450	300
Sheep	700	600	525	450	350
Swine	800	700	600	450	350
Poultry	1,200	1,100	900	600	400

[1] Exposure dose in area or building where livestock are located.

Poultry. As indicated above, poultry are among the more radioresistant species of our domesticated animals. Therefore, poultry may represent one of the more dependable sources of fresh foods of animal origin which may be available after a nuclear attack. Furthermore, most poultry are reared under shelter or are provided with some shelter for protection from the normal environment. Consequently, compared with other livestock species, poultry should enjoy the greater chance for survival following a nuclear attack, because of the greater availability of immediate shelter for protection from radioactive fallout.

Still another factor to support the above conclusion is that most poultry are raised on commercially prepared or packaged grains or feeds and, moreover, these feeds are necessarily under some form of shelter. Therefore, considering the various livestock diets, poultry diets are least likely to be contaminated by radioactive nuclides. Thus, the hazards of direct and indirect (via the diet) fallout contamination are significantly reduced.

Milk, may be contaminated with radioisotopes from fallout; the most important of these are iodine and strontium. Cows that have received a large dose of external gamma radiation or a large dose of internal radiation from ingested fallout will soon cease to give milk. The fact that a cow still produces is evidence that radiation injury is minimal and that the body burden is not great. Nevertheless, action may be required regarding the disposition of the milk. A realistic decision requires accurate radiological measurement of the contamination, most of which will consist of radioisotopes of iodine and strontium. Until data are available, such milk can be diverted to cheese or powdered milk plants for processing. Due to radioactive decay the hazard from radioactive iodine would be of short duration.

Croplands. A nuclear attack on this country could contaminate huge areas of crop and rangelands with radioactive fallout. This contamination presents a twofold problem: (1) the external exposure of agricultural workers who attempt to enter heavily contaminated areas - or to leave protective shelter in such areas - to carry out farm duties, and (2) the continued production of food without excessive internal radiation hazard to the population, because succeeding crops grown on this soil would take up some of the contamination. The first hazard - external exposure - can be at least partially combatted by observing maximum work periods and denial times for outdoor activity. In combatting the second hazard, research workers are conducting studies on methods of using contaminated soil for agricultural purposes or for decontaminating it.

NATIONWIDE RADEF REQUIREMENTS

After a nuclear attack upon the United States, fallout would be widespread and of varying degrees of intensity. Further, under various combinations of attack and weather, any area of the country may be subjected to a serious fallout situation. Ionizing radiation emitted by the fallout could cause millions of casualties; prevent carrying out emergency postattack operations; lessen the survivors' abilities to work; and deny the use of some areas and facilities for weeks to months unless effective countermeasures could be applied.

Need for a Radef Capability. There must be a capability at all levels of government to rapidly detect, measure, report, plot, analyze and evaluate postattack fallout conditions in order to furnish information to authorities at all levels of government as a basis for making decisions affecting:

1. The period of shelter occupancy.
2. Restoration of vital facilities and obtaining needed food, water, and supplies at the earliest possible time.

3. Fire fighting, law enforcement, and other public service operations.
4. Relocation of people from areas of high radiation intensity.
5. Rescue, first aid, medical, and welfare operations.
6. Decontamination, recovery, and rehabilitation operations.
7. Control of radiation exposures of workers assigned to postshelter tasks in fallout areas.

Policy and Assignment of Responsibility. Because of the likely magnitude of the postattack fallout problem, responsibility for protection of personnel as well as responsibility for the early restoration of essential industrial and agricultural operations must be shared by Federal, State and local governments, industry, the family and the individual. The Federal Civil Defense Act of 1950, as amended, and amplified by Presidential Executive Orders, provides in part: "It is the policy and intent of Congress to provide a system of civil defense for the protection of life and property in the United States from attack. It is further declared to be the policy and intent of the Congress that the responsibility for civil defense shall be vested jointly in the Federal Government and the several States and their political subdivisions. The term civil defense ". . . shall include . . . (a) measures to be taken in preparation for anticipated attach (including the establishment of appropriate organizations, operational plans, and supporting agreements); the recruitment and training of personnel; (b) measures to be taken during attack . . .; and (c) measures to be taken following attack (including . . . monitoring for specific hazards of specific weapons; ...)."

Under Executive Order 10998, the U. S. Department of Agriculture is directed to develop plans for a national program, direct Federal activities, and furnish technical guidance to State and local authorities concerning protective measures, treatment and handling of livestock, including poultry, agricultural commodities on farms or ranches, agricultural lands, forest lands, and water for agricultural purposes, any of which have been exposed to or affected by radiation or fallout contamination.

Executive Order 11001 assigns to the Department of Health, Education, and Welfare the responsibility for developing and coordinating programs of radiation measurement and assessment as may be necessary to carry out the responsibilities involved in the provisions of preventive and curative care related to human exposure to radiation, including rehabilitation and related services for disabled survivors.

Executive Order 10999 assigns to the Department of Commerce (Weather Bureau) the responsibility for preparing and issuing currently, as well as in an emergency, forecasts and estimates of areas likely to be covered by fallout in event of attack and for making this information available to Federal, State and local authorities for public dissemination.

Executive Order 11003 assigns to the Federal Aviation Agency the responsibility for formulating plans for the development, utilization, expansion and emergency management of the Nation's civil airports, facilities and equipment required for essential civil air operations. This could include assistance in developing aerial monitoring capability.

Federal Assistance Available to State and Local Governments. Under authority contained in Public Law 920, 81st Congress, as amended by Public Law 85-606, the Assistant Secretary of Defense (Civil Defense) may assist the State and local governments in developing their radiological defense capability provided OCD standards are met. The assistance to State and local governments includes, but is not limited to:

a. the grant of Radef instruments and equipment needed for training personnel and for carrying out emergency operations.
b. the grant of spare parts, tools, test equipment and batteries needed to maintain the monitoring instruments.
c. the loan of radioactive byproduct materials required to calibrate monitoring instruments and train monitors.
d. the provision of up to 50 percent of the necessary costs of special items of Radef equipment.
e. the training of monitor instructors, radiological defense officers (Radef Officers) and instrument maintenance technicians.
f. the provision of up to 50 percent of the necessary costs for the training of monitors.
g. the provision of up to 50 percent of the necessary costs for administrative expenses associated with the planning, development, implementation and operation of the Radef program; the salaries of the Radef Officer, his staff and the instrument maintenance personnel; the expenses for the rental of a maintenance shop facility; and the transportation costs for shipment of instruments to and from the maintenance facility.

Additional Radef assistance is provided by the Office of Civil Defense (OCD) to State and local governments in the form of criteria and guidance for:

a. planning and developing a monitoring, reporting and evaluation capability.
b. developing a capability for applying protective measures and decontamination procedures.
c. implementing and carrying out standardized emergency operating procedures.
d. limiting radiation exposure of emergency personnel and the general public.

Further, a fallout monitoring capability has been developed at selected field facilities of many of the Federal agencies and departments. In the event of nuclear attack, fallout information could be made available to local governments in the general vicinity of these Federal field facilities. OCD is assisting in the development of fallout monitoring capability at approximately 6,000 field facilities of the Departments of Agriculture and the Interior, the Federal Aviation Agency and the Weather Services, and local government should establish liaison with these stations in order to arrange for the receipt of fallout information during an emergency.

Nationwide Requirements. A minimum of 150,000 monitoring stations is required across the United States to provide the requisite operational intelligence at Federal, State and local levels of government. Six thousand of these

Recommended numbers of operational monitoring stations, Monitors, and RADEF officers

State	Monitoring stations	Monitors	Local RADEF officers
Region 1:			
Connecticut	1,619	6,476	201
Maine	1,278	5,112	205
Massachusetts	4,020	16,080	461
New Hampshire	578	2,312	94
New Jersey	4,328	17,312	578
New York	7,661	30,644	1,006
Rhode Island	508	2,032	63
Vermont	501	2,004	81
Puerto Rico	602	2,408	85
Virgin Islands	17	68	3
Total	21,112	84,448	2,777
Region 2:			
Delaware	275	1,100	48
Kentucky	2,743	10,972	583
Maryland	1,600	6,400	252
Ohio	6,351	25,404	864
Pennsylvania	9,576	38,304	1,617
Virginia	2.702	10,808	450
West Virginia	2,863	11,452	599
District of Columbia	96	384	1
Total	26,206	104,824	4,414
Region 3:			
Alabama	3,148	12,592	443
Florida	3,052	12,208	460
Georgia	3,228	12,912	528
Mississippi	2,342	9,368	311
North Carolina	3,332	13,328	537
South Carolina	1,895	7,580	287
Tennessee	2,588	10,352	395
Canal Zone	20	80	3
Total	19,605	78,420	2,964
Region 4:			
Illinois	6,253	25,012	908
Indiana	3,466	13,864	528
Michigan	4,242	16,968	574
Minnesota	3,531	14,124	479
Wisconsin	3,563	14,252	461
Total	21,055	84,220	2,950
Region 5:			
Arkansas	2,268	9,072	310
Louisiana	2,441	9,764	392
New Mexico	1,536	6,144	135
Oklahoma	3,296	13,184	358
Texas	9,732	38,928	1,185
Total	19,273	77,092	2,380
Region 6:			
Colorado	1,821	7,284	221
Iowa	3,540	14,160	534
Kansas	3,131	12,524	400
Missouri	3,657	14,628	487
Nebraska	2,502	10,008	302
North Dakota	1,496	5,984	160
South Dakota	1,641	6,564	187
Wyoming	902	3,608	69
Total	18,690	74,760	2,360
Region 7:			
Arizona	1,369	5,476	111
California	7,403	29,612	807
Hawaii	587	2,348	95
Nevada	377	1,508	50
Utah	1,093	4,372	157
American Samoa	10	40	1
Guam	10	40	----------
Total	10,849	43,396	1,221
Region 8:			
Alaska	265	1,060	33
Idaho	1,030	4,120	149
Montana	1,701	6,804	160
Oregon	1,852	7,408	249
Washington	2,364	9,456	323
Total	7,212	29,848	914
Grand total	[1] 144,002	[2] 576,008	[3] 19,980

[1] In addition, there are about 6,000 stations comprising the Federal monitoring network.
[2] Exclusive of shelter monitors, Federal monitoring network, and aerial monitors.
[3] In addition, an estimated 150 professional RADEF officers will be required for State and sub-State emergency operation centers, and 100 for field installations of Federal agencies, making a grand total of 20,230.

stations are being established in Federal facilities, and the remaining 144,000 stations in State and local facilities. An average of four trained monitors is required for each station. Communities over 500 population, State and county governments, and certain special installations require a Radef Officer and one or more assistant Radef Officers to plan, organize, implement and operate the Radef system. The following tabulation indicates for each State the recommended minimum numbers of State and local monitoring stations, the numbers of monitors, and the numbers of Radef Officers. However, the final determination of numbers and location of monitoring stations and personnel will depend largely on State and local analyses of their detailed requirements.

The number of assistant Radef Officers depends on community size. Large cities will require several, while small communities may require none. Requirements statewide are estimated to be approximately equal to the number of Radef Officers for the State. Additionally, emergency operating center (EOC) personnel such as recorders, plotters and analysts will be needed in each community. Chapter 2 provides more detail concerning Radef personnel.

Locations of Monitoring Stations. The monitoring stations must be properly distributed geographically in order to provide representative information from all inhabited and habitable areas of the community.

For cities, the total requirement will be related to the population and associated services, business and industry. However, a single "monitoring station" can serve a larger segment of the populace where the population density is high; e.g., apartment or closely built districts, than where the population is more widely dispersed as is typical of suburban areas, small municipalities and villages. The density of the monitoring station network in urban areas should be approximately as follows:

Population	Number of Stations
500 - 1,000	3
1,000 - 2,500	4
2,500 - 50,000	$4 + \frac{\text{population}}{4,000}$
Greater than 50,000	$12 + \frac{\text{population}}{10,000}$

Rural areas should have their own monitoring capability as a basis for the protection of personnel, the care of livestock, land utilization in the subsequent production of food, and for measuring the contamination of individually owned crops, both harvestable and stored. Where the average farm size is large, and the population density low, a monitoring station can adequately serve a larger rural area than where the average farm size is small and the population density higher. The density of the monitoring stations in rural areas should be approximately as follows:

Average farm size (acres)	Number of sq. miles of farmland per monitoring station
Less than 160	25
160 to 320	36
320 to 640	49
640 to 1,280	64
Over 1,280	81

In rural as in urban areas, the monitoring stations must be properly distributed to provide representative reports from all habitable locations.

Aerial Monitoring Capability. An aerial monitoring capability should be developed at the approximately 3,000 public use airports that have servicing facilities. This will provide capability for the more thorough monitoring of the sparsely settled areas as well as capability for the rapid monitoring of transportation routes and essential areas and facilities that may or may not have a monitoring capability.

Executive Order 11003 charged the Federal Aviation Agency (FAA) with the management of civil non-air-carrier aircraft during an emergency period. Therefore, the plans for the utilization of aircraft will be in consonance with the FAA "State and Regional Defense Airlift Plan (SARDA)." Civil defense programs can be more readily established through utilizing capabilities of existing organized groups of aircraft owners. Each of the fifty States has a working agreement with the Civil Air Patrol Wing of its State. Local civil defense plans for the use of non-air-carrier aircraft should be in accord with State plans. Detailed guidance for planning and developing an aerial monitoring capability is presented in Chapter 3.

Monitoring Capability at Community Shelters. Each licensed community shelter is furnished food, water containers, medical kits, sanitation kits, and a shelter radiation kit. For proper use of the shelter radiation kit, local government must train an average of four monitors per shelter. Local and State civil defense directors may select some of the community shelters as fallout monitoring stations when the shelters provide needed geographic coverage and communication capability. Where planned operations permit, the personnel assigned to the fallout monitoring station may be assigned the dual functions of operational shelter monitoring.

Maintenance and Calibration Capability. Experience factors indicate that all survey meters require periodic calibration and about 10 percent of the survey meters and dosimeter chargers require annual maintenance. Each State must develop a capability to maintain and calibrate the monitoring instruments. The Federal Government provides considerable assistance to the States in these matters.

CHAPTER II

RADEF PLANS AND ORGANIZATION

LEGAL BASIS - The Federal Civil Defense Act of 1950, as amended, provides in part:

> It is the policy and intent of Congress to provide a system of civil defense for the protection of life and property in the United States from attack. It is further declared to be the policy and intent of the Congress that the responsibility for civil defense shall be vested jointly in the Federal Government and the several States and their political subdivisions.

> The term civil defense ... shall include . . . (A) measures to be taken in preparation for anticipated attack (including the establishment of appropriate organizations, operational plans, and supporting agreements); the recruitment and training of personnel; (B) measures to be taken during attack . . .; and (C) measures to be taken following attack (including . . . monitoring for specific hazards of special weapons; . . .)

STATE AND LOCAL PLANS - GENERAL

To qualify for Federal financial assistance ". . . for necessary and essential State and local civil defense personnel and administrative expenses . . ." it is necessary that there be an approved State plan which is in effect in all political subdivisions of the State, and which provides, in part, for the development of State and local emergency operations plans conforming to approved standards.

The States have basic plans developed and approved under Federal Survival Plans projects. The plans include "Annexes" which present in somewhat greater detail the plans for performance of specific emergency functions including radiological defense. The operational civil defense plans of local government should be in accord with the concepts and provisions of the State plan and should provide in greater detail for its application to the local area. The Radiological Defense Service (Radef) annex to the local plan supports and amplifies the basic plan, presenting the organization of the local radiological service and describing the time-phased readiness and emergency functions to be performed.

State and local civil defense plans, supported by appropriate Radiological Services annexes, after approval by proper authority, provide the legal basis for establishment of the radiological services and for the performance of radiological defense functions during a national emergency.

RADEF PERSONNEL

The following statements of duties and qualifications are summary in nature. They present recommended qualifications, by functions, and broad statements of duties to be performed. The following sections of this chapter and Chapters 3 through 8 provide details further defining the responsibilities and duties of Radef personnel. Larger organizations may require additional specialized personnel; e.g., a chief of monitoring services. However, in smaller organizations one person may be required to perform several functions.

Radef Officer. The complexity of duties of Radef Officers will be great at both local level and State level. The following descriptions are guides. For a State or large city, the officer should be a full-time paid professional employee. For a small community, a qualified volunteer or government employee can probably develop the required capability on a part-time basis. However, during an emergency, this job should be fulltime. When qualified employees of State and local governments are not, or cannot be made available to serve as Radef Officers, high school and college science teachers, industrial scientists, and retired civilian or military personnel meeting the technical qualifications may be considered for filling the position.

Duties - Plan and implement programs to minimize the effects of radiation resulting from a nuclear attack on the United States. Recommends actions and coordinates emergency radiological service activities in his area, including monitoring, reporting, analyzing, evaluating radiological data, preparation of summary reports and warning messages, and recommends countermeasures.

Qualifications - College-level training in the physical sciences or experience which gives a like background. Experience in an administrative or planning capacity. Knowledge of radioactive isotopes and nuclear radiation, and their effects on living tissue. General knowledge of civil defense operations and thorough understanding of radiological defense operational plans - Federal, State and local. Successful completion of the OCD course, "Radiological Defense Officer," or the equivalent.

Radef Training Officer/Assistant Radef Officer. Basic qualifications and training for these positions are similar. Preattack, the Radef Officer may require assistance to accomplish necessary training, whereas postattack there would be a greater need for support in the direction of operations. In the larger organizations, particularly, it may be appropriate that these functions not be combined.

Duties - Under the general supervision of the Radef Officer, conducts indoctrination courses for administrative personnel; plans and directs training and refresher courses for monitors; prepares and assists in the administration and evaluation of tests and exercises; and assists in the training of the emergency operations center (EOC) radiological staff. Under the general supervision of the Radef Officer, directs the EOC radiological services staff and monitoring operations during the postattack period.

Qualifications - College-level training in the physical sciences, or experience which gives a like background. Experience in teaching or training is desirable. Completion of the OCD course, "Radiological Monitoring for Instructors," or the equivalent. On-the-job training in radiological service operations as a minimum. However, completion of the OCD course, "Radiological Defense Officer," is desirable.

Specialist in Decontamination.

Duties - Under the general direction of the Radef Officer, develops plans for radiological decontamination of vital facilities and areas. Coordinates field training of fire services, engineering and public works services, and private contractors, for performing those postattack decontamination functions for which they have potential capabilities. Recommends, coordinates and provides technical direction of decontamination activities.

Qualifications - Engineering or other appropriate technical training. Architects and engineers who have completed the course, "Fallout Shelter Analysis," would have an excellent background. City or public works engineers, industrial safety supervisors, and Radef Officers generally would have acceptable backgrounds. Completion of the "Radiological Monitoring for Instructors" course and the OCD course, "Radiological Defense Officer," or equivalent.

Analyst.

Duties - Prepare monitored radiological data in analyzed form for use in the area served and for reporting to other levels of government. Evaluate the radiation decay patterns as a basis for estimates of future dose rates and radiation doses associated with shelter occupancy, emergency operations and post shelter living.

Qualifications - Competence in algebraic computation. Ability to present information graphically and to use charts and graphs efficiently. On-the-job training in specific procedures.

Plotter.

Duties - Record incoming data in appropriate tabular form and on maps. Perform routine computations under direction.

Qualifications - Familiarity with the area and maps of the area served. Ability to make simple, accurate computations. On-the-job practice in assigned duties.

Chief of Monitors.

Duties - Supervises the assignments of monitors. Supervises the collection of radiological data, in coordination with the chief of plotting and analysis. Assures that radiation exposure records of monitors are maintained and that monitoring assignments are in accord with appropriate radiation exposure control standards.

Qualifications - Familiarity with the area and the established monitoring system, stations, shelters and aerial monitoring capability. Completion of the "Radiological Monitoring" course as a minimum, and on-the-job practice in assigned duties; completion of the "Radiological Monitoring for Instructors" course is desirable.

Monitor.

Duties - Measure, record, and report radiation doses and dose rates. Provide limited field guidance on radiation hazards associated with operations to which he is assigned. Perform operators maintenance of radiological instruments.

Qualifications - Completion of high school or the equivalent. Completion of the "Radiological Monitoring" course or its equivalent.

RADIOLOGICAL SERVICE PLANS

This section presents guidance which may be used in review and modification of existing radiological service plans, or for initial preparation of plans in localities establishing a radiological service. It is again emphasized that the Radiological Service annex to the civil defense plan must be in accord with the basic plan, and serve to support and amplify its broad radiological defense provisions.

The main body of the annex should be limited to basic concepts appropriate to the area of operation, which are not subject to frequent change. It should (with approval by appropriate authority) provide the authority for performing specific functions. However, the details subject to change should appear as attachments which can be revised and approved at a lower executive level than would be required for revision of the basic annex. Examples are lists or maps of monitoring locations, rosters of personnel, standing operating procedures (SOP) for the EOC, monitoring procedures at specific shelters and operational monitoring stations, etc.

LOCAL RADEF PLANS

Radiological defense operations will be required in communities ranging in size from villages to cities of several million population, in towns or townships, and in counties. No single example or representative plan would be appropriate for all. However, an outline of a representative plan is presented for guidance as to typical format, organization and responsibilities of personnel, and time-phased execution of operational responsibilities (see Annex 1 to this chapter). In the smaller communities, the responsibilities of several of the indicated personnel may be performed by a single person. On the other hand, in large cities, a staff of several persons may be required to perform the functions assigned to one person in the outline. Staffing recommendations are also presented in Annex 1.

The "Illustrative Outline, Local Radiological Service Plan" (Annex 1) does not describe how the various functions are to be performed. The other Chapters of this Guide and the radiological service training courses provide guidance for the performance of those details.

Examinations of the outline, including the Table of Organization, clearly show that portions of the radiological service are performed by other emergency service groups and utilize capabilities of personnel deployed for the performance of other functions. This is necessary to provide "built-in" monitoring capability for those services needing it, to make maximum use of the communications capability, and to utilize capabilities of personnel deployed for performance of other functions. It is recognized that implementation and direction of such a loose organization is difficult. Therefore, effective coordination with the directors of the other services is essential. The basic Radef annex will state the broad nature of the required coordination.

A carefully prepared document showing the details of the coordinated responsibilities and functions, when approved by the civil defense director and appropriate higher authority, can materially assist in the implementation of programs. The numerous minor details would be worked out directly with representatives of the services.

COORDINATION OF COUNTY AND LOCAL USDA RADEF PLANS

The U. S. Department of Agriculture is directed, pursuant to Executive Order 10998, to develop plans for a national program, direct Federal activities, and furnish technical guidance to State and local authorities concerning protective measures, treatment and handling of livestock, including poultry, agricultural commodities on farms or ranches, agricultural lands, forest lands, and water for agricultural purposes, any of which have been exposed to or affected by radiation or fallout. The local application of USDA plans and programs will be centered primarily at the county level of government. Annex 2 of this chapter provides guidance concerning the coordinated function of county Radef and the local representatives of USDA.

STATE PLANS

During the several years since the completion of State operational survival plans, there have been changes in weapon designs, capabilities, and delivery systems. Also, there have been changes in Federal portions of plans and programs to counter threats more effectively. Continuing review and periodic revision of State radiological plans is essential.

States are responsible for assisting their political subdivisions in the development of civil defense capabilities, including Radef, and are necessarily concerned with the adequacy of local plans and organizations. To the extent that dispersed State installations are responsible for monitoring and reporting, State Radef plans and organizations would be similar to those of local governments.

State plans should recognize the assistance to be provided local governments in training personnel and developing effective organizations. Also, the State plan and organization should provide for postattack Radef support to local governments.

ILLUSTRATIVE OUTLINE
LOCAL RADIOLOGICAL SERVICE PLAN

NOTE: It is not intended that this outline serve as "copy" for a local Radef annex. For clarity, most of the major topics include more detail than would appear in the basic annex. The statements in the basic annex should be broad enough to include required concepts but need not, and should not, include distracting details that can appropriately be presented as attachments detailing specific topics, or as SOP's which describe detailed operations of the respective subgroups of the Radiological Service.

MISSION

To provide capability for radiological monitoring and reporting; analysis, presentation, and evaluation of data; and technical staff support as a basis for (a) the control of radiation exposures of persons performing civil defense operations, and (b) the direction of activities of the populace to minimize fallout radiation hazards resulting from nuclear weapons attack.

ORGANIZATION

General. The "Table of Organization, Local Radef Operations," is presented on the following page. It shows chain of command and indicates the important coordination with other services necessarily performing limited radiological service functions. Recommended Radef staffing at emergency operating centers for several sizes of communities are presented in the section titled, "Suggested Radef Staffing at Emergency Operations Centers." (see page 2-13).

Radef Officer.

1. Appointed by Civil Defense Director.
2. Reports to and supplies staff support to the Civil Defense Director.
3. Responsible for:
   a. Planning
   b. Personnel
      (1) Recruits and appoints with approval of director.
      (2) Directs activities.
      (3) Determines line of succession of staff.
   c. Determining local aspects of training and evaluating the effectiveness of training programs.
   d. Liaison with local civil defense services.
   e. Preparation of radiological information for release to the public through appropriate channels.
   f. Preparation of reports to appropriate higher authority.
   g. Coordination of Radef functions of other services within the local jurisdiction.
   h. Coordination of operational plans with local representatives of Federal and State governments.

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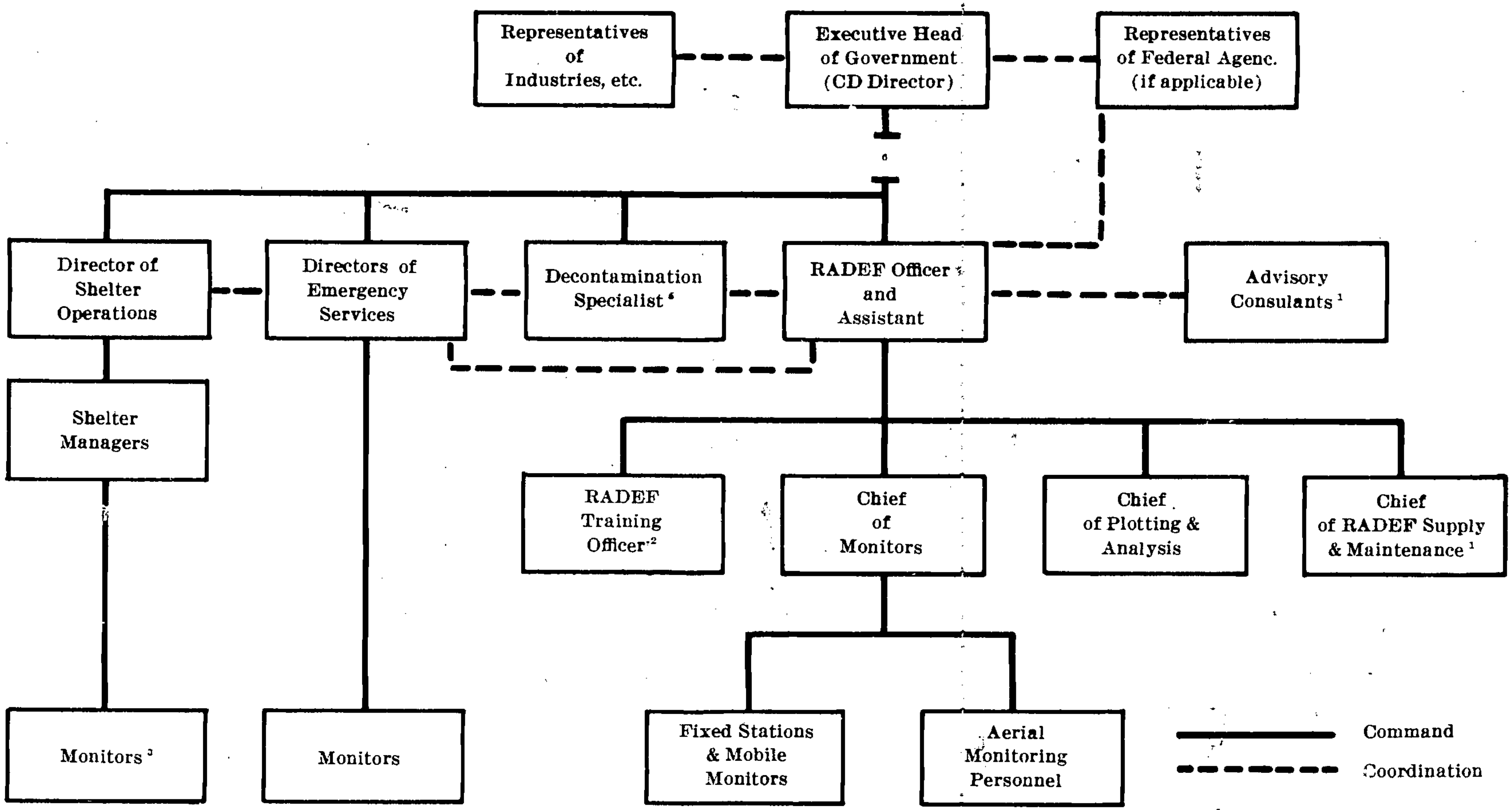
TABLE OF ORGANIZATION LOCAL RADEF OPERATIONS



[1] Should have operational assignments, and where feasible, should include a meteorologist.
[2] May be Assistant Radef Officer.
[3] Subject to reassignment to mobile monitoring at conclusion of shelter period.
[4] Includes Public Health, Welfare, Police, Fire, Public Works, P.I. Officer, etc.
[5] Under direction of Radef Officer when required by local plan
[6] Could be intermediate executive Officers, e.g. Operations Officer.

i. Emergency Radef operations.

Advisory Consultants.

1. Nature of personnel:
   a. Physicists and chemists
   b. Radiologist
   c. Meteorologist
   d. Professional engineers

2. Duties:
   a. Promote the recruitment of technically competent personnel for the Radef Service.
   b. Provide technically accurate advice and guidance to the Radef Service during implementation of programs and postattack.
   c. Perform Radef operational functions as appropriate.

Staff.

1. Assistant Radef Officer - Assists the Radef Officer and acts for him in his absence.

2. Radef Training Officer - Duties:
   a. Adapts Federal training materials and guidance to lesson plans which satisfy local training requirements in:
      (1) EOC operational procedures.
      (2) Monitoring and reporting techniques and operations.
      (3) Orientation for executives.
      (4) Decontamination (when assigned to Radiological Services by the basic civil defense plan).
   b. Provides for elements of the training program, including:
      (1) Specialized training of key personnel (at OCD schools, etc.).
      (2) Schedules local courses for initial training and refresher training.
      (3) Operational tests, exercises, evaluation and remedial training.
      (4) Provisions for facilities, equipment and training aids.
   c. Maintains roster of trained personnel and recommends assignments.

3. Chief of Plotting and Analysis - Duties:
   a. Provides for:
      (1) Necessary maps, materials and plotting equipment.
      (2) Receipt of upper fallout (UF) wind data.
      (3) Continuing training of his staff
   b. Directs his staff in preparation or maintenance of:
      (1) UF wind vector plots
      (2) Fallout forecasts
      (3) Message and reporting logs
      (4) Dose and dose rate plots and analysis
      (5) Reports to higher heads of government
   c. Assists the Radef Officer in preparation of advisories

d. Assists in the planning of mobile and aerial monitoring missions.

4. Chief of Monitoring - Duties:
   a. Assists in training of monitors and, in coordination with the training officer, recommends assignment of monitoring personnel.
   b. Maintains current roster of monitoring stations and teams.
   c. Directs monitor personnel relative to:
      (1) Monitoring procedure
      (2) Reporting
      (3) Mobile and aerial monitoring missions.
      (4) Postattack redistribution (reassignment) of monitors.
   d. Maintains radiation dose records of monitors when operationally feasible.

5. Specialist in Decontamination - Duties:
   a. Plans and develops decontamination capability, including:
      (1) Assessment of existing suitable equipment and operators, and maintenance of current lists.
      (2) Studies of the feasibility of decontaminating vital areas and facilities.
      (3) Assures assignment of trainees through coordination with emergency services, industries, contractors, etc.
      (4) Assists in training personnel to apply existing skills in decontamination operations.
   b. Provides staff support concerning:
      (1) Time phase feasibilities of decontamination.
      (2) Methods to be employed.
   c. Provides for field operations.
      (1) Technical direction and coordination.
      (2) Evaluation of effectiveness.

6. Chief of Radef Supply and Maintenance - Duties:
   a. Requests radiological equipment.
   b. Assures appropriate storage at designated dispersed locations.
   c. Distributes and maintains custody records of operational and training equipment.
   d. Provides for scheduled operability checks and local aspects of maintenance and calibration of radiological equipment.
   e. Coordinates transportation of personnel and equipment.
   f. Trains for and performs postattack functions as assigned.

EXECUTION AND OPERATIONAL RESPONSIBILITIES

Readiness Development Period.

1. Organize and staff the emergency Radef service at the EOC.

2. Develop the planned operational capability through:
   a. Recruitment and training of personnel
   b. Requests for radiological equipment
   c. Maintenance of personnel rosters
   d. Liaison with other civil defense elements.

3. Establish monitoring capability at selected locations.

4. Coordinate training and operational capability of other civil defense services performing monitoring functions.

5. Evaluate and perfect capability through tests and exercises by the various elements of government.

6. Provide authoritative public information to PIO on hazards of nuclear attack and protective measures.

7. In coordination with communications, provide for adequate communications for all Radef functions.

8. Prepare SOP's for:
   a. Supply and local aspects of instrument maintenance and calibration programs.
   b. EOC radiological service staff procedures. (See "Checklist for Preparation of EOC Radiological Operations SOP").
   c. Decontamination procedures (where the responsibility of the Radef Service).
   d. Fixed monitoring station procedures to include mobile monitoring (see page 2-19 for illustrative SOP).
   e. Community shelter monitoring procedures.
   f. Aerial monitoring and survey procedures.

Period of Extreme International Tension. Perform the following functions in accordance with the corresponding SOP's:

1. Place personnel on alert.

2. Perform operational check and users maintenance of equipment.

3. Disperse equipment not previously distributed for operational purposes.

4. Activate Radef service at EOC with key personnel.

5. Maintain and plot UF data on current basis.

6. Supply UF wind vector plots for use by the EOC staff.

7. Check Radef Service supplies.

8. Check communication capabilities specifically assigned to Radef.

9. Prepare public information material for release through established channels.

At Warning that Attack is Imminent or Has Begun.

1. Complete staffing of all radiological defense installations in

accordance with directives based on civil defense plan, or take protective action and report to duty stations in accordance with the local plan.

2. Complete actions listed under "Period of Extreme International Tension," if required.

3. If no such warning was received, give the following priority:
   a. Alert personnel.
   b. Staff Radef Service at EOC.
   c. Prepare UF wind vector plots.

<u>Postattack Period</u>. In accordance with SOP's for:

1. Period of high radiation hazard:
   a. If required by basic plan, observe and report strike time and weapon effects for evaluation of location and yield of explosion (SOP).
   b. Prepare fallout forecasts for the civil defense director and his staff.
   c. Prepare public warnings and directives for release through authorized channels.
   d. Receive from higher echelons selected flash reports of fallout arrival at other locations and apply for forecasting arrival time of fallout.
   e. Receive high priority or flash reports of arrival of local fallout and report to next higher echelon.
   f. Receive, plot and analyze radiological reports.
   g. Prepare scheduled radiological reports for transmission to the next higher echelon.
   h. Continually evaluate the radiological situation for use in issuing public guidance and in planning and directing emergency operation.
   i. Receive, plot and display Radef information from higher echelons for use by the EOC staff.
   j. Give technical assistance to civil defense director and staff.

2. Operational recovery period:
   a. Continue to receive, plot, analyze and display local radiological information.
   b. Prepare and transmit in accordance with established reporting procedures, radiological information required by the next higher echelon.
   c. Perform detailed mobile and aerial monitoring, or surveys as required.
   d. Continue to assess radiation exposure of emergency personnel as a basis for reassignment, replacement and rehabilitation.
   e. Evaluate radiological decay characteristics and predict future dose rates and doses (SOP).
   f. Estimate the dose to populace having various degrees of radiation protection and the feasibility of remedial movement, when required.

g. Prepare appropriate public information releases.
h. Perform other duties as directed.

3. Transition to near-normal operations:
   a. Continue operational recovery activities.
   b. Restaff and train Radef personnel as required.
   c. Maintain instruments and equipment.
   d. Assist other civil defense services in assessing the radiation hazards.
   e. Assist public health and agricultural officials in evaluating the radiological contamination of food and water.
   f. Advise other services on decontamination and waste disposal operations, as required.

APPROVED:

Date ______________ Chief executive of local government ______________

SUGGESTED RADEF STAFFING AT EMERGENCY OPERATIONS CENTERS

Generally the space available in emergency operations centers is limited and places restrictions on staff size. There will be need to adapt the size and balance of the Radef staff to the particular requirements of the locality. A few of the factors to be considered when formalizing the staff organization are as follows:

1. Population served and population density.
2. Extent of the area of responsibility.
3. Nature of the area occupancy; e.g., primarily industrial, residential, rural, etc.
4. The relative independence of or dependence upon the next higher echelon of civil defense operations.
5. The extent to which the staff receives individual reports from monitoring stations as contrasted with the receipt of summarized or consolidated analyzed reports.
6. The nature of the communications system.
7. The efficiency of the reporting, message handling, plotting, analysis, evaluation and display processes developed. All of these will be affected by the basic training of the staff and the practice tests and drills employed to develop and maintain operational efficiency.

The ratio of the staff personnel to the population will generally decrease as the population of the area being served increases. However, the ratio of decrease does not necessarily have a simple relationship to the increase in population because of the variables previously discussed. Each Radef Officer, under the general direction of his immediate superior, should evaluate the requirements peculiar to the organization he serves.

It should be recognized that, with the passage of time, the nature of the workload will change. Following the arrival of fallout, monitoring and reporting will be frequent to reflect the rise of radiation dose rates as fallout is deposited, and their decrease during the early period characterized by relatively rapid radioactive decay. Later, when change is less rapid, routine reports will be less frequent but there will be many reports of detailed monitoring of areas and facilities. Also, as recovery operations are initiated and carried forward, the staff will have added responsibility for evaluating the potential hazards associated with a wide variety of priority field operations. See Chapters 3 and 5.

The staffing suggested in this Annex should be considered as a broad guide, subject to alteration to meet special requirements. The suggested staffing is for around-the-clock operation at the principal operations centers. However, after about two days or from the beginning of recovery operations, the heaviest load can be expected immediately preceding and during the daylight working hours.

RADEF Staffing Guide—Urban

Population	Approximate number monitoring stations	RADEF officer	Assistant RADEF officer (RADEF training officer)	Chief of monitoring	Analysts	Plotters
250,000–1,000,000	40–110	1	1 or 2	1	3	6
25,000–250,000	15–40	1	1	0 or 1	2	4
2,500–25,000	5–15	1	1	←	1 →	1
Up to 2,500	3–5	1		←	1	→

Based on OCD guidance concerning the density of urban monitoring and reporting stations, the column "Approximate number monitoring stations" is included to give ready reference to the numbers of radiation measurements to be processed following each scheduled monitoring operation.

<u>Cities of over one million population</u>. It is assumed that peacetime operations of government services are on a decentralized basis; e.g., boroughs, precincts, etc., which provide a reasonable span of control, and that emergency operations plans contemplate utilization of those organizational structures. Each of these larger cities may adapt the Radef guidance principles for cities of appropriate size to these administrative subdivisions and to its central operations center.

<u>Population of 250,000 to 1,000,000</u>. Line one of the Staffing Guide chart suggests an EOC Radef staff for around-the-clock operations. The suggested staff should be able to process hourly reports from the indicated 40 to 110 reporting stations during the early period of rapidly changing dose rates. However, during this period when few unsheltered operations would be undertaken in heavily contaminated areas, the load on other staffs within the EOC

could be light enough to allow some temporary support to the Radef staff. Also, the number of separate reports from individual monitoring stations should be kept small. Summary messages from appropriate data collection points can be handled more efficiently than an equivalent number of separate dose rate reports from individual monitoring stations.

During later periods, the load from prescheduled monitoring station reports will be light, but reports from detailed mobile monitoring will contribute to the load. Unless Radef plotting, analysis and evaluation operations are efficiently executed, staff work in support of planning field operations will be beyond the capabilities of the small staff. It will not be possible to provide detailed guidance for every planned emergency service operation and maintain the associated individual exposure records. Rather, the Radef staff should maintain displays of the radiological situation and provide broad radiological guidance for use by the other operating services. This presupposes that each emergency service responsible for extensive recovery operations will have its own plans and personnel for appropriate application of the general guidance, and for the control of exposures of its personnel. For example, at its communications and dispatching center, the fire service might have the equivalent of an assistant Radef Officer, charged with these responsibilities and the preparation of summary reports to the EOC from those monitoring stations manned by the fire service.

Population of 25,000 to 250,000. The indicated staffs for cities in this population range should be able to perform the required functions, and would operate in a manner similar to that indicated for larger cities. It would be possible for these staffs to provide specific guidance for a larger fraction of the operational missions, thus reducing the extent and complexity of the Radef capabilities built into the other emergency services.

Population of 2,500 to 25,000. In cities of this population range most of the radiological data would be reported directly from the monitoring stations to the EOC for utilization by the Radef staff which, in turn, would be responsible for detailed Radef guidance for most operational missions of the serveral services. These services would have little requirement for executive level Radef personnel.

Population up to 2,500. In most of these smaller communities (a) the volume of radiological data will be small, (b) recovery operations will not be extensive and will be much simpler than in larger communities, and (c) there will be little need for around-the-clock operations after the first 24 hours and the Radef staff can serve on an on-call basis during periods when little field activity is contemplated. For the period when shelter is the primary countermeasure, consideration might be given to assignment of a representative of another service to serve a Radef standby watch.

In many of these smaller communities the responsibilities of the Radef officers will be somewhat reduced because they will be able to receive technical guidance from the Radef services of nearby larger cities, or from the counties within which they are located.

The determination of appropriate staff size and functional balance is based upon criteria similar to those discussed for urban organizations. Therefore, only the additional considerations applicable to these levels of government are presented.

Staffing Guidance - Counties. To a major degree the incoming data should be from collection centers, usually at the cities and towns, and should be summary in nature and reduced in detail. The county Radef staff may provide general countywide guidance for application at the urban level but would not be expected to provide direct guidance for specific operations, except when they are performed directly by or under the immediate supervision of county services. Thus, their organizations and mode of operation would generally be similar to those of medium-size to large-size cities.

Staffing Guidance - States. Generally, the State Radef requirements for staff size and assignment are expected to be about the same as those for a major city. Because the State is primarily responsible for support rather than being directly responsible for most emergency operations in the field, there is little requirement for the detailed Radef data needed at local levels. The data reported from local levels to the State should be representative rather than detailed, should be summary in nature, and the reports need not be as frequent as required at local levels. The State is responsible for general guidance for the broad area.

Most States have assumed major responsibility for assisting their political subdivisions in the development of local Radef capabilities. Consequently, it is appropriate that the major portion of the State Radef staff be well qualified professionals having an assignment for providing this assistance, preattack, and performing EOC operations, postattack.

Availability of Radef Officers. Ideally, all Radef Officers should have appropriate technical qualifications and receive formal training in the OCD course, Radiological Defense Officer, or its equivalent. For the larger cities and counties, and for States, the Radef Officer should be a well-qualified full-time professional. However, in some of the smaller political subdivisions this may not be feasible. Personnel to be considered for this position should have college level training in the physical sciences and where they are to serve on a volunteer or assignment basis may be (a) technically qualified employees of other government services,(b) scientists employed in business or industry, (c) science instructors, retired military Radef personnel, etc. Where it is not feasible for personnel to attend courses presented under OCD auspices, it may be necessary to develop capabilities required by the smaller political subdivisions through State or county sponsored seminars or workshops.

Availability of Radef Training Officer/Assistant Radef Officer. Where feasible the qualifications and training should be the same as those for the Radef Officer. Recruitment can be from the sources indicated for Radef Officers. As a minimum, he should have completed the OCD course, "Radiological Monitoring for Instructors" and should receive inservice training in emergency operations.

Availability of Chiefs of Monitoring, Analysts, and Plotters. Preattack, these need not be full-time Radef personnel. They may be employees of other government services or other personnel having the requisite capabilities but not having priority assignments for the postattack period. Analysts should have competence in algebraic and graphic mathematical computations, and plotters should be familiar with the areas of responsibility and the maps depicting them. Training should be accomplished through periodic reassignment from normal duties to Radef training, practice-and-test activities conducted under the direction of the Radef services to which they are assigned for postattack operations.

Availability of Advisory Consultants. Some Radef plans indicate the intent to utilize the support of a group of technically competent advisory consultants, both in the development of the radiological program and during emergency operations. Where such personnel are to serve at the EOC, space limitations will usually make it necessary that they be assigned to performance of a regular staff function in addition to serving in an advisory capacity.

Availability of Augmenting Forces and Replacement Personnel. The staffing guidance presented above is minimal and allows little reserve capability to compensate for the absence of one or more staff members. Therefore, it is important that the staff members be trained to perform several functions in order that efficient operation can be realized through adjustment of assignments. Also, consideration should be given to the appointment and training of augmenting forces, or understudies, for the various staff positions. They might be assigned, subject to recall, to assist with Radef functions at centers of operations for other emergency services. If before the arrival of fallout, it became apparent that the Radef staff at the EOC would be incomplete, appropriate replacements could be directed to report to the EOC. Similarly, if additional assistance were required during the period of recovery operations, augmenting forces could report to the EOC without receiving intolerable radiation exposures.

CHECKLIST FOR PREPARATION OF EOC RADIOLOGICAL OPERATIONS SOP

The SOP should provide specific detail concerning WHO (by title), WHEN, WHERE and HOW for the following functions, as applicable.

Functions

1. Alerting of personnel (see example Roster of Radef Operation Personnel).
2. Preparation for operations (rearrangement of space, setting out special equipment, maps, etc.).
3. Delineation of communications channels and procedures (in consonance with local CD plan).
4. Schedules for reports from monitors
5. Receipt of UF data, preparation of wind vector plots and fallout forecasts.
6. Reporting to other elements of government.
7. Presentation and display of radiological information to EOC staff.
8. Training in EOC operations, if required postattack, to fill position vacancies or augment staff.

9. Coordination with other services.
10. Message and data handling.
11. Plotting and analysis.
12. Preparation of advisories.
13. Radiological calculations in support of evaluation (item 15).
    a. Decay characteristics
    b. Estimation of future dose rates and doses.
14. Control and direction of monitoring operations:
    a. Scheduled on-station monitoring and reporting.
    b. Coordination of monitoring by various services recognizing changing radiological and operational situations.
    c. Reassignment of shelter monitors in support of recovery operations.
    d. Radiation exposure control for monitors.
    e. Planning and assignment of mobile (surface and/or aerial) monitoring and survey missions and associated reporting systems and procedures.
15. Evaluation and staff support, concerning:
    a. Relative hazards in various types of shelter.
    b. Need for and feasibility of decontamination and/or remedial movement.
    c. Shelter stay time.
    d. Hazards associated with emergency operations (proposed and in progress).

ROSTER

RADEF OPERATION PERSONNEL

November 16, 1962

Name	Address	Phone		
		Home	Business	
Richardson, M. C.	227 North Rampark	MO6634	MA3215	RADEF officer.[1]
Miller, C. S.	2064 McElvertt St	SE8436	BL1968	Assistant RADEF and training officer.[2]
Turner, L. A.	9063 Grover Ave	NO1106	OX7111	Chief, plotting and analysis.[1]
Mann, Z. F.	4110 Lewis Place	BL5437	MA9934	Plotter.[2]
Smith, D. A.	3364 Wilson St	LO3004	MA70 3	Plotter.[1]
Bigger, M. V.	217 Dupoint Ave	DL9786	PL0775	Senior analyst.[2]
Callahan, B. H.	5502 McDill Ave	MO7681	OX2444	Analyst.[1]
Wright, C. M.	694 McElvertt St	SE8486	MA2926	Chief monitor.[1]
Weinthrub, G. N.	7854 Gross St	NO6229	OX3468	Assistant monitor Chief.[2]
Hiscox, I. J.	4710 Mt. Pleasant	DE4442	PL1367	Chief supply and maintenance.[1]
Little, V. C.	116 Nelvin Ave	BL5753	BL6879	Assistant supply and maintenance.[2]
Curruth, Y. T.	2674 Rosson St	LO3207	BL4030	Assistant supply and maintenance.[1]
Matt, V. O.	69 Royal Place	NO4997	MO7345	Assistant supply and maintenance.[2]
Bryant, L. D.	3219 Hinds Park	SE1117	PL6011	Assistant supply and maintenance.[2]

[1] 1st Shift (subject to postattack revision)
[2] 2nd Shift

Order of Succession

RADEF officer	Richardson, M. C.
Assistant RADEF officer	Miller, C. S.
Chief plotting and analysis	Turner, L. A.
Senior analyst	Bigger, M. V.

CITY STREET DEPARTMENT

SOP FOR FIXED FALLOUT MONITORING STATION XYZ
AND
EMERGENCY MONITORING OPERATIONS IN AREA 27A

(Illustrative Example)

References.

1. Local radiological service plan
2. City Street Department emergency operations plan
3. Handbook for Radiological Monitors, OCD, April 1963

General. The primary functions of monitoring teams are to provide timely and accurate information to the Radef service required for proper analysis and evaluation of fallout in their designated area of responsibility, and to give a monitoring capability to the City Street Department during emergency operations. (See Tables 1 and 2.)

Organization.

1. Fixed Monitoring Station XYZ is located in Room B-26, Baker Building, and is manned by personnel of the City Street Department.

2. Monitoring personnel will consist of a Senior Monitor (monitor in charge) and three monitors. (See Table 3.)

3. The monitoring operations during the shelter period will be conducted under the direct supervision of the Radef Officer.

4. During emergency field operations the team will render monitoring support to the City Street Department in coordination with the Radef service.

Equipment and Supplies.

1. Monitoring instruments - The monitoring equipment will be stored in Room B-26, Baker Building. Two sets of serviceable batteries will be maintained on hand, however, the batteries will not be inserted in the instruments during storage. (See Table 4 for inventory of radiological instruments.)

2. Administrative supplies and forms - An adequate supply of administrative supplies such as paper, pencils, etc., and forms will be maintained in the monitoring station. Forms will consist of the following:
   a. Radiation Exposure Record
   b. Inspection, Maintenance and Calibration Log for Radiological Instruments
   c. Radiological Reporting Log

3. Vehicles - As assigned by Transportation, utility pickup trucks CSD 337 and CSD 360 will be made available by the dispatcher for use by monitoring teams for emergency operations. These vehicles will come under the control of the senior monitor upon an attack, or warning of an attack, and will be housed, when not in use, in the designated location in City Street Department maintenance building number 2. (See Table 1.)

Communications. The telephone will be used in reporting radiological information to the EOC during the period of in-shelter monitoring. The City Street Department radio net may be utilized for this purpose in the event of telephone communications disruptions. During emergency operations monitoring, the department's radio net may be used for high priority reporting to EOC. The call sign designation is listed on the card attached to each radio of the department.

Monitoring Operations. Radiological monitors will perform functions as outlined in this section. Any departure from these procedures must be approved by the Radef Officer and the department's civil defense coordinator.

1. Readiness operations - During peacetime, monitoring personnel will take the following actions under the supervision of the senior monitor:
   a. Perform operational check on all survey meters and rezero all dosimeters on or about the 20th of March, May, July, September, November and January.
   b. Record the results on the inspection, maintenance, and calibration log.
   c. Initiate action for the repair or replacement of inoperable instruments through the department's civil defense coordinator.
   d. Make instruments available to the Radef supply and maintenance officer for calibration on or about the 20th of March and September in conformance with his specific request.
   e. Replace batteries on or about the 20th of March, or sooner if necessary.
   f. Participate in refresher training exercises and tests as requested by the training officer through the civil defense coordinator for the City Street Department.
   g. Maintain current sketches of the area of responsibility shown in Tables 1 and 2, indicating monitoring station, inshelter monitoring point, and preselected monitoring points within the area of responsibility.

2. Shelter operations -
   a. Readiness actions:
      (1) Reporting for duty - All team members will report to Station XYZ with the least possible delay following warning that attack on the nation is likely to occur, or has occurred.

(2) Instrument operability check - The first monitor arriving at the station will perform an operational check on all survey meters and charge the dosimeters.

(3) Operational readiness report - A report will be made to the EOC that "Station XYZ is operational." When time permits, attempts will be made to contact missing team members by telephone.

(4) Station safety - Check to see that doors, windows, or other openings are securely closed during fallout deposition.

(5) Place one CD V-730 dosimeter and one CD V-742 dosimeter, after being properly zeroed, in the rack on the table provided as the inshelter monitoring point (see location indicated on Table 1).

(6) Place second CD V-742 dosimeter in a plastic container and place on the stake provided at the unsheltered monitoring point.

3. Fallout monitoring station operations -

a. Flash reports - Begin outside surface monitoring to determine the time of fallout arrival. When outside dose rate exceeds 0.5 r/hr, make Flash report to the EOC, using the following format: This is Monitoring Station XYZ. Dose rate exceeded 0.5 r/hr at 1000 hours.

b. Monitoring times and reporting schedules - All reports will utilize local time, and will conform to the reporting schedule shown on the radiological reporting log (see Handbook for Radiological Monitors, Chapter IX). Reporting times indicated on the radiological reporting log will be converted to local time using the time conversion chart on the reverse side of the log. These conversions will be entered in the spaces provided above Greenwich meridian times of the log.

c. Dose rate reports - Except as provided in (e) below, the scheduled unsheltered dose rates will be measured and recorded. Upon call for report from the Radef Officer, the report will be rendered in the following format. Example: This is Station XYZ. 2200 hour dose rate 57 r/hr.

d. Dose measurement report - The accumulated dose measurements will be reported as a part of, and immediately following the 2200 hour (2300 hours daylight time) report using the following format. Example: Measured dose at 2200 hours 720 roentgens.

e. Discontinuance of unsheltered monitoring - When the unsheltered dose rate reaches approximately, or exceeds 100 r/hr, they will be calculated from sheltered dose rates. See Chapter IX, Handbook for Radiological Monitors, page 9-12, paragraph titled "Unsheltered Dose Rate Measurements."

f. Resumption of outside monitoring - Resume outside monitoring after the unsheltered dose rate has decreased to 25 r/hr.

Monitoring in Support of Emergency Operations. When it has been determined, in coordination with the EOC, that radiation levels have decreased sufficiently to permit high-priority street maintenance operations and, later, as operational recovery activities are initiated, including decontamination of streets and structures in the area of responsibility, the monitoring team will be required to provide radiological monitoring support to these operations as a primary mission. At this time, reporting of radiological information will become a secondary mission.

1. Except where radiological coordination has been effected through the department representative at the EOC, the senior monitor will obtain the following information from the EOC and furnish it to the coordinator of operations of the city street department:
   a. The time when personnel of the department may leave shelter to perform specific missions.
   b. The allowable dose for the complete mission; from time of departure until return to shelter.
   c. The dose rate to be expected in the area of the mission.
   d. Procedure and schedule for reporting radiological information to the EOC.

2. When the senior monitor has assigned a monitor to accompany an emergency operational mission, the monitor will:
   a. Advise on protective measures to be taken by members of the group to prevent the contamination of their bodies. (See Handbook for Radiological Monitors, Chapter IX).
   b. Read his instrument frequently during each operation and advise the individual in charge of the mission on the necessary radiological protective measures and when the radiation exposure is approaching the planned maximum mission dose.
   c. Determine the effectiveness of decontamination measures when supporting decontamination operations.
   d. Monitor personnel and equipment on return to shelter or base of operation to determine the decontamination requirements.
   e. Direct decontamination of personnel and equipment, in coordination with the person in charge and assure that the decontamination is effective.
   f. Record monitored information on sheets attached to the Radiological Reporting Log in the format appropriate to the mission. Report data to EOC, if required in mission directive.
   g. Assist in recording exposure doses of emergency team members on individual radiological exposure records.

3. Obtain monitoring readings at preselected monitoring points designated in Table 2, when directed.

Table 1 Diagram of Monitoring Station XYZ
Table 2 Area of Emergency Operations
Table 3 Roster of Monitors
Table 4 Status of Monitoring Instruments

APPROVED:

Radef Officer	Date
Director of City Street Department	Date

TABLE 1

City Street Department SOP Fixed Fallout Monitoring Station XYZ and Emergency Monitoring Operations in Area 27a

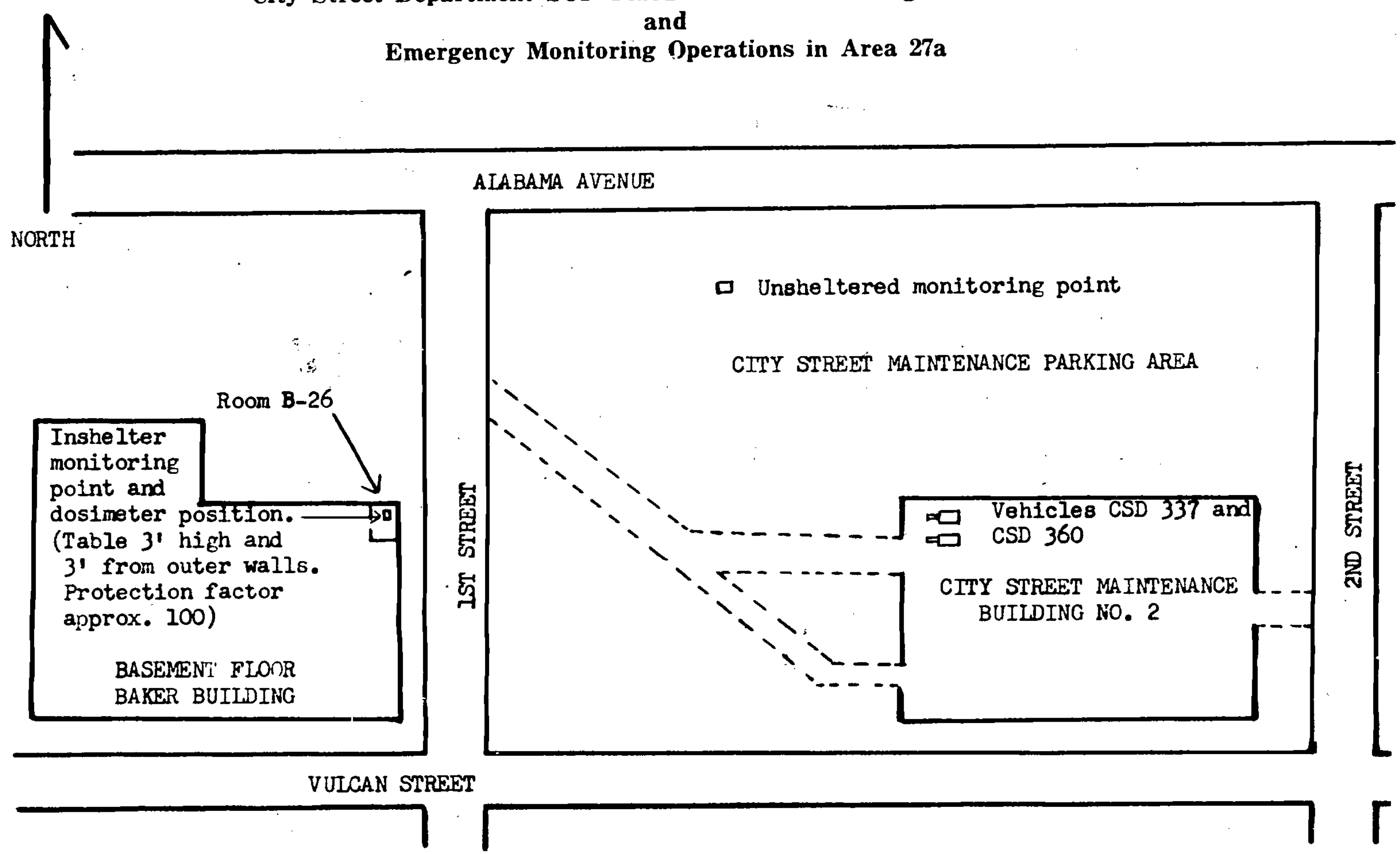
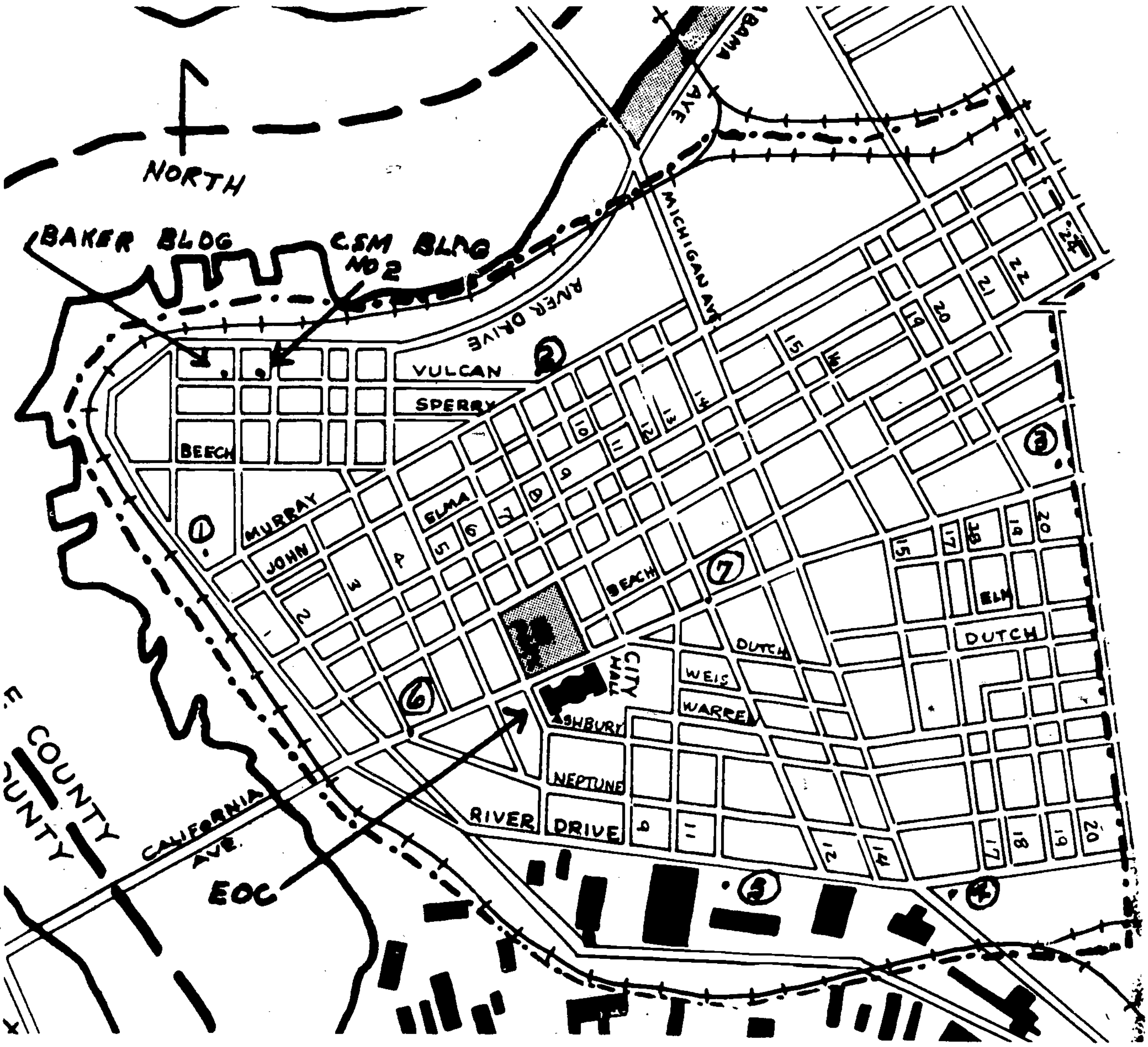


TABLE 2

City Street Department SOP Fixed Fallout Monitoring Station XYZ and Emergency Monitoring Operations in Area 27A



— · — · — · Boundary Area 27a

① Etc. Preselected monitoring points

TABLE 3

ROSTER OF MONITORS
MONITORING STATION XYZ AND AREA 27A

Name	Division	Home address and phone	
Daniels, L. C [1]	Street maintenance	1542 Elm Ave	MO62371
McCue, O. B	do	402 S. 20th St	LO34536
Johnson, W. D	do	118 N. 15th St	NE21161
Leary, B. F	do	521 N. 19th St	NE21885

[1] Senior monitor.

Roster is listed in succession of command.

EMERGENCY TELEPHONE NUMBERS

RADEF officer	McLaughlin, G. H	OX71163
RADEF supply and maintenance officer	Williams, E. C	OX74110
EOC location	Room B-117, City Hall	OX74100, OX74101

TABLE 4

RADIOLOGICAL INSTRUMENTS
MONITORING STATION XYZ AND AREA 27A

Operational Monitoring Kits, CD V777, 2 each consisting of the following:

Number	*Item*	*Quantity*
CD V-700	Geiger counter (0–50 mr/hr)	2
CD V-710	Survey meter (0–50 r/hr)	1
CD V-715	Survey meter (0–500 r/hr)	2
CD V-720	Dosimeter (0–500 r/hr)	1
CD V-730	Dosimeter (0–20 r)	1
CD V-740	Dosimeter (0–100 r)	1
CD V-742	Dosimeter (0–200 r)	2
CD V-750	Dosimeter charger	2

INSTRUMENTS REQUISITION PENDING

CD V-742	Dosimeter (0–200 r)	20

COORDINATED FUNCTIONS
COUNTY RADEF - REPRESENTATIVES OF USDA

The States and their political subdivisions have broad responsibility for developing radiological service capabilities throughout their areas. The USDA is assigned certain responsibilities for radiological defense as it affects agriculture and agricultural resources. These include developing plans and furnishing technical guidance covering protective measures for the treatment and handling of livestock, including poultry; agricultural commodities on farms or ranches; agricultural lands; forest lands; and water for agricultural purposes, any of which have been exposed to or affected by radiation. It also includes activities to assure the safety and wholesomeness, and minimize losses from radiological effects and other emergency hazards of livestock, meat and meat products, poultry and poultry products in establishments under the continuous inspection of the U. S. Department of Agriculture, and agricultural commodities and products owned by the Commodity Credit Corporation, or by the Secretary of Agriculture. In order to avoid duplication of equipment, training, and personnel requirements, the following division of responsibilities should be observed.

Responsibilities of Local Government.

1. Establish local procedures for monitoring and reporting necessary for the evaluation and control of radiation exposure of the (rural) population, livestock, and poultry.
2. In conjunction with representatives of USDA, establish local procedures for the radiological monitoring and reporting (or mapping) of contamination of privately owned farmland and agricultural commodities.
3. Establish monitoring and reporting systems to supply the intelligence necessary for the short- and long-range protection of the lives and property of (rural) people. Appropriate monitoring information should be made available respectively to the local government and to USDA representative(s).
4. Perform other appropriate radiological defense functions as directed in the Federal Civil Defense Guide.

Responsibilities of The Department of Agriculture (local representatives).

1. In conjunction with the local civil defense office, establish local procedures for the radiological monitoring and reporting (or mapping) of contamination of privately owned (a) farmland, and (b) agricultural commodities (stored or harvestable).
2. Based upon local monitoring information and USDA guidance, recommended appropriate (a) use of agricultural lands, (b) use or disposition of agricultural commodities, and (c) care or disposition of livestock.
3. In conjunction with the local civil defense, advise the farm population on precautions to take to minimize radiation exposures associated with important farm work; i.e., denial time, stay time, shielding required, etc.

4. Perform other radiological defense functions in consonance with Executive Order 10998 and official OCD guidance.

Organization. The organization of local government varies significantly from State to State. However, in most States the element of government most active in administering local aspects of USDA programs is the county. For this reason, it is expected that a major part of the radiological defense for agricultural areas will be organized and administered primarily from the seat of county government.

The following personnel will be among those concerned with the joint responsibility for local agricultural radiological defense:

1. County civil defense director (policy)
2. County radiological defense officer
3. Chairman, USDA County Defense Board
4. Local representative of the Agricultural Marketing Service, Agricultural Research Service, Forest Service, or Soil Conservation Service, having radiological defense responsibilities.

Operational Plans (Joint USDA and Local Functions). Since farm size, land use, terrain, road systems, and communications requirements will vary greatly from area to area, detailed plans will vary and must reflect local conditions. The following are general recommendations of items for such a detailed plan.

1. USDA (local representative) will recommend guides and procedures for that part of the monitoring required for evaluation of:
   a. acceptable land and farm water use;
   b. the degree of contamination of agricultural commodities, stored or harvestable on farms, ranches, and at bin sites, and forest products;
   c. the probable effects on livestock and poultry.

2. For land use, except national forest lands, the Soil Conservation Service, USDA, will recommend:
   a. The spacing of the monitoring grid (at section line corners, etc.), and/or aerial monitoring flight patterns. This item of the plan should be subject to postattack revision for those areas where fallout deposition is quite irregular. Early monitoring performed for the safety of people and property should indicate whether or not deposition was markedly irregular.
   b. Methods of reporting, plotting and mapping the radiological defense situation as it affects agricultural operations.
   c. In conjunction with the county radiological defense officer, recommend when monitoring for land or water use evaluation should be undertaken.
      (1) Dose rates decayed to intensity low enough to present acceptable hazard to monitors.
      (2) Dose rates high enough for surface or aerial measurement with OCD survey instruments.

3. For specialized monitoring directly assigned to USDA, the agencies made responsible for the functions will plan the extent and methods of carrying out the assignments.

4. The Department of Health, Education and Welfare, in cooperation with their State and local government counterparts, has certain responsibilities for monitoring food for radiological contamination with the exception of food and related items assigned to USDA.

5. In an emergency, the USDA County Defense Board will apply USDA criteria in recommending:
   a. Disposition to be made of commodities, livestock and poultry.
   b. Utilization of land.
   c. Other disposition relating to agricultural commodities and agriculture, and forest lands within the county.

6. The county civil defense is responsible for performing radiological defense functions in conformance with Federal and State plans. Those functions include the development of monitoring and reporting capability in support of USDA requirement.

CHAPTER III

IMPLEMENTATION OF RADEF PLANS INCLUDING EMERGENCY OPERATING CENTER FUNCTIONS

The "Plan for the Security Control of Air Traffic and Electromagnetic Radiations During An Air Defense Emergency" (SCATER) has been superceded by the "Plan for the Security Control of Air Traffic and Air Navigation Aids" (SCATANA). The reader is requested to substitute the word "SCATANA" for SCATER wherever it appears in this Guide.

This Chapter provides guidance to assist State and local governments in implementing their radiological defense plan and in carrying out essential Radef procedures at the Emergency Operating Center (EOC). Since the majority of the population is associated with local government (county or municipal) and since the primary survival and recovery operations will be carried out at the local level, the guidance material in this Chapter is directed generally to the local situation. However, appropriate guidance material is also included to assist the State in performing its Radef support mission. Guidance concerning the development of the Radef plan, and details regarding the organization required to administer the plan are contained in Chapter II.

Basis for Radef Operations. A capability must be developed preattack to detect, measure, report, plot, analyze and evaluate fallout contamination. Further, a capability must be developed preattack for the application of countermeasures, including decontamination, remedial movement, and individual and collective protective measures. Once developed, these capabilities must be exercised and tested frequently during peacetime in order to maintain efficiency and improve operating procedures. At the time of attack or threatened attack, the emergency Radef operating procedures that have been developed will be placed into effect.

COORDINATION AND IMPLEMENTATION OF THE RADEF PLAN

As indicated in Chapter II, an operational capability must be developed on the basis of the local or State Radef plan that has been approved by the Radef Officer and other appropriate government officials. The Radef plan must be in consonance with the basic State or local civil defense plan, and it must be compatible with the standing operating procedures (SOP's) of the other emergency services. After development, coordination, and approval of the Radef plan have been accomplished, implementation of the plan must be undertaken.

Selection of Locations for Monitoring Stations. Chapter I provides guidance for determining the approximate number of monitoring stations required for urban and rural areas. Chapter XI includes a master roster listing the locations of Federal agency facilities where a monitoring capability has been established. In selecting locations for monitoring stations, the local Radef Officer should indicate on a map of his area of responsibility, in appropriate color or symbol code, the following:

1. The existing Federal, State and local facilities that currently have a fallout monitoring and reporting capability.

2. Locations of licensed and stocked community shelters.

3. Locations having a protection factor of 100 or better, not licensed as community shelters but potentially suitable for monitoring stations. (Shelter survey reports are a source for some of this data.)

4. Locations of key facilities such as police stations, fire stations, hospitals, emergency operating centers, radio transmitter sites, water pumping stations, sewage disposal plants, etc., that may have to be manned during the early postattack period.

5. Locations of the civil airports and landing fields that are maintained and have fueling facilities.

6. Major railroad, motor freight and water transportation terminals and repair shops; and the locations of those industries whose early reactivation would be essential to the survival and recovery of the local area and the nation.

The populated areas, as well as other habitable areas that may be needed for remedial movement, should be examined with regard to the locations that have been indicated by color on the map. If the indicated locations are fairly uniformly distributed across the area of concern, and if the total number of locations is approximately equal to that required for the area, the multicolored map will provide a good basis for establishing the monitoring station network. However, potential monitoring station locations must additionally provide fallout protection for the monitors and must have communications (telephone or radio) for the transmission of radiological reports to the EOC or to a collection center.

As a basic policy, OCD requires that monitoring station locations provide a PF of at least 100 in order to qualify for a CD V-777 operational monitoring kit. However, operational monitoring kits are granted by OCD for monitoring stations with a PF less than 100 in those areas where such protection does not exist and cannot be implemented readily, if appropriate justification is included in the request (see Chapter VIII).

In all habitable areas, the local Radef Officer must develop a proper distribution for the monitoring station network, but at the same time an effort must be made to obtain locations with a sufficient degree of fallout protection to permit the monitors to sustain their essential functions. The Radef Officer may establish some of the monitoring and reporting stations at those community shelters that provide proper geographical distribution and communications.

If the map, referred to above, does not provide a good geographical coverage of the area of concern, or if the number of locations is significantly less than the number of monitoring stations required for the area, the Radef Officer must make a more thorough survey of the area to locate proper facilities for monitoring stations. In some instances, homes may have to be used for monitoring stations but, to the extent possible, selection should be limited to those homes that have a fallout shelter.

The county Radef Officer must similarly develop a monitoring station network in the habitable rural areas of the county. Maximum use should be made of grain elevators, centralized schools, and other sizable rural buildings that provide an appropriate degree of fallout protection and that have adequate communications (telephone as a minimum). It is recognized that many of the rural monitoring stations must be located at farm and ranch homes. However, where possible, the use of homes for monitoring stations should be limited to those homes that have fallout shelters, root cellars, tornado cellars, or other suitable shielded area.

The State Radef Office must establish a monitoring capability at State facilities, particularly those remote from municipalities, such as highway patrol and maintenance stations, conservation stations, forest and game preserve stations, State institutions, etc.

Aerial Monitoring Responsibility, and Selection of Bases of Operation. The development of an aerial monitoring and survey capability is primarily the responsibility of the State Civil Defense Director. However, close coordination between the State Civil Defense Director, Federal Aviation Agency (FAA) representative, and the State aeronautical authorities is essential. Planning for this capability should be made in conjunction with the development of the State plan for the emergency dispersal of non-air-carrier aircraft for which the State aeronautical authorities are responsible. Further coordination should be effected with the Office of Emergency Planning (OEP), Office of Emergency Transportation (OET), Department of Commerce, and other governmental agencies as required. The State and local plan should be compatible with the FAA SARDA Plan.

The airports and landing fields having refueling facilities should be plotted on a State map indicating the potential aerial survey capability existing at each of these locations. Based upon this potential, the State should be divided into survey areas appropriate for providing monitoring support to urban areas, the counties, and Statewide operations.

Approval and Designation of Selected Monitoring Station Locations. If the basic Radef plan, as described in Chapter II, has been properly developed and previously coordinated with the other services of local government, implementation of the elements of the Radef system will be considerably facilitated. The Radef Officer should explain to the participating services that they will need a monitoring capability in order to safely sustain their essential emergency postattack operations in areas of fallout and, thus, the instrumentation can serve a dual purpose. It will provide the capability for the services to determine the radiation hazard in fallout areas where they may have to operate, as well as provide a capability for determining exposures of their personnel. Also, by reporting fallout information to the EOC, the services will be providing basic intelligence required by local government to effectively direct the survival and recovery functions. After the plan for the fallout monitoring network has been tentatively drafted, the local Radef Officer should submit the plan for concurrence.

To assist in implementing the plan, the mayor might convene a meeting of the directors of all the municipal government elements, (fire, police, health, engineering, sanitation, maintenance, etc.) whose facilities and personnel will be required to implement the fallout monitoring station network. At this meeting, the mayor could present the proposed monitoring station network as an officially approved local emergency plan, and could call upon the civil defense director and the Radef Officer to explain the operational requirements that the plan would place upon each of the participating community services. Additionally, the Radef Officer would advise the service directors of the type and number of monitoring instruments that would be made available for each monitoring station; the numbers of their personnel who would require training; the length of the training course; the provision of monitor training (by whom and when); and the availability of refresher training, tests and exercises.

If required to implement this element of the industries' emergency preparedness programs, the mayor or the civil defense director might be asked to schedule a separate meeting with management of the industries whose participation is desired in the monitoring station network. Similarly, there might be a meeting with the adult private citizens whose participation in the monitoring station network is desired. At these meetings, the Radef Officer could explain the necessity for the monitoring station network, pointing out to participating industrial management and private citizens the advantages of having a monitoring capability within industry, and within residential and agricultural areas.

Selection of Personnel to be Trained for the Radiological Defense System. As indicated in Chapter I, monitors must be trained for the community shelters and for the monitoring stations. Additionally, personnel such as recorders, plotters, and analysts must be trained to assist the Radef Officer at the EOC; and the decontamination specialist and crews must be trained for recovery operations. Personnel to perform these Radef functions should, to the extent possible, be selected from existing government employees. This is particularly true with the emergency services in order to provide a "built-in" capability. However, there should also be a sizable selection of government personnel from the services having no early post-attack assignment. This will relieve emergency services personnel from "on-station" monitoring activities which interfere with their primary assignments.

To obtain the required personnel, the Radef Officer must do considerable staff work and coordination with the participating elements of government, industry, and community organizations. Further, prior arrangements might be made by the civil defense director, through the mayor's office, for the issuance of proper directives to the local government agencies and requests to local industry for the assistance and cooperation of their personnel. Chapter II describes more fully the duties and qualifications of Radef personnel and suggests political sources of personnel.

Selecting the Radiological Defense Officer. The careful selection, appointment, and proper training of a well qualified person as the radiological defense officer is mandatory at each local and State jurisdiction in order to plan, develop, implement, and operate the radiological defense program. Because of his many and varied technical and administrative responsibilities, the Radef Officer must be well qualified, and at the State level as well as at the larger local levels, he must be a full-time government employee with permanent status. At the smaller municipal levels, the Radef Officer's responsibilities may be assigned on, perhaps, a half-time basis to a local government employee, preferably with technical background, or to a representative from industry. If, in some of the smaller areas, it is not feasible to assign a person on a half-time basis, an interim or alternate arrangement must be adopted. As an example, in a smaller community, the Radef Officer may be the high school science teacher who has been given additional incentive, perhaps $1,000 or more per annum, to develop the program during evenings and weekends. Federal contributions are available from the Office of Civil Defense for half of the administrative costs of the Radef program, including the salaries of the Radef Officer and his staff, provided OCD standards are met.

Selecting Personnel to be Trained as Monitors. Monitors should be selected primarily from State and local government employees. This will provide better unity and a more effective span of control. It is suggested that, to the extent practicable, all firemen, policemen, State highway patrolmen, highway maintenance personnel, their augmenting forces and their reserves be selected for monitor training. Further, radiation monitoring should be included as part of the basic training for all new recruits in these services, and refresher monitor training should be routinely scheduled. To supplement this initial cadre of monitors, high school and college science teachers, selected State, county and municipal employees in the engineering, sanitation, welfare, and health services, as well as other State and local employees, as appropriate, should also be selected for monitor training.

In areas where monitoring stations have been established in industrial plants, hospitals, commercial buildings, and other facilities, appropriate personnel who are normally employed at these facilities should also be selected for monitor training. The planning for this will have to be properly staffed and coordinated in advance with the management staffs of these private concerns. In rural and suburban areas, where a home shelter may have been designated as a part of the monitoring and reporting system, if possible, members of the family who will occupy the shelter should be selected for monitor training. Since a large cadre of monitors will be required, the selection of personnel for training should be fairly broad.

Decontamination. Guidance concerning decontamination programs and operations is presented in Chapter XII. Responsibility for decontamination programs, particularly in the smaller jurisdictions, may be assigned to the Radef Officer.

Selecting Radef Personnel for the Emergency Operating Center. The Radef Officer will need a supporting staff to assist him in the control center. To the extent possible, he should make use of qualified local or State government employees and, in some instances, Federal employees, if they have not been previously assigned elsewhere. For receiving and recording the dose rate reports from the monitoring stations, the Radef Officer should plan to have clerical help made available at the time of emergency. It is recognized that available space in the EOC may severely limit the size of the EOC staff (see Chapter II). However, in selecting a balanced staff, several requisite capabilities should be recognized. For plotting reports on a map of the area and for assisting in the preparation of visuals, the Radef Officer should plan to have drafting personnel, illustrators, or artists available at time of emergency. For preparation of forecasts and analyses, the assistance of meteorologists, cartographers, geographers, geologists, or civil engineers should be sought. For assistance in evaluation and technical guidance, the Radef Officer should enlist the services of all monitor instructors, selected science teachers, health physicists, as well as other available active or retired personnel in his area who have had experience in these operations. Arrangements to make these people available in time of emergency will require planning and considerable prior staff work on the part of the Radef Officer soon after his Radef plan is accepted as a basis for operation.

Assignment of Personnel. After the selection of personnel for Radef operations has been approved by appropriate authorities, each individual concerned should be advised, in writing, of the specific function that he has been assigned to perform and the location to which he will report. He should also be advised of the specific training that he will be given and the tentative schedule for his training.

Maintenance of Directories and Rosters. Under the supervision of the local Radef Officer, there must be maintained a current directory of the locations of all monitoring stations, aerial survey bases of operation, and licensed community shelters in the local jurisdiction. Also, a current roster of all selected and trained local Radef personnel must be maintained along with a record of each person's emergency assignment. At State level, similar records must be maintained of State facilities and personnel.

Initial Training of Radef Personnel. All radiological defense personnel will require training to perform their specialized functions. Some of the procedures such as recording, plotting, and decontaminating are fairly routine, and adequate "on-the-job" training can be provided by the Radef Officer during tests and exercises. However, training of a formal nature is needed for monitors, monitor instructors, aerial monitoring teams, and particularly for Radef Officers.

Training of Radef Officers and Monitor Instructors. State or local civil defense directors may send qualified personnel to the OCD Staff College, or to either of the two OCD Training Centers, for Radef Officer and Monitor Instructor training. Participants approved by the State Civil Defense Directors and OCD regional directors may be reimbursed up to one-half of their principal transportation expenses and per diem by the Office of Civil Defense for their participation in courses at the three OCD schools. Further details on eligibility for this reimbursement should be obtained through local or State civil defense offices. The successful completion of the "Radiological Monitoring for Instructors" course, or its equivalent, is a prerequisite for enrollment in the Radiological Defense Officer course. The State and the larger local civil defense offices should send more than one person for Radef Officer training in order to provide assistance and an increased operational capability.

Training of Radef Monitors. Monitor training should be conducted by instructors qualified through completion of the OCD "Radiological Monitoring for Instructors" course, or its equivalent. State and local governments may be reimbursed by OCD for a portion of the costs of local courses of instruction for monitors, in accordance with established schedules, provided OCD standards are met. Upon completion of training, each monitor will receive his duty assignment and be furnished a copy of the "Handbook for Radiological Monitors." This handbook contains the detailed instructions for monitoring and reporting operations, as well as special instructions concerning the monitor's responsibilities and procedures for dealing with routine and emergency radiation conditions "inside" and "outside" shelter. The Office of Civil Defense provides these manuals for distribution to the monitors.

The capabilities existent in the Armed Forces may be used to supplement the monitoring instructor training resources. If this method is used, OCD will provide the curricular material, training instruments, and guides; and local government will provide the facility or quarters where the training will be conducted as well as make the selected personnel available for monitor training.

Training of Aerial Monitors. The monitor training, described above, is a prerequisite for aerial monitor training. Pilots and other personnel chosen for special training in aerial monitoring techniques should be from among the best qualified monitors since these personnel will be required to operate without close direction and supervision, under hazardous conditions which might require on-the-spot decisions and prompt actions to assure reliable monitoring information and personal safety. The State Civil Defense Director has primary responsibility for establishing the aerial monitoring capability within his State.

The aerial survey meter CD V-781 is adapted with a simulator assembly for use in training aerial monitors.

OCD is responsible for establishing civil defense training requirements, policy, general guidance, and procedures for carrying out State and local civil defense aerial monitoring and support operations, all in consonance with guidance provided by FAA and the Civil Air Patrol in their areas of responsibility. OCD will assist in training selected instructors to provide training for aerial monitors and will assist in the provision of contributions for student expenses and per diem for training of instructors, and for training of aerial monitors in accordance with financial assistance programs.

State civil defense units may arrange with OCD national headquarters for the training of aerial monitor instructors and, in coordination with local civil defense units as required, are responsible for the training of personnel involved in the support of civil defense missions. CAP units are responsible for carrying out the training normal to CAP operations which apply to civil defense type missions and for specialized training applying to these missions.

Training of EOC Radef Personnel. The training of EOC Radef personnel should be planned and developed by the Radef Officer. However, in the actual on-the-job training of recorders, plotters, and analysts, the Radef Officer should enlist the assistance of the trained monitor instructors in his area. He might enlist the assistance of physics professors, members of the American College of Radiology, retired military officers, or professional meteorologists. For assistant Radef Officers, the Radef Officer should provide to his monitor instructors on-the-job instruction in EOC radiological operations, or he should have them sent to one of the OCD schools for training as a Radef Officer.

Executive Training and Orientation. In addition to the training of the appropriate Radef personnel, there should be an orientation briefing, or series of briefings, scheduled by the head of government for his executive staff and the executive personnel of industry within the local area. Briefing material might be presented by the mayor, the civil defense director, the Radef Officer and the decontamination specialist. The briefing(s) should include presentations concerning the threat; effects of nuclear weapons with emphasis on the effects of fallout, countermeasures under development by the local government, and the role expected of government and industrial executives in support of the local mobilization and survival plans; and the indoctrination of the public in individual and group protective measures.

Subsequent Training and Refresher Courses. Subsequent training of monitors, to provide for attrition and refresher training of monitors on a scheduled basis, should be arranged for by the local Radef Officer, making use of the trained monitor instructors in his area. Refresher training of emergency operating center personnel, as well as other Radef personnel, can be accomplished by means of practice exercises and operational tests. Guidance for preparing input data for practice Radef exercises is contained in subsequent sections of this chapter and in Chapter VI.

Developing a Surface Mobile Monitoring Capability. As an element of surface mobile monitoring, the Radef Officer must make arrangements to ensure that fallout data monitored by the emergency services, enroute to and at the scene of emergency operations, is reported promptly to the headquarters of the specific service for relay to the EOC. It is also essential to establish monitoring stations and the associated mobile monitoring capability, utilizing monitoring personnel other than those from government services which are already assigned postattack emergency functions. This is necessary to reserve the potential exposure of specialized emergency personnel so that maximum performance of their services may be retained. In many cases, vehicles for surface mobile monitoring will not be made available by State or local governments exclusively for fallout monitoring purposes. Therefore, plans should be made to use any transportation which may be available.

Since the role of the State is primarily one of support, the State Radef Officer should develop a mobile monitoring capability among the State highway maintenance and patrol services. Early fallout information, along highways and routes of ingress and egress to communities, is extremely important at State levels.

Field procedures for area surveys are detailed in the "Handbook for Radiological Monitors." The Radef Officer is responsible for preattack planning of detailed surveys to be conducted from each monitoring station. The plans for potential missions should be incorporated in the standing operating procedures of the respective stations. Assigned monitors should have a clear understanding of the purposes of their missions, and be familiar with mission details in order to minimize field exposures.

In a postattack situation, surveys should, where practicable, be deferred until dose rates have decreased to tolerable levels. In general, they should not be performed far in advance of apparent requirements for the data. Subject to the broad direction of the civil defense director, the Radef Officer is responsible, postattack, for assigning maximum mission doses, and the maximum dose rates to be expected in the areas of assigned operations.

Developing Aerial Monitoring Capability. Fallout information obtained from monitoring stations and mobile surface monitoring will generally be adequate as a basis for directing survival and recovery actions in urban areas. However, the broadbrush monitoring of transportation routes, large areas such as agricultural lands, and areas surrounding essential facilities remote from a surface monitoring capability, can best be accomplished by aerial monitoring. Additionally, aerial monitoring would be of value for obtaining fallout information from urban as well as rural areas where communications from surface monitoring stations have been destroyed or have failed. Also, in areas of high radioactive contamination that would preclude surface mobile monitoring, aerial monitoring is of particular value since it provides the flexibility for operating from areas of low contamination into areas of high intensities. Further, aerial monitoring operations can be carried out at altitudes of several hundred feet, thus, considerably reducing the exposure to monitoring personnel. Therefore, an aerial monitoring capability should be developed at the approximately 5,000 civil airports across the United States that are maintained and have fueling facilities.

The effective development of aerial monitoring programs and reliable postattack operations can be expected only if the capabilities of organized flight groups are utilized. For that reason, it is planned that a major part of the aircraft and flight personnel needed for aerial monitoring will become available through the Civil Air Patrol (CAP), a civilian auxiliary of the United States Air Force. However, to provide an appropriately dispersed capability, it will probably be advantageous to utilize the capabilities of all non-air-carrier aircraft as provided in the FAA SARDA plan.

Development of an aerial monitoring capability requires coordination at the State and local level between appropriate representatives of civil defense, FAA, State Aeronautics Boards, air organizations (primarily CAP), and other agencies having related assignments. Detailed guidance for planning and developing an aerial monitoring capability is presented in Annex 1 to this chapter.

Limitations of Aerial Monitoring. It is unlikely that extensive aerial monitoring operations could be undertaken in most sections of the country following a massive nuclear attack until 24 to 48 hours, or longer, after attack, because aerial readings may not be valid while significant amounts of fallout are still airborne; radiation levels at the airfields may delay flight preparation; and, although arrangements have been made to assign high priority to such flights, authorization of monitoring flights by NORAD through Plan SCATER could be delayed, particularly under conditions of repeated or extended attacks. Therefore, aerial monitoring cannot be substituted for "on-station" or "surface mobile" monitoring. Aerial monitoring must be considered supplementary to the basic element of the system --the monitoring station network.

Availability of Instruments, Supplies and Services. All operational monitoring stations, community shelters, surface mobile and aerial monitoring facilities, and EOC's must be provided with fallout monitoring instruments, and provision must be made for maintenance and calibration of the instruments. Further, all monitoring stations, shelters, and EOC's must be provisioned with sufficient food, water, medical and sanitation supplies to sustain the occupants for a period of at least two weeks. Additionally, special equipment is required by the Radef Officer and his staff at the EOC to carry out their special functions concerned with recording, plotting, analysis, and evaluation of the fallout hazard, and the provision of technical guidance. The Office of Civil Defense provides considerable assistance to State and local governments in the provisioning of these facilities.

Basically, sets or kits of instruments for on-station and mobile monitoring, for use by shelter monitors and for training, include high and low range survey meters, dosimeters and dosimeter chargers. Also, special training equipment, including radioactive sources and demonstration equipment, is provided. Ongoing development of radiation detection and measuring devices; changes in the threat; program emphasis; and availability of funds result in changes in instrument design, complements of instruments in sets and kits, and their availability. The OCD Instruction providing information and instructions regarding instrument availability will be consolidated in Chapter VIII, in a format allowing for ready revision as required.

Availability of Dosimeters for Emergency Workers. The Office of Civil Defense is procuring CD V-742 dosimeters for use by fire, police, medical, rescue, decontamination, resupply, and other personnel performing priority tasks in contaminated areas. These dosimeters are made available to the States, under an OCD allocation plan, as they are delivered from the manufacturers. The States, in turn, are responsible for distribution in accordance with OCD instructions for State and local ready reserve storage, primarily at shelters or other facilities planned as centers of postattack emergency operations.

Availability of Radef Equipment for the EOC. As indicated later in this Chapter, the Radef Officer and his staff at the EOC will need suitable work space, maps, plastic and tracing paper overlays, drafting equipment, light tables, radiation slide rules, nomograms, compass, protractor, graph paper (linear and full logarithmic), colored wax and grease pencils, special forms, templates, etc. The purchase of this equipment is eligible under the provisions of the OCD Contributions Program.

Availability of Food, Water Containers, Medical, and Sanitation Kits for Monitoring Stations. The establishment of fallout monitoring stations at licensed community shelters will provide for the essential food, water, medical, and sanitation requirements of the monitors since OCD is provisioning a two-week supply of these items at all licensed community shelters. At locations other than community shelters where monitoring stations are established, the purchase of these items by State or local government for the monitoring personnel is eligible under the provisions of the OCD Contributions Program. In order to sustain essential monitoring operations, it is necessary that each monitoring station be provisioned with at least a two-week supply of food and water and sanitary facilities.

Availability of Assistance for Maintenance and Calibration. As an interim measure, OCD has assisted the States in the maintenance of instruments by providing repair and maintenance service at selected Federal installations, and by providing financial assistance to those States maintaining instruments in their own repair shops or by contract with private firms. To meet the maintenance and calibration requirements for instruments at the 150,000 monitoring stations, at the bases of aerial monitoring operations, and at community shelters, it is important that a maintenance and calibration capability be established in each State, under State direction. OCD assists the States in the operation of their maintenance and calibration programs by (1) providing financial assistance for salaries of personnel, shop rental, transportation of instruments, and administrative costs; (2) loan of calibrators; (3) grant of maintenance shop equipment, spare parts, replacement instruments, and batteries. OCD will also train shop personnel for State governments.

Details concerning OCD assistance for the maintenance and calibration programs that are available to the States are in the Contributions Manual, Office of Civil Defense Instructions and official memoranda, and will be summarized in Chapter VII.

Preparation of Special Forms. Special forms will be required (a) for the chief monitor to record his bimonthly instrument operability checks at each of the monitoring stations and at each of the community shelters, (b) for the monitor to record his radiation dose rate and dose readings, (c) for recording at the EOC of radiation reports from the monitoring stations and shelters, (d) for individual exposure records, and (e) for use in surface mobile and aerial survey. Since specific details of these forms will vary from area to area, their preparation and issue is a local responsibility. However, Annex 3 to this Chapter furnishes sample forms that local government may wish to modify to meet its own requirements.

Arranging for Exchange of Fallout Information With Neighboring Elements of Government. The local Radef Officer must make arrangements, through the civil defense director's office, with neighboring communities or counties for the exchange of Flash reports of the arrival of fallout and subsequent dose rate reports. (See Chapter V for details concerning message format, frequency of reporting, etc.). These reports from neighboring elements of government are required in order to (a) more correctly estimate fallout arrival time, (b) plan remedial movement, and (c) provide support. The State Radef Officer must arrange for similar exchanges with neighboring States and Provinces.

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Arranging for Communications. Through coordination with the communications specialist, the Radef Officer must arrange for the optimum use of existing telephone, radio, and teletype facilities in order that (a) fallout reports may be forwarded rapidly to the EOC from the monitoring stations and the shelters, (b) fallout vector (UF) reports may be forwarded rapidly from the nearest Weather Bureau office or other source, (c) fallout warnings and advisories may be issued promptly to the general public, (d) summarized fallout information may be exchanged with neighboring communities or counties (at the State level, exchange would be between neighboring States, as well as between States and neighboring Canadian Provinces), (e) required fallout reports may be forwarded rapidly to State level, and (f) aerial monitoring reports may be promptly forwarded to the appropriate EOC. Figure 1 illustrates the flow of Radef information for which a communications capability must be provided.

Tests and Exercises. After the development of an operational capability is underway, the Radef Officer should occasionally prepare and conduct exercises to provide an opportunity for practice to his monitors and control center personnel, and to test operating procedures.

When preparing the input data for the exercise, the Radef Officer should first develop an arbitrary fallout situation and draw it on a map of his area. In developing the fallout situation, the tables in Chapter VI may be used, or the Radef Officer may refer to any of the nuclear cloud models or templates available for planning purposes. Having prepared the initial map for a specific time (e.g., H + 1 hours), the Radef Officer should prepare fallout maps for successive time periods (e.g., H + 2 hours, H + 3 hours, H + 4 hours, etc.). It is suggested that in preparing the successive maps, the Radef Officer assume that the fallout will decay in accordance with the $t^{-1.2}$ decay criterion. This is acceptable for planning, or for exercise purposes.

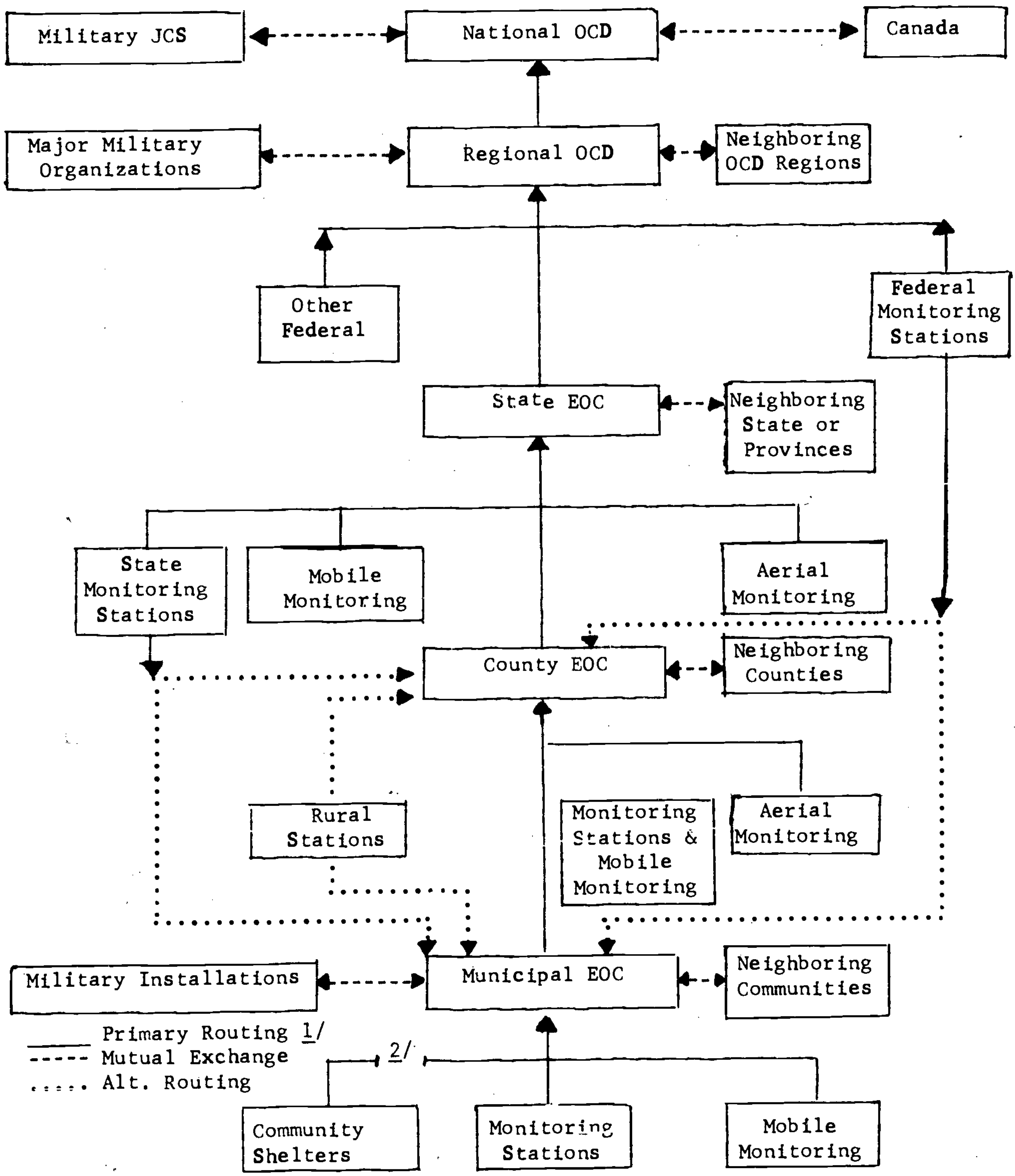
After the fallout maps have been prepared, a grid of the operational monitoring stations should be superimposed over these maps. This will indicate the hypothetical dose rate at each monitoring station for each time period. To simulate the fallout condition at each monitoring station, the dose rate should be indicated on printed meter faces for each hour of report planned for the exercise.

Figure 2 is an example of a type of printed meter face that might be used for a monitoring station to report at four different times during the exercise. The example is for a station (assigned ARLP location designator by the Radef Officer) that is scheduled, for the purposes of the exercise, to take dose rate readings at 1400 EST, 1600 EST, 1800 EST and 2000 EST on 17 June 1965. The printed meter faces are drawn to represent the CD V-715 (or 717). If the CD V-720 is available in the field, rather than the V-715, the same printed meter face could be used without confusion, particularly if the 0.1 range switch position is marked out. However, if the CD V-710 meter is in use, the major meter scale markings should be 0, 0.1, 0.2, etc., to avoid confusion.

The monitors would be furnished the printed meter faces in advance for their particular monitoring station and told to report to the control center in

FIGURE 1

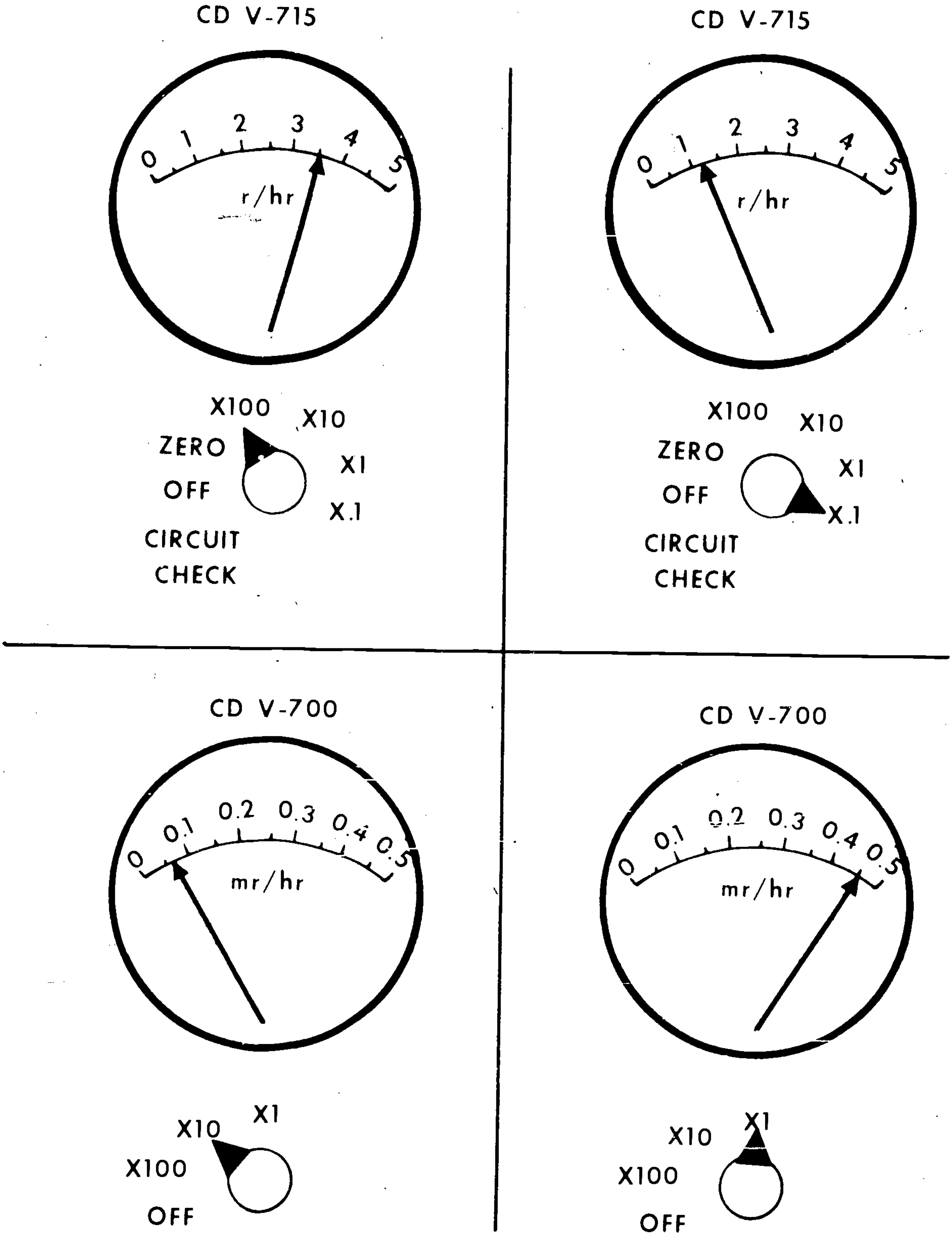
FLOW OF RADEF INFORMATION
(Limited Counterflow of Processed Data)



1/ Condensed, summarized or analyzed data transmitted between levels of government.

2/ If required by local plan.

FIGURE 2


CD V-715
0 1 2 3 4 5
r/hr
X100
X10
ZERO
X1
OFF
X.1
CIRCUIT
CHECK
CD V-715
0 1 2 3 4 5
r/hr
X100
X10
ZERO
X1
OFF
X.1
CIRCUIT
CHECK
CD V-700
0 0.1 0.2 0.3 0.4 0.5
mr/hr
X1
X10
X100
OFF
CD V-700
0 0.1 0.2 0.3 0.4 0.5
mr/hr
X1
X10
X100
OFF

accordance with their standard reporting procedures. The monitors would not be told the indicated meter face readings since this is a test of the monitors' ability to read the meter faces. However, in the example provided, the indicated dose rates are 350 r/hr., 125 r/hr., 70 r/hr., and 45 r/hr. at the successive time periods.

The dose rate reports from each monitoring station would be reported to the EOC at the appropriate times in accordance with local reporting procedures, and would be recorded on the forms designed for that purpose. The data would be plotted, analyzed, and evaluated in accordance with the Radef SOP for operations at the EOC. The Radef Officer and the assistant Radef Officer should practice the preparation of advisories of the type that would be issued to the general public, or to the operating services. Also, there would be practice in the preparation of the type of messages that would go forward to the State level.

There should be a critique to determine how well the monitors were able to read the meter faces; whether reporting procedures and communications from the monitoring stations were satisfactory; whether recording and plotting procedures at the EOC were adequate; how closely the analyzed charts resembled the original hypothetical maps from which dose rate data were extracted; and finally, how well and how efficiently the monitoring and reporting system functioned. The primary purpose of the practice exercise is to point out deficiencies and to improve operating procedures. A critique will indicate areas where additional training is required.

Subsequent training exercises should incorporate dose rate reports from surface mobile and from aerial monitoring operations. After an acceptable degree of operational proficiency is achieved, the Radef Officer, through the civil defense director, should plan and carry out community-wide Radef exercises, using all the resources of government.

RADEF PROCEDURES AT THE EOC

The Radef Annex and its supporting SOP's must list the functions to be performed at the EOC, assign responsibility for carrying out the functions, and provide detailed operational procedures in the form of appendices, attachments, and SOP's. This Chapter will provide guidance to assist the Radef Officer in the implementation of a Radef capability, and the execution of essential Radef functions at the EOC. At warning that an attack is imminent, or report of an attack on the nation, radiological defense plans and supporting SOP's automatically become directives for Radef personnel to man assigned posts and perform planned monitoring and reporting functions.

Reporting of Personnel for Emergency Operations. The alerting of Radef personnel should be an automatic operation, triggered by the issuance of "attack warning," or the occurrence of an actual attack. Under either situation, all Radef personnel will immediately report to their assigned locations and perform the readiness actions prescribed in their respective SOP's. For example, monitors at shelters and operational monitoring stations will immediately perform instrument operational checks and prepare report logs for use. At the EOC, the staff will prepare logs for systematic recording of Radef reports;

prepare for analysis, evaluation, and display of Radef intelligence; and assure the availability of latest UF reports.

Verification of Operational Readiness. Reports of operational readiness from the shelter monitors and the operational monitoring stations will be systematically logged at the EOC on forms as indicated in Annex 3. Particularly in large urban areas where there are many shelters, the report of shelter monitor operational readiness is likely to be one item of the shelter manager's readiness report. The Radef Officer should arrange for that portion of the shelter manager's report to be made available to his staff. The Radef Officer, or designee, should periodically check the operational readiness column of the log to determine the state of readiness of his monitoring network. The Radef Officer should contact monitoring stations or shelters from which readiness reports are missing and should assist, if possible, in resolution of any problems. For example, if the shelter manager should advise that no monitor has reported for duty, the Radef Officer should, if time and communications permit, poll nearby shelters to determine if one or two monitors can be reassigned.

Flash fallout reports and subsequent dose rate reports from the monitors (see Chapters V and IX) will be recorded on the log as they are received at the EOC. To assure receipt of all important fallout reports, the Radef Officer will check the recording log each six hours. If there are stations not reporting, especially at local levels, the Radef Officer should contact these stations to determine why they have failed to file scheduled reports. If there are problems at the monitoring stations, the Radef Officer should try to assist in the resolution of the problems.

At the EOC, if the staff is incomplete, the Radef Officer should adjust staff assignments, briefly review the functions of each group of personnel and, if required, provide accelerated training for reassigned personnel. Radef readiness reports from one level of government to another, or to neighboring governmental units, would be appropriate only as items in more comprehensive situation reports, except where specifically requested.

Preparing Fallout Forecasts. In his planning, the Radef Officer must make arrangements for the routine receipt of the current "UF" data that would affect his area. He must also arrange for the immediate receipt of special "UF" data in the event of an emergency. Chapter VI, "Application of Meteorological Data to Radef," presents detailed information concerning the availability of UF reports, and the preparation of fallout area forecasts from UF fallout vector data. The Radef Officer should develop a capability within his staff to apply current fallout vector data (UF) to nuclear detonation (NUDET) locations so that fallout forecasts may be prepared and issued as appropriate. At State and the larger EOC's, the Radef Officer should also make prior arrangements to have a Weather Bureau or private meteorologist on his EOC staff to assist in preparing the fallout forecasts and in preparing fallout analyses. The "UF" data does not take temporal and spatial variations into account, and the meteorologist can make adjustments to the basic "UF" data to account in part for these variations.

The Radef Officer, in his planning, is cautioned not to place greater use or reliance on the forecasts than is warranted. When current wind data are used, the forecasts can provide a fairly valid indication of the direction and average speed of spread of fallout along the surface of the earth. Therefore, they should be used to alert an area of the liklihood of fallout and its anticipated time of arrival. This information may assist some communities, or industries, in planning a better utilization of available time between attack and expected arrival of fallout. However, fallout warnings and advisories per se should be issued on the basis of reports from the monitors and not on the basis of forecasts. Also, it is recommended that remedial movement to escape fallout not be carried out on the basis of forecasts.

In time of emergency, the first member of the Radef staff to report to the EOC should establish communications with the Weather Bureau or other prearranged source to obtain the latest UF reports applicable to the EOC's area of responsibility. Further, the UF data should be plotted on maps in accordance with the State or local operational plan, and the maps made readily available for the Radef Officer and the civil defense director.

Message Handling and Data Flow. The procedures for handling messages, and the methods and forms in which data are processed and utilized will be influenced by the nature of the communications system(s), established message center procedures, and time phased requirements for the use of data, including its presentation in a variety of forms. Careful planning of reporting procedures, message routing, and data handling can materially reduce the communications load and increase the efficiency of Radef operations.

In the smaller jurisdictions, where for example there are ten monitoring stations, the Radef Officer may be able to communicate directly with his monitoring stations. However, normally, at the larger EOC's messages are routed through message and communications centers. To the extent feasible, scheduled monitor reports should be processed through collection centers, appearing in the message centers as summary reports of the monitored data from several stations. For example, several monitoring stations might be established at fire stations using the same radio net for report. Soon after a scheduled monitoring time, the authorized representative of the fire department at the EOC communications center might request reports from the fire department monitoring stations by "roll call;" the stations responding with their monitored radiation dose rates and/or doses.

Within the EOC, the Radef messages must be processed in an orderly manner if confusion and wasted motion are to be avoided. The "Radiological Log" is designed to present an orderly summary of the stations that are operating, Flash reports of fallout arrival, and scheduled reports of unsheltered doses and dose rates reported from monitoring stations.

The following procedures are recommended: Station designators should be entered in the first column, preattack. They may be grouped by communications net over which they report; they may be arranged in geographical configurations; or they may be arranged in alphabetical or numerical order to best meet local requirements. The columns for logging operational readiness and Flash reports of fallout arrival are self explanatory. The succeeding columns conform to the reporting schedules recommended in Chapter V, and Attachment C in the "Handbook for Radiological Monitors." It is to be noted that each vertical column presents a written record of monitoring as of the specified hour, as well as indicating the stations from which reports have not been received. Horizontal columns indicate the dose rate histories at the respective stations, and accumulated radiation exposure doses. It is suggested that messages reporting scheduled monitored data be logged first; passed to the plotters for plotting as directed; and then be filed in groups indicating the times of monitoring. Analysis, evaluation and display are carried forward from the plot. For evaluation of the radioactive buildup and decay, the data for a very few representative stations can readily be copied from the appropriate horizontal columns, with little if any interference with the logging procedure for plotting on full logarithmic graph paper. All other messages routed to the Radef service would be logged in accordance with the general procedures established for the EOC.

Plotting, Analyses and Presentation of Fallout Data. Fallout reports from the monitors must be plotted and analyzed as a basis for (a) evaluating the radiation hazard, (b) issuance of warnings of fallout and advisories concerning countermeasures, and (c) provision of technical guidance.

Receiving and Plotting Flash Reports from the Monitoring Stations. Each official monitoring and reporting station (including selected community shelters previously designated by the Radef Officer) will send a Flash report to the control center when the outside, unsheltered radiation dose rate reaches or exceeds 0.5 r/hr. Each station will report to the control center by telephone, or radio, giving the station designator (previously assigned), the time that fallout was detected, and the single word, "Fallout." (See Chapter V). This will show the time that the dose rate at that location reached or exceeded 0.5 r/hr. The Flash report received at the control center should be recorded on the log along with the time of occurrence. After the recording of this information on the log, the recorder should relay the data or message to a map plotter who will plot it with a capital "F" and the time of occurrence at the location of the monitoring station. This will provide a visual display of the actual spread of fallout across an area and, when combined with current UF data, may be used as a basis to warn other areas downwind of the expectancy and approximate arrival time of fallout.

Receiving Dose Rate Reports From the Monitoring Stations. Dose rate information reported from the monitoring stations will be recorded in the Radiological Log as indicated under the heading, "Message Handling and Data Flow." It is recommended that the monitoring stations report dose rate information to the control center once an hour for the first 12 hours; once each 3 hours for the next 12 hours; once each 6 hours for the next 24 hours; and once daily thereafter. If the recommended frequency of reporting exceeds the local communications capability and/or the capability of emergency operating center personnel to process the data, frequency of reporting during the first 24 hours may be reduced. However, reporting hours must conform with requirements from higher levels of authority. The standardized times for taking observations and reporting procedures are contained in Chapter V.

Preparing Fallout Analyses From Dose Rate Reports. After being logged, selected reports will also be plotted rapidly on the local map and a fallout analysis will be prepared. As a minimum, analysis will show the locations of the 1, 10 and 100 r/hr dose rate contours if they occur during this early period. Under some conditions, the dose rate gradient may be very steep and dose rates across a city may vary by more than one or two orders of magnitude. Also, there may be hot spots, but it is not likely that these will be detected during the first few hours.

The early fallout analyses at local level will be prepared rapidly to obtain a quick, broad, general picture of the developing situation across the area. During this early period, the situation will change rapidly as the dose rates build up to a maximum, level off and begin to decay, possibly followed by subsequent buildups as additional fallout from later or farther distant detonations spreads across the area. Care will be taken not to permit people to come out of their shelters prematurely. It is better to keep people in their shelters for a longer period than necessary rather than a shorter period. This is especially true during the early periods when there is considerable uncertainty and, particularly, if the dose rate is rising.

Typically, maps should be plotted and analyzed at local levels each three hours during the first 12 hours. However, during this period the radiological situation can be expected to change rapidly and the Radef service may be required to prepare special analyses, based on recent data, at any hour. Further, the hourly reported dose rates recorded on the log will be used as a guide for evaluation of the continuing buildup of fallout, or preparation of fallout advisories during the intervals between preparation and display of complete analyses. From the limited amount of "on-station" monitored data, fine definition of the locations of dose rate contours cannot be expected (a city of 100,000 population would have 22 monitoring stations). Normally, the dose rate contours will be oriented in the direction of the 60,000 ft. UF fallout vector. The direction of this vector may be obtained from the current UF report, but topography or tall buildings and changing wind directions may cause the orientation of the contours to vary from this direction.

During the period from 12 to 24 hours after fallout arrival, fallout maps should be plotted and analyzed once every 6 hours at local levels. During the period one to two days after fallout arrival, fallout maps should be plotted and analyzed once every 12 hours at local levels. Thereafter, maps will be plotted and analyzed daily, based upon daily fallout observations taken at the monitoring stations at 0300 GMT (10 PM, EST), supplemented by reports from surface mobile and aerial monitoring operations. During the first 48 hours after the arrival of fallout, analyses will be prepared showing the location of the 1, 10, and 100 r/hr dose rate contours across the area. After two days subsequent to the onset of fallout, the analyses will be prepared showing the locations of the 0.1, 1, and 10 r/hr dose rate contours. After two weeks, the analyses will show the locations of the 0.01, 0.1, and the 1 r/hr dose rate contours.

At State levels during the early period, fallout information may be limited from the remote and less populated State areas and the analyst may have to do considerable interpolating. The fallout vector data (UF) in streamline format (see Chapter VI) may be helpful to the analyst. To obtain more information concerning these remote areas, the State Radef Officer should request aerial monitoring operations, or ground survey, as soon as the apparent urgency of the situation and technical considerations indicate that such action is appropriate. At State level, dose rate analyses should be prepared at least each 12 hours during the first day on the basis of observations at 0300 and 1500 Z, and after the first day analyses at State level should be prepared once daily, based on observations at 0300 Z.

Presentation of Data at the Emergency Operating Center. The Radef Officers at all levels of government will be required to provide technical guidance and present briefings to the EOC staff, and to the chiefs of the emergency operating services regarding the developing fallout situation during the early periods, as well as briefings concerning the magnitude and intensity of the fallout situation after most of it is deposited. Many of the control center personnel and service chiefs may not be thoroughly conversant with the phenomena of fallout, its characteristics, and the problems and hazards of fallout. Therefore, the Radef Officer will present the developing or existing fallout situation in a clear, simple manner which shows the problem and reflects the survival and recovery action required.

Flash Reports. As indicated earlier, Flash reports will be plotted as received on maps of the particular area of responsibility at each civil defense level. At local levels, there should be an enlarged map of the local area covered by transparent plastic to be used for briefing purposes. This map should be mounted on the wall in the control center or seat of emergency government, and clearly visible to the civil defense director and his staff. The locations of the monitoring stations should be indicated on the enlarged map. As Flash reports are received, these may be indicated on the display map by the letter "F." Additionally, the map may be shaded lightly to distinguish the areas with fallout from the areas without fallout. Across a community, every monitoring station may, under some circumstances, forward a Flash report and the entire areas on the map might be shaded. However, if there is a variation across the local area, the shading on the map could show this variation clearly. If the Radef Officer desires to keep permanent records of all maps, he should have several maps readily available for posting on the wall, or should make and retain analyses on tracing paper or plastic overlays, which can be placed "in register" on the appropriate map at later times as required. Requirements will vary from area to area.

At State levels, there should also be an enlarged plastic covered display map of the State mounted on the wall of the EOC. Alternatively, if permanent records are required, a large supply of maps will be needed. The map should show the locations of all communities and counties reporting to the State level, as well as the State monitoring stations which report directly to the State. The map should also show highways and secondary roads. As Flash reports are received from monitoring stations or lower government echelon, this should be noted on the map along with the time that the fallout was monitored, such as "F-0910." If available, NUDET reports should be indicated as "X" on the map. As Flash reports are received and plotted, the map should be shaded to show the progress of fallout across the State from the ground zero location. Plotting the time of fallout occurrence at each point will indicate the speed at which fallout is spreading across the State. The Radef Officer, or preferably his meteorologist, will keep this display map up-to-date in order that the EOC staff may be kept apprised of the developing situation. The meteorologist could extrapolate the shaded areas in the downwind direction with dash lines indicating the expected direction of further spread of fallout. This will provide assistance to the EOC staff in planning their immediate operations. As later Flash reports are received, the meteorologist would add these to the display map, extend the shaded areas on the basis of the reports, and modify his forecast accordingly.

Dose Rate Situation Display. The Flash reports of fallout arrival at local and State levels are satisfactory as a basis for warning people. However, actual survival and recovery actions will be based upon specific dose rate reports. After the first dose rate analysis is prepared on a work chart at the local EOC, it should be sketched freehand on the display map showing the locations of the 100, 10 and 1 r/hr dose rate contours across the local area. Obviously, the Flash report analyses, previously spotted on the map, would be cleaned off before the dose rate analysis could be sketched, or a new map posted if permanent records are required.

To indicate the different degrees of fallout intensity, the areas enclosed by the 100 r/hr dose rate contour could be shaded red. The areas between the 10 and the 100 r/hr contours could be shaded blue. The areas outside the 1 r/hr contour would be left unshaded. This visual would readily indicate to the EOC staff the areas of light to severe fallout and provide early guidelines as a basis for action. This visual will be updated periodically so that the EOC personnel can be kept current with the changing situation. The date and time of the dose rate reports upon which the analysis is based will be indicated on the visual.

Preparation of supplementary warning of fallout and advisories, and the issuance of technical guidance by the Radef Officer will be based on the actual current working charts, or analyses, as they are prepared. The display map is for visual reference only for the benefit of the control center staff. After the first two days, the shading of the contour areas could be modified to conform with the analysis routine; i.e., the areas enclosed by the 10 r/hr contour could be shaded red, the areas between the 10 and 1 r/hr contours blue, and the areas between the 1 and 0.1 r/hr contours yellow. A similar change of shading could be made after two weeks. After the first two days, the display map could be prepared during the late night or very early morning and be ready for the EOC personnel by daybreak each morning. This will provide a quick and ready basis for planning the day's operations of the emergency crews who will perform their activities mainly during the daylight hours.

Unsheltered Radiation Dose Situation Display. During the first six days, postattack, accumulated radiation dose analyses will be prepared daily at the EOC on the basis of dosimetric measurements reported by the monitoring stations (see Chapter V). This chart will be helpful to the EOC staff as an indication of the accumulated radiation exposure to the general public under different conditions of shelter. The areas inside the 5000 r dose contours could be shaded red. This can indicate the areas where good fallout shelter would be required to prevent radiation casualties. Also, it visually portrays the areas from which survivors, without adequate fallout shelter, should be remedially moved to less hazardous locations to avoid serious overexposure.

The areas between the 1000 r and 5000 r dose contours could be shaded blue. This can indicate the areas where people would need fallout protection--the equivalent of a "deep basement corner" or better to prevent occurrence of serious radiation sickness. It can also indicate those areas from which people without this degree of protection would have to be remedially moved to a better location.

The areas between the 100 r and 1000 r contours could be shaded blue. The blue shaded areas will show to EOC personnel the locations where average basement protection or better would generally be required. It could also show the areas from which survivors would have to be evacuated to a better location if they did not have average basement protection. Operationally, early warning of fallout to the people in these heavy fallout areas should have brought about their remedial movement during the first day or two. However, if a better location were not available, or if survivors had not been physically able to carry out such movement, the maps would clearly indicate the magnitude of the medical care and mortuary problem facing local government.

Since it is generally assumed that there is no measurable biological recovery during the first four days postexposure, these dose maps during the first six days will be a good approximation of the unsheltered equivalent residual dose. For example, people sheltered in an average basement in an area where the outside, unsheltered dose was 1000 r would have an equivalent residual dose of about 100 r. The dose analyses for the fifth and sixth days would overestimate the ERD by about 1% on the first day and 3% on the sixth day. However, this would be sufficiently accurate for purposes of the visual display. The dose analysis, after shading, could also be posted on the wall of the EOC next to the dose rate analysis. This map should be prepared immediately upon completion of the dose rate analysis, and should be ready for the EOC day shift as they report for duty.

The "dose rate" and "dose" visual displays will vary from one level of government to another, and from one time period to another, with regard to area detail. At higher levels of government where the primary mission is support, and at the local level when dose rates are too high for mobile monitoring to be feasible, the visuals will be smoothed--reflecting the gross problem--rather than the details. When mobile monitoring has become feasible, the local government, which will actually direct and carry out survival actions, will require detailed visuals that reflect the problem on a "block-to-block" basis.

Radiation Decay Graphs. As a third visual at local levels, the Radef Officer might post in graphic or tabular form the past history of the change of dose rates with respect to time at a few representative spots across the local area. The Radef Officer might also indicate on the display his forecast of dose rates. At the State level, a similar visual of past and predicted dose rates could be posted for heavy fallout areas along the major highways or at strategic facilities. This type of visual will assist the EOC staff in determining where decontamination efforts should be concentrated, and it will assist them in planning emergency operations. These displays, collectively, will also indicate to local government those areas which should be posted with standard fallout contamination markers.

As appropriate, the Radef Officer should develop and display other visuals as required for briefing purposes, and for use by the EOC personnel.

Preparation of Emergency Information Fallout Warnings and Advisories. One of the primary functions of the Radef staff at the EOC is the preparation of emergency information warnings and advisories concerning the fallout situation. These messages will be issued to the general public by the major, civil defense director, or other appropriate official, but they will normally be prepared by the Radef officer and his staff on the basis of (a) fallout forecasts before the arrival of fallout, (b) Flash reports at the time of arrival of fallout, and (c) dose rate and unsheltered dose analyses and radiation decay graphs after the arrival of fallout.

Preattack Emergency Information on the Basis of Fallout Forecast. The "UF" data that have been plotted preattack in accordance with the preceding discussion on preparation of fallout forecasts should be applied to the likely targets within 500 miles of the EOC's area of responsibility, and the likelihood of fallout occurrence as well as its time of arrival should be estimated for the area of concern. An indication of the amount of time available, between attack and fallout arrival, would be of value to essential industrial facilities, such as oil refineries, steel mills, and food processing plants that must undertake extensive shutdown procedures. It would also be of value to farmers and ranchers who must make time consuming arrangements for the protection of their livestock as well as the protection of their families.

This early, preattack advisory, based upon wind conditions, might well be included as part of a general educational type information broadcast to the public. It need not be a special broadcast, and it should be given a "low key" type treatment, so that the general public will not take inadvisable action on the basis of the advisory. All advisories should stress the importance of seeking shelter whenever warning is issued that fallout is approaching or has arrived, or whenever fallout occurrence is suspected from observation of particles settling through the air, or from observation of a nuclear detonation in the upwind direction. In some instances, advisories of this nature may have to be specialized to meet the needs of specific industries. Annex 4 to this Chapter contains sample preattack advisories.

Postattack Advisories Prior to Arrival of Fallout. The Weather Bureau plans to issue UF data on an accelerated basis at the time of threatened attack. During the preattack and early postattack periods, the Radef staff at the EOC must continue to up-date its wind data on the basis of subsequent UF messages from the Weather Bureau or other sources. As the attack develops, the latest UF data should be applied to each reported or deduced ground zero location, and the area of expected fallout as well as the estimated arrival time should be determined. If professional meteorological guidance is available, the fallout forecast should be refined in an attempt to account for temporal and spatial variations. The mayor, or local civil defense director, may wish to issue an emergency information advisory on the basis of the forecast, and the Radef staff will prepare the advisory. Sample advisories of this type are included in Annex 4 of this Chapter.

The postattack fallout forecast may be considerably refined on the basis of the Flash reports from the monitoring stations. At local levels, the refinement would be based primarily upon Flash reports from neighboring communities upwind from the area of the EOC's responsibility. For example, a Flash report of fallout arrival from a community several miles upwind would be of considerable value for refining the earlier forecast based upon wind and NUDET data only. At the State level, this refinement of the fallout forecast can be accomplished more effectively, since State will be following the spread of fallout over a large area, and will be receiving Flash reports from State monitoring stations and from each community so affected. The State should report pertinent data to areas likely to receive fallout.

As soon as the local Radef Officer can obtain a reliable fix on the direction and speed of the spread of fallout, he should prepare a fallout advisory for the people of his area of responsibility to be issued by the civil defense director, mayor, or the office of the governor. The initial advisory or warning of approaching fallout should be brief and terse--reporting the facts and telling the people precisely what to do. It should be issued as a special warning rather than a routine, scheduled advisory. Annex 4 to this Chapter contains sample warnings. The warning should be rebroadcast and up-dated as reports indicate that fallout is getting closer.

Issuance of Emergency Information Warning at Time of Fallout Arrival. Most people, nationwide, will be expected to go to shelter upon issuance of attack warning. However, in some areas where there may be insufficient shelter, people may need to use all available time prior to arrival of fallout to improvise fallout protection; make their shelters ready for occupancy; and/or augment survival supplies. Also, as indicated earlier, some agricultural and industrial personnel may similarly be required to delay entry to shelter. For these personnel, issuance of a fallout warning at the time of fallout arrival is important. Therefore, as soon as the first monitoring station in the EOC's area of responsibility files a "Flash report" a fallout warning similar to the examples in Annex 4 should be broadcast and rebroadcast several times directing all people to seek immediately the best shelter available.

Issuance of Emergency Information Advisories After Arrival of Fallout. During the first 12 hours after fallout arrival, the Radef Officer, or his staff, should prepare fallout advisories on an hourly basis for issuance to the general public. However, as before, the advisory should be issued under the authority of the civil defense director, mayor, or Governor. Annex 4 to this Chapter contains sample advisories of the type that would be prepared from dose rate analyses during the first 12 hours after attack.

It is not possible to provide specific guidelines that will apply in every case in the preparation of advisories. The Radef Officer will have to make maximum use of the intelligence (dose rate reports) available, and apply good judgment based upon his training and experience. Factors such as the age of the fallout material and its decay characteristics must be considered in attempting to evaluate the reported dose rates in terms of biological hazard.

Generally, within 12 to 18 hours after completion of the attack, most of the "close in" fallout of concern to survival will be deposited. Therefore, if the total nuclear attack does not continue for a period of more than six to 12 hours, the dose rate reports during the period 18 to 30 hours after attack should be fairly indicative of the magnitude of the fallout problem against which local government will have to effect countermeasures. Therefore, during this period, 18 to 30 hours postattack, the fallout analyses will be considerably more comprehensive than the earlier analyses. On the basis of these more comprehensive analyses, the advisories to the general public during this period can and should be more detailed, providing more information on items such as estimates of shelter stay time.

Further, shortly after the first day or so, postattack (unless there are repeated attacks) decisions should be made concerning prolonged shelter stay, or remedial movement to less hazardous locations. If decisions are made to undertake remedial movement, the advisories to those portions of the general public involved must be specific and clearly expressed.

In the areas of lighter fallout, where remedial movement would not be required, fallout advisories should be prepared and issued to the general public every six hours, subsequent to the first day postattack. As a rule, the people should be told frankly in general terms about the fallout condition, and they should be given specific instructions on how to survive and keep their radiation exposures to practicable minimum levels. Before release of the populace from shelters, travel into contaminated areas should be restricted by the appropriate placement of barricades displaying contamination markers or warnings, and advisories to the general public should so indicate.

The general public should be allowed freedom from shelter, at least on a part-time basis, as early as possible without exceeding the exposure criterion which the mayor or civil defense director has adopted. Even limited relaxation, such as one hour out of shelter per day in the basement area, or in other less shielded sections of large buildings after the first two days continuously in shelter, will make the problem more manageable. Also, an occasional hour outside the group or home shelter should be planned as soon as radiological decay will safely permit such a sortie. The advisories to the general public should clearly indicate when such relaxation can be permitted and for how long a period of time. Also, the advisories might indicate that it is desirable for people to put on overshoes before leaving shelter, and to remove these overshoes at the threshold before re-entering the group or home shelter in order not to track fallout into the shelter area.

At local levels, the Radef Officer may have to prepare occasional warnings and advisories for the general public regarding contamination of food and water. They must be patterned to fit the particular hazard or condition that exists, and they should be in easily understood terms with specific instructions for actions to be taken by the general public to cope with the hazard.

At State levels, warnings and advisories will be prepared by the State Radef Officer and issued to people in areas where warnings are not provided for by municipal or county levels. This will primarily include farmers or ranchers in the more remote areas. The radiation exposure of farm personnel should be kept to the lowest levels practicable, consistent with the importance of the farm mission to be accomplished. Since food production is essential to the survival of the nation, adult farmers over 40 years of age will be considered as emergency workers where a definite need exists.

The preparation of fallout warnings and advisories for agricultural people will require greater specialization and care than is the case with the general public. Although it may be possible to keep the general public in fallout shelter for several days postattack, this will generally not be possible for farmers. At county and State level, preparation of special advisories for farmers should be prepared in coordination with representatives of USDA Defense Boards. At the time of issuance of attack warnings, and again at the time of issuance of a warning of the expectancy of fallout, advisories to farm personnel would include advice concerning:

1. Final preparation of shelter for livestock occupancy, protection, and provision for feed and water.

2. Protection against fallout contamination of sources of water, stocks of feed, etc.

Reporting. Following a nuclear attack, radiological information would be needed by the public, by industries, and by the various levels of government. The amount and kind of data required varies with the intended use and with time, postattack. The total national monitoring system includes on-station and mobile monitoring from stations established at industrial installations, Federal, State and local installations, and at other locations appropriately dispersed throughout the urban and rural areas of the Nation. Figure 1, page 3-13, indicates the general flow of Radef information from monitoring stations to EOC's, and between the various elements of government. It does not indicate (a) time phased schedules for monitoring and reporting, (b) the selection and condensation of data for reporting to EOC's at the same, higher, or lower levels of government, or (c) reports to the public and industry, previously discussed under headings of warnings and advisories. Chapter V provides detailed guidance concerning reporting procedures, including types of reports required, content of reports, report format, and reporting schedules by level of government and time phase.

The Radef Officer at each EOC should prepare a condensed table of the Radef communications traffic that will pertain to his operations. This table should be posted conspicuously in the EOC to indicate the type and frequency of reports scheduled to be prepared for transmission from the EOC. Tables or charts indicating the specific scheduled Radef reports to be received or initiated by the EOC will vary with the governmental level, and local adaptations of Federal monitoring and reporting guidance.

TECHNICAL SUPPORT AND GUIDANCE FUNCTIONS

As a member of the civil defense staff, the Radef Officer is responsible for providing technical support and guidance to the civil defense director and to other members of the staff, including the chiefs of emergency operating services.

The hazards associated with unsheltered activities are dependent upon several factors, including the exposure history in shelter and in the performance of any previous unsheltered activities; the dose rate in the areas of activity, probably variable from location to location; and the time span or duration of the activity. It may be necessary to engage in activities for essential purposes before these factors can be evaluated. Therefore, during the early periods, before a complete evaluation of the hazards can be determined, the following data may be used as a guide for directing shelter and operational activities:

TABLE 1

If dose rate has fallen to: (in r/hr)	Activities That May Be Tolerated
Less than 0.5	No special precautions necessary for performance of essential tasks, except to keep fallout particles from contaminating people and to sleep in the shelter.
0.5 to 2	Outdoor activity (up to a few hours per day) tolerable for essential purposes, which include fire fighting, police action, rescue, repair, securing necessary food, water, medicine and blankets, important communications, disposition of waste, exercise and obtaining fresh air. Eating, sleeping, and all other activities should be conducted in the best available shelter.
2 to 10	Very short periods (less than an hour per day) of outdoor activity are tolerable for the most essential purposes. Shelter occupants should rotate outdoor tasks to minimize total doses. Outdoor activities of children should be limited to 10 to 15 minutes per day. Rescue, repair, communications and exercise may safely take place in less than optimum shelter.
10 to 100	Time outside of shelter should be held to a few minutes and limited to those few activities that cannot be postponed for at least one more day. Insofar as possible, all people should remain in the best available shelter no matter how uncomfortable.
Greater than 100	Outdoor activity of more than a few minutes may result in sickness or lethality. The only occasions which might call for moving are (1) risk of death or serious injury in present shelter from fire, collapse, thirst, etc., and (2) present shelter is greatly inadequate--might result in fatality--and better shelter is only a few minutes away.

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The data in the previous paragraph must be modified as early as possible, taking into account the age of the fallout debris. If the fallout debris is relatively young (2 or 3 hours old) greater relaxation of shelter control can be tolerated than that indicated in the previous table for specific observed dose rates. On the other hand, if the fallout debris is relatively old (several days or weeks) more rigid control would be required than that indicated in the previous table for specific observed dose rates.

Guidance for Estimating Shelter Stay Time. During the period 12 to 24 hours after attack, the Radef Officer should make a forecast to indicate how long people will have to remain in shelters. In preparing the forecast, the Radef Officer should consult health service and other appropriate sanitation officials. During these early periods, forecasts of this nature must be considered tentative and subject to change based upon subsequent dose rate reports. The technical guidance, based upon the forecast, should reflect the actual and anticipated state of conditions. For example, if the forecast indicates that people will have to remain in shelter for two weeks, the guidance should make this situation very clear.

Rationing of food supplies inside shelter will have to be based upon the expected shelter stay time. The forecast of stay time should not be overly pessimistic, but it should tend to be on the conservative side. Further, the actual number of days required in shelter may have to be adjusted upward or downward after the hazard has been more thoroughly evaluated. It is not possible to give specific guidelines since the age of the fallout material at arrival time, quality of the fallout shelter, availability of supplies, and other factors will affect each decision. However, as a rough guide the Radef Officer may wish to refer to the following:

TABLE 2

Preliminary Estimate of Stay Time in Shelter

Dose Rate	Hours After Detonation, Assuming Fallout Complete (Dose Rate Decreasing)	Minimum* Shelter Stay Time
200 r/hr	H + 3 hours	2 weeks
200 r/hr	H + 6 hours	More than 2 weeks
200 r/hr	H + 12 hours	More than 2 weeks
100 r/hr	H + 3 hours	4 days
100 r/hr	H + 6 hours	More than 2 weeks
100 r/hr	H + 12 hours	More than 2 weeks
50 r/hr	H + 3 hours	1 day
50 r/hr	H + 6 hours	5 days
50 r/hr	H + 12 hours	More than 2 weeks
25 r/hr	H + 3 hours	1 day
25 r/hr	H + 6 hours	2 days
25 r/hr	H + 12 hours	7 days

TABLE 2 (Continued)

Dose Rate	Hours After Detonation, Assuming Fallout Complete (Dose Rate Decreasing)	Minimum* Shelter Stay Time
10 r/hr	H + 3 hours	Less than 1 day
10 r/hr	H + 6 hours	Less than 1 day
10 r/hr	H + 12 hours	1 day

*Where feasible, shelter stay time should be increased to further reduce the radiation exposures.

Guidance for Forecasting Future Dose Rates. Attempts to predict the radioactive decay of actual fallout on the basis of any given decay law or curve are certain to be grossly inaccurate. However, for planning and for exercise purposes, the $t^{-1.2}$ decay criterion appears to be as good as any for times up to 100 days. After 100 days, the decay curve of the mixture of U^{235} fission products, with allowance for fractionation in the nuclear cloud, may give a closer approximation to decay. Based upon these criteria, and for purposes of illustration, Table 3 indicates the dose rates which might be anticipated at subsequent periods based upon an H + 1 dose rate of 1,000 r/hr. The table also indicates the outside, unsheltered radiation dose which might be anticipated during various intervals of time in an area where the dose rate one hour after detonation (H + 1) was 1,000 r/hr, or would have been if it had been deposited by that time.

TABLE 3

DOSE RATES*				OUTSIDE, UNSHELTERED RADIATION DOSE*		
H+1	Hours	1000	r/hr	H+1 to H+6	Hours	1500r
H+6	Hours	116	r/hr	H+6 to H+12	Hours	450r
H+12	Hours	51	r/hr	H+12 to H+24	Hours	390r
H+24	Hours	22	r/hr	Second Day		340r
D+2	Days	9.6	r/hr	Third Day		180r
D+3	Days	5.9	r/hr	Fourth Day		120r
D+4	Days	4.2	r/hr	Fifth Day		88r
D+5	Days	3.2	r/hr	Sixth Day		68r
D+6	Days	2.55	r/hr	Seventh Day		57r
D+7	Days	2.15	r/hr	Second Week		230r
D+14	Days	0.93	r/hr	Third Week		120r
D+21	Days	0.57	r/hr	Fourth Week		80r
D+28	Days	0.40	r/hr	Second Month		170r
D+2	Months	0.16	r/hr	Third Month		91r
D+3	Months	0.10	r/hr	Fourth Month		35r
D+4	Months	0.042	r/hr	Fifth Month		25r
D+5	Months	0.031	r/hr	Sixth Month		20r
D+6	Months	0.027	r/hr	7th to 12th Month		50r
D+1	Years	0.0055	r/hr	Second Year		13r
D+2	Years	0.00072	r/hr	Third Year		4r
D+3	Years	0.00036	r/hr	Fourth Year		2r
D+4	Years	0.00029	r/hr	Fifth Year		1.5r
D+5	Years	0.00025	r/hr			

*Computations rounded to two significant figures

TABLE 3 (Continued)

DOSE RATES*	OUTSIDE, UNSHELTERED, RADIATION DOSE*	
From H+1 through:	First Week	3200r
	First Two Weeks	3400r
	First Month	3700r
	First Year	4000r

*Computations rounded to two significant figures

For H + 1 dose rates other than 1000 r/hr., the values on this table could be adjusted accordingly. For example, if the H + 1 dose rate was 3000 r/hr., the subsequent dose rates indicated on the table would be three times as great, and the radiation dose during each interval of time would be three times as great. If the H + 1 dose rate was 100 r/hr., all dose rate and radiation dose values on the table would be divided by 10.

This system for forecasting future dose rates is satisfactory for planning and for exercise purposes as previously stated. However, it is not satisfactory for operational use and should not be used operationally. Fallout at any one location may comprise debris from several weapons of different design, detonated at materially different times over different types of soil, over metropolitan areas, or over fresh or salt water. It will be most impracticable to keep track of the individual contributions and ages of each detonation comprising the fallout. The most practical method of forecasting dose rates under these conditions appears to be based upon the technique of plotting observed dose rates versus time on full logarithmic graph paper or linear graph paper, and then extrapolating the plotted curve. Plots of this type for two or three representative points across a community will generally be adequate. The procedure for plotting this information is quite simple. The observed dose rates will be plotted against time on graph paper and then projected into the future for the period of concern to forecast future dose rates. However, as a practical limit, forecasts of future dose rates should not generally exceed the time period for which decreasing dose rate records are available.

Guidance for Computing Equivalent Residual Dose (ERD). After the first few hours postattack, technical guidance relating to the exposure of the emergency forces and the general public should be based on more careful analyses and a more thorough evaluation of the fallout hazard in terms of its effects on people. The equivalent residual dose (ERD) should be used as a basis in decisions affecting radiation exposure of humans. The ERD, which takes into account biological recovery processes, is at any time equal to 10 percent of the accumulated dose (the irreparable fraction of injury) plus the fraction of the remaining dose which has not been repaired. Starting with the fifth day after exposure, it is assumed that radiation injury is repaired at the rate of 2.5 percent per day of the remaining repairable injury. At this rate of recovery, half of the repairable dose is repaired in about one month.

The ERD can be expressed mathematically as (1) $ERD = 0.1D + 0.9D\,(0.975)^{t-4}$ Where D is the dose in a single day and t is the number of days from the time of exposure to the time at which the ERD is to be computed. (A table of the powers of 0.975 is included in Annex 6 of this Chapter.)

As an example, assume that a group of emergency workers had been exposed to 30 r each day for six consecutive days, and to 20 r on the seventh day (exposure determined by dosimeter readings from a CD V-740, or CD V-742). Total exposure has been 200 r. About two weeks after the first day of exposure, this group is needed to carry out another emergency mission in a fallout area. The Radef Officer must compute their ERD at the end of 14 days to determine whether they can be used without risk of serious radiation sickness. The computation, based upon equation (1), above, is shown in Table 4 below.

TABLE 4

1 Day	2 D Exposures	3 $(0.975)^{t-4}$	4 Value of $(0.975)^{t-4}$	5 0.9D	6 (Column 4 X 5) Not Yet Recovered	7 Nonrecoverable 0.1D
1	30 r	$(0.975)^{10}$	0.776	27	21.0	3
2	30 r	$(0.975)^{9}$	0.796	27	21.5	3
3	30 r	$(0.975)^{8}$	0.816	27	22.0	3
4	30 r	$(0.975)^{7}$	0.837	27	22.6	3
5	30 r	$(0.975)^{6}$	0.859	27	23.2	3
6	30 r	$(0.975)^{5}$	0.881	27	23.8	3
7	20 r	$(0.975)^{4}$	0.904	18	16.3	2
	200 r				150.4	20

Therefore, the ERD at the end of the fourteenth day is 150.4 + 20, or 170.4 r.

On the basis of this calculation, it is apparent that, if necessary, an additional dose of approximately 30 r might be tolerated on the 15th day. However, since the exposure of this group has been rather large, it would be preferable to assign the task to another group with less exposure or, if possible, to postpone the operation. This will take advantage of further radiation decay as well as additional biological repair.

Tables, slide rules, graphs, charts and nomograms have been prepared and are included in Annex 6 of this Chapter to assist the Radef Officer in the rapid computation of the ERD under different situations. These include planning situations where a $t^{-1.2}$ decay criterion has been assumed as well as operational situations in which exposures have been determined by dosimetric measurements. The slide rules and nomograms are applicable for computing the ERD under operational situations such as shock doses, relatively large initial exposures followed by varying daily doses, protracted relatively low level daily exposures, or combinations of these situations.

Guidance in Applying ERD Concept to Emergency Operations. Chapter 1 indicates the following average consequences from various equivalent residual doses:

TABLE 5

Consequences or Effects	Short-Term Dose, or ERD
1. Smallest effect detectable by statistical study of blood counts of a large group of people.	15 r
2. Smallest effect detectable in an individual by laboratory methods.	50 r
3. Smallest dose that causes vomiting on day of exposure in at least 10 percent of people	75 r
4. Smallest dose that causes epilation (loss of hair) in at least 10 percent.	100 r
5. Largest dose that does <u>not</u> cause illness severe enough to require medical care in the majority of people (more than 9 out of 10).	200 r
6. Dose that would be fatal to about 50 percent of people.	450 r*
7. Dose that would be fatal to almost everyone.	600 r*

*ERD not applicable

The Radef Officer should consider the data in the above table as a "price list" to be used in furnishing technical guidance to the civil defense director and to the emergency operating personnel. As indicated before, the principle should always be kept in mind that even small radiation doses are harmful. Therefore, in making operational decisions, methods should be devised to keep radiation exposures of groups and individuals as low as practicable. The following procedures can help to keep exposures low. Extend the period in shelter; postpone unsheltered operations as long as feasible; and rotate personnel to distribute exposures. The more accurately radiation exposures of groups and individuals can be determined, the more effectively radiation exposure controls can be applied in carrying out survival and recovery operations.

To apply radiation exposure control principles effectively, it becomes necessary for the civil defense director, mayor, fire chief, police chief, Governor or other policy making officials to determine just "how important" it really is to carry out high priority tasks. Further, it requires a command decision from these officials concerning the number of people, or manpower, that should be temporarily or possibly permanently expended in carrying out the task. The latest fallout analysis will provide the tool that the Radef Officer will use in estimating the total exposure that will be involved in carrying out a priority mission. Table 5 initiates the cost in exposure of manpower. If the exposure cost will be too great, alternate solutions will have to be considered.

The Radef Officer may be required to estimate the exposure that would be involved if the mission were postponed for one day, two days, a week, etc. Alternatively, he would have to estimate what the exposure would be if partial decontamination, such as a quick flush down, could be effected. Another solution might involve the use of several groups consecutively, thus decreasing the total exposure to each group. However, in each case, the Radef Officer should assist the official in making his command decision by pointing out the course of action that will permit accomplishing the mission by the time required, but with the least amount of radiation exposure. Possible future required use of the emergency operating staff must always be considered. The ERD concept and the data in subsequent paragraphs will assist the Radef Officer in determining exposures that can be tolerated without loss of emergency personnel capabilities.

Although Table 5 indicates that an ERD criterion of 200 r might be applied for carrying out high priority emergency operations without significant loss of personnel, a criterion of this magnitude would only be used under conditions of extreme emergency, and then only on the basis of a command decision. To the extent practicable, the ERD of emergency personnel should always be kept well below 200 r. If accomplishing a highly important and urgently necessary mission will require an ERD exceeding 200 r, it should be carried out on a volunteer basis. The following simplified table is an example of an exposure control schedule which would keep the ERD below 200 r during the first year.

TABLE 6

First month	no more than 200 r*
Next 5 months	no more than 25 r/wk
Next 6 months	no more than 10 r/wk

* Concentrated during early part of month or more or less evenly distributed throughout the month.

In the above table, the ERD does not exceed 200 r. However, the total exposure during this 12 month period is about 1,000 r, which is extreme, and such an exposure schedule could not be justified. The 200 r exposure of emergency personnel during the first month when dose rates are highest may have to be accepted in areas of heavy fallout. However, exposure control practices should keep subsequent exposures well below 25 r/wk during the next 5 months and considerably below 10 r/wk after six months, when dose rates have decayed to relatively low levels.

Guidance for Controlling Radiation Exposure of the Labor Force. The over-all objective in the protection of the labor force is to limit fallout exposure to the extent practicable, consistent with available fallout shelter and shelter habitability, but recognizing that there are essential functions which the surviving skilled and unskilled labor force will have to perform to ensure the survival and recovery of the nation.

In determining how soon the labor force can be released from fallout shelter for active duty, a decision must be made regarding the ERD which will be used as a criterion for radiation exposure for these personnel. No "hard and fast" rule can be given to be applicable in each case. The decision will generally be made at the local level by the mayor or civil defense director, in collaboration with his staff, including the Radef and health officers. A primary determining factor will be the urgency of the situation; i.e., how essential is the early reactivation of a particular facility, and can such reactivation be postponed to take further advantage of radiological decay. Where practicable, the exposure of the adult labor force should be controlled to the extent that their ERD does not significantly exceed 100 r.

Guidance for Controlling Radiation Exposure of the General Public. The data in Table 5 pertain only to acute effects, and not to long range effects, such as shortening of life span, genetic damage, increased incidence of leukemia and bone cancer, premature aging, etc. Therefore, in dealing with the general public, the criterion should be to keep exposures as low as practicable - consistent with the availability of shelter, feasibility of postattack remedial evacuation or decontamination, and the necessity for re-establishment of essential industrial and agricultural operations. In the re-establishment of essential industrial and agricultural operations, adults over 40 years of age should primarily be used, and adults under 40 as well as children should be kept in shelter as long as feasible. The data in Table 5 would suggest that the ERD of shelterees should be kept below 100 r to limit the incidence of transient nausea. In most areas of the county, the ERD's of people occupying community shelters could be kept below 100 r. In very highly contaminated areas, decontamination of selected areas and structures, or remedial evacuation would be required to avoid higher exposures.

Guidance for Carrying out Remedial Movement. Before deciding upon remedial movement to another location with less fallout as an appropriate countermeasure, the problem must be thoroughly examined by the civil defense director in conjunction with his Radef Officer, medical officer, and welfare and transportation officials. Postattack remedial movement to another area will not only take people from their homes or communities, in which they have a relative degree of comfort and sense of security, but it will require mass transportation across fallout areas, the establishment of reception and care centers, and the subsequent transportation of food and other required survival items. Various types of shelter regimentation should be considered alternatively to remedial movement. However, if relatively poor fallout protection (such as the first floor of a home) is all that is available in much of a community, remedial movement may be the only solution.

As indicated by the ERD charts in Annex 6, the ERD for the shelter period will generally reach a maximum during the first seven to ten days. With a single wave of attack, the referenced charts indicate that if people within shelters have not been exposed to a sickness dose during the first seven to ten days, they will probably not be exposed to a sickness dose thereafter, as long as they remain in that fallout shelter. Since it is not possible to keep people in shelter indefinitely, a relaxed shelter regimentation, decontamination, or remedial movement may have to be placed into effect about two weeks postexposure, or earlier if orderly movement can be planned and carried out.

A "rule of thumb" may be used to estimate the most favorable time to carry out postattack movement from a structure having a low protection factor (PF) to a nearby shelter having a much higher PF. If the contamination is the same at both locations, and the PF of the shelter is at least ten times that of the original structure, the PF of the first structure times the hours in transit equals the optimum time (hours after burst) to begin movement to better shelter. For instance, if one were located in a heavy fallout area in a structure with a protection factor of 10 and he could move to a structure with a protection factor of 100 or better in one-half hour, the optimum time for moving would be 10 X 1/2 hour, or 5 hours after the time of the nuclear explosion. Movement of this type to better shelter would generally be advisable before fallout arrival, or during the early hours postattack, but not while significant amounts of fallout particles are still in the air.

There is also a rule of thumb for determining the optimum time to carry out remedial evacuation of a fallout area to an area of little or no fallout. For evacuation, the individual should wait for a time (in hours) equal to three-fifths of his shelter factor for each hour it will take him to get to the radiation free area. For instance, if one were in a structure with a shielding factor of 20 and he could evacuate to an area relatively free of fallout radiation in 6 hours, the optimum time to carry out evacuation would be 3/5 X 20 X 6 = 72 hours, or 3 days after the burst. The rule indicates that the optimum evacuation time would be about 15 days. However, as indicated in the previous section, if evacuation is not required during the first 7 to 10 days, some other form of regimentation or decontamination for exposure control might be preferable to movement from the area. Each case must be evaluated separately.

Annex 6 of this Chapter contains graphs and illustrative calculations that will assist the Radef Officer in making a more comprehensive analysis of the relative radiation hazards involved in remedial movement as compared to additional stay time in shelter.

Guidance Concerning Agricultural Operations. Local representatives of the U. S. Department of Agriculture are responsible for the application of USDA criteria and guidance for protection of agricultural personnel, commodities, and production capabilities. State and local governments are given broad responsibility for monitoring, providing guidance and direction to the populace. The division of responsibilities for radiological services as they pertain to agriculture are outlined in Annex 2 to Chapter II, entitled "Coordinated Functions, County Radef - Representatives of USDA."

Basic guidance to farm personnel must emphasize the necessity for entrance into shelter upon fallout arrival. The degree of exposure control must be worked out by the county or State Radef Officer in cooperation with Department of Agriculture representatives in a manner that will keep the ERD of adult farmers (beyond 40 years of age) commensurate with the urgency of the tasks to be performed. With careful planning, the exposure of the adult farm group can be controlled sufficiently to prevent the occurrence of serious radiation sickness, if the farmers remain in the family fallout shelter the larger percentage of each day at least during the early period, and limit their outside activities to essential chores within the barn or sheltered area where the livestock are kept. With a shielding factor of about 100 in the family shelter and a shielding factor of 2 to 10 in the barn, the exposure of the adult farmers can be properly planned so that they will not become ill. Where possible, nonadult farm people (children) should be treated as the general public; i.e., they should not be considered as emergency workers. Their exposures should be more vigorously controlled.

With reference to ingestion standards in relation to contaminated food and water, the specific criterion to be applied must be determined at the time and place of the event since the determination will be affected by many factors, such as the degree of contamination, the availability of uncontaminated food stocks, the anticipated demand for food supplies during the next month, and the rapidity with which transportation can be re-established. For example, if uncontaminated food supplies were exhausted and transportation can be re-established, a different criterion will have to be applied concerning the consumption of contaminated food than would be applied if there were large supplies of uncontaminated food available. It is not possible to provide a specific criterion for each type of incident. Consequently, the civil defense director should make prior arrangements to have both agricultural and medical specialists available in the EOC for consultant service in time of emergency.

The following points may assist the county Radef Officer to better understand the necessity for a coordinated Department of Agriculture/county radiological defense program:

1. Dairy cattle must be milked at least once a day, or they may cease to produce milk. Not all milk will be suited for human use, however.

2. Livestock have to be fed and watered at least every other day (preferably once a day) or they may become sick and die.

3. If some crops are not harvested at a particular period of ripening or development, they may be lost.

4. If some crops are not seeded or planted during a particular interval of time, they may not mature before the end of the growing season.

5. Fallout may contaminate growing crops in the field.

6. Fallout may contaminate the soil, be taken up by the roots, and become part of the cellular tissue of the plant.

7. Fallout may contaminate pasture land and limit its use for grazing, particularly for the first few weeks after attack.

8. Fallout may contaminate open reservoirs, ponds and streams used for watering livestock.

9. External as well as internal exposure to nuclear radiation is detrimental to livestock as well as to humans on the farm.

10. In performing chores necessary for sustained agricultural production, radiation exposure to adult farmers must be kept below an ERD of 200 r or they will become ill and need medical attention. Where practicable, exposure of farm children should be kept well below an ERD of 100 r.

11. It is probable that chickens will not lay if the radioactive body burden is large enough that their eggs are unfit to eat. Since chickens are more radiation resistant than other farm animals and, since they are usually fed stored foods, chickens and their eggs can serve as a major relatively uncontaminated source of food early in the postattack period.

12. Cows that have received a large dose of external gamma radiation or a large dose of internal radiation from ingested fallout will soon cease to give milk. The fact that a cow still produces milk is reasonable evidence that radiation injury is minimal and that the body burden is not great.

The county or State Radef Officer will find considerable guidance material in the U. S. Department of Agriculture publication, "Protection of Food and Agriculture Against Nuclear Attack." This manual is comprehensive and clearly portrays the hazards and effects of fallout on the farmer, his livestock, and his land. It presents practical guidance for reducing these effects and describes methods of decontamination and salvage. The biological food cycle for strontium 90, cesium 137 and iodine 131 are described in detail, and practical methods for rotation to crops having low calcium (strontium) content are presented. The Radef Officer may also wish to refer to "The USDA Radiological Monitoring Manual."

Guidance for Carrying Out Decontamination Operations. If essential functions can be resumed at a satisfactory time, decontamination will not be required. This will be determined from the exposure control guidance previously presented. However, if occupation of certain areas or, if essential functions are required at an earlier time, decontamination will be necessary. The decision as to the radiation exposure to be accepted by the personnel to perform the functions and by the decontamination personnel will generally be made at the local level by the civil defense director, in collaboration with his decontamination specialists and Radef and health officers. In some cases, decontamination may be required in areas for occupation by the general public to keep their radiation exposure low.

The 200 r ERD criterion could be applied to the decontamination teams for high priority missions. The exposure to decontamination teams should be kept below a maximum ERD of 200 r whenever practicable. The primary determining factor should be the urgency of the situation; e.g., how essential is the early reactivation of an essential facility, and can such reactivation be postponed further to take advantage of radiological decay.

Guidance Concerning Reclamation and Rehabilitation Phases. Executive Order 11001 assigns to the Department of Health, Education and Welfare the responsibility for developing and coordinating programs of radiation measurement and assessment as may be necessary to carry out the responsibilities involved in the provision for preventive and curative care related to human exposure to radiation, including rehabilitation and related services for disabled survivors. Executive Order 10998 assigns similar responsibilities to the Department of Agriculture as they pertain to agricultural products and lands.

Two to four weeks after attack the radiation hazards in most sections of the country will have decayed sufficiently to permit the undertaking of extensive decontamination operations. The Radef Officer at the local level will have many functional responsibilities to carry out prior to, during, and subsequent to decontamination operations. However, these are covered in detail in Annex 6 to this Chapter. The Radef Officer should familiarize himself with the data in these sections. Several weeks to months postattack the external gamma radiation hazard may become of secondary importance, and the internal hazard from ingestion of radioactive materials may comprise the primary problem to the health of the survivors. During this period of return to quasi-normal conditions, the public health and agricultural aspects referred to above assume greater importance. Certain controls may have to be imposed during this period to keep the total body burden of radioactive materials to acceptable limits. Among other things, these might entail:

1. restrictions from growing crops with high calcium content on heavily contaminated agricultural lands,
2. the withholding of heavily contaminated or highly radioactive foods from normal distribution,
3. reduced consumption of milk by children, unless the milk can be decontaminated,
4. the withdrawal of heavily contaminated land from production of food,
5. the slaughter of moribund animals,
6. the seclusion of some areas from normal habitation,
7. the heavy liming of acid soils,
8. the restricted use of contaminated water supplies,
9. the redistribution of population, etc.

Although the evaluation of the degree and type of hazardous contamination from a long-range standpoint and the subsequent recommendations for countermeasures are primarily the responsibilities of the State and local public health and agricultural services, the Radef Officer can be of considerable help to these services. Therefore, to the extent possible, he should assist them. The monitoring instruments and the monitors used in the monitoring and reporting system during the survival and recovery period should also be used to the maximum extent possible to support these longer range operations. Further, the Radef Officer, his assistant Radef officers and other specially trained EOC personnel should be able to provide technical assistance and operational support. Close coordination with these interrelated services during the survival and recovery phases would pave the way for a smooth transition to this final phase of dealing with the long-term problems associated with the ingestion of radioactive materials.

Guidance for Maintaining Exposure Records. Generally, exposure records of emergency operation personnel will be maintained by each service, such as police, fire, rescue, etc. Records of exposures of the general public at community shelters should be an individual responsibility. Individual exposure forms, similar to the example in Annex 3 of this Chapter, should be prepared and distributed to shelterees. At the end of each day, the shelter manager should announce and post the daily measured in-shelter exposure to the shelterees for recording on their individual exposure record forms. Separate exposure records of task forces emerging from shelter for resupply or other emergency functions should be maintained by the shelter monitor in addition to the recording of the data on each individual's exposure record card.

PLANNING AND DEVELOPING AN AERIAL SURVEY CAPABILITY

This section describes the general organization, methods, and techniques involved in the planning and execution of aerial monitoring. It is compatible with the Federal Aviation Agency State and Regional Defense Airlift Planning Handbook. Annex 2 to this Chapter is a plan for the emergency use of non-air-carrier aircraft to support selected civil defense operations.

There are approximately 80,000 to 90,000 non-air-carrier aircraft in the United States. The Federal Aviation Agency (FAA) is responsible for the preparation of national emergency plans and the development of preparedness programs covering the emergency management of civil aircraft other than air-carrier aircraft. Non-air-carrier aircraft coming under a type of organization which will lend itself to an effective training atmosphere should be considered for a potential capability for performing aerial monitoring missions. The Civil Air Patrol (CAP), civilian auxiliary of the United States Air Force having approximately 4,500 aircraft, is one of the air organizations having the prerequisites to fulfill a portion of the aerial monitoring requirement.

CAP Organization. The CAP organization is governed by a national board of senior members. The organizational structure is patterned after the USAF. It consists of a national headquarters, eight regions and a wing in each of the fifty States, Puerto Rico, and the District of Columbia. The wings are subdivided into groups, squadrons, and in rare instances, flights. The squadron is a basic unit. Members of CAP work on a volunteer basis only. More than one-half of the States have at least one group which serves as an administrative headquarters between wing and squadron. The group may or may not have an operational capability. There are three types of squadrons in the CAP organization. These consist of the cadet squadron, senior squadron, and the composite squadron. The cadet squadron is made up of boys and girls and at least three senior members, and primarily functions as a youth aerospace educational program. The senior squadron is composed of only senior members, while the composite squadron contains both senior and cadet members. All members of the senior squadron and the senior members of the composite squadron will be available for civil defense missions in an emergency. The CAP units have been authorized to perform aerial radiological survey in support of civil defense emergency operations of States and territories, and their political subdivisions in addition to the other civil defense and non-civil defense missions.

Agreements with CAP. Formalized agreements for the support of aerial radiological monitoring operations postattack have been made by most of the States, the District of Columbia, and Puerto Rico with the respective CAP Wings of their areas. These agreements should be reviewed periodically and changes made, as appropriate, to assure the operational capability.

Standing Operating Procedures (SOP). It is essential that detailed plans for the conduct of aerial survey operations in an emergency be established at the State level and furnished to local governments to aid them in the preparation of their SOP's. These SOP's should be compatible with the "Plan for the Emergency Use of Non-Air-Carrier Aircraft to Support Selected Civil Defense Operations," Annex 2. Any plan or SOP for the emergency use of any part of the non-air-carrier aircraft capability, including CAP, to support postattack civil defense emergency missions must be developed in conjunction with the Federal Aviation Agency, since FAA is charged with the management of these aircraft during an emergency.

EOC Planning for Aerial Survey Missions. The initial planning for aerial survey missions is the responsibility of the EOC in the area of concern. Flights in most cases will be launched from areas of no fallout or areas that are not seriously affected by contamination. Aircraft will be required to fly to the area to be surveyed, conduct the mission, and return to the designated airport. Since many of these flights will involve the use of aircraft which are under the control of one civil defense jurisdiction in support of another jurisdiction seriously affected by contamination, close coordination must be maintained between aerial survey units and the initiating EOC in planning and conducting missions.

During period of attack or threatened attack, the North American Air Defense Command (NORAD) controls access to the air for flight operations under the provisions of "Security Control for Air Transportation and Electromagnetic Radiation," (SCATER). However, arrangements have been made with NORAD to assign priority to aerial monitoring operations. During periods SCATER is imposed, prior approval must be obtained for aerial monitoring flights. The flight plan must be submitted to the nearest FAA facility and the FAA, in turn, forwards the request to the appropriate regional NORAD office for approval. During the planning period, the Radef Officer is responsible for checking these procedures carefully with the FAA to make sure that arrangements have been made to handle requests for approval of aerial survey missions. Arrangements for the use of military aircraft, if available, will be made through the appropriate CD regional director.

Aerial monitoring conducted as a part of the initial damage assessment missions can be of value in indicating the approximate fallout hazard to be expected and the general direction it is proceeding. During this early period, it is not expected that any accurate information concerning the radiation intensities can be obtained because of the high probability that contaminated particles might be suspended in the air resulting in possible contamination of the aircraft (for decontamination procedures for equipment, see Chapter 12, Decontamination and Related Countermeasures).

It is unlikely that extensive detailed aerial survey operations could be initiated in most sections of the country following a massive nuclear attack until 24 to 48 hours, or longer, after attack because aerial readings may not be valid while significant amounts of fallout are still airborne. Radiation level at the airfields may delay flight preparation and, although arrangements have been made with NORAD to assign high priority to such flights under the provisions of SCATER, authorization for monitoring flights could be delayed, particularly under conditions of repeated or extended attacks. To prevent unnecessary delay in early survey missions, preselected courses and/or routes should be specified in State or local SOP's for areas likely to require aerial survey.

Material contained on pages 3-42 through 3-48 has been incorporated in Chapter IX Annex 1 Handbook for Aerial Radiological Monitors (pages 9-37 through 9-66).

PLAN FOR THE EMERGENCY USE OF NON-AIR-CARRIER AIRCRAFT TO SUPPORT SELECTED CIVIL DEFENSE OPERATIONS

MISSIONS

1. Airlifting urgently-needed personnel and supplies.
2. Disaster reconnaissance appraisal, visual and/or photographic, including aerial radiological monitoring.
3. Communications by courier flights and/or such nongovernmental aeronautical radio facilities as available.
4. Aerial functions in support of total commercial, executive, personal, industrial and agricultural requirements in survival and recovery actions.

ORGANIZATION AND PERSONNEL

Organization. Preattack preparation: Existing organizations of non-air-carrier groups such as the Aircraft Owners and Pilots Association, Civil Air Patrol, Flying Farmers, Flying Physicians, National Business Aircraft Association, etc., will be used. Also, the existing organizations of the OCD, FAA, State and local civil defense, and State and local Emergency Transportation Authority will be used.

Attack and postattack operations: The organization, as established preattack, will generally apply.

Personnel. All available existing pilots, observers, ground supporting personnel, and aircraft should be utilized as appropriate to perform the required missions.

COMMAND AND CONTROL

Preattack. The development of an operational capability will be the responsibility of State and local civil defense directors in coordination, as required, with the Federal Aviation Agency (FAA), Office of Civil Defense (OCD), Office of Emergency Planning (OEP), Office of Emergency Transportation (OET), Department of Commerce, State aeronautical authorities, and other governmental agencies.

Postattack. The claimants for utilization of non-air-carrier aircraft should be primarily from the State Civil Defense Director and, secondarily, from the local civil defense director. These missions will be directed to the Emergency Transportation Office at State and local levels for execution. Under some conditions of postattack security control of air traffic (SCATER), coordination for flight approvals must be carried out through the local Air Route Traffic Control Center (ARTC) of the FAA, which will contact the appropriate NORAD (CONAD) Regional Commander for approval to carry out the flight mission. Action will be taken as required by Plan SCATER.

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AUTHORITIES AND ASSIGNMENTS

Federal Assignments.

1. The Department of Commerce, under the authority of Executive Order 10999, will, in consonance with plans developed by other agencies assigned operational responsibilities in the transportation program, develop plans for and be prepared to provide the administrative facilities for performing emergency transportation functions when required by the President.

2. The Office of Emergency Planning, under authority of Executive Order 10952, will develop plans for the continuity of Federal operations in the event of a nuclear attack, and for the performance, as necessary, of such emergency activities as the evaluation of remaining resources after an attack, their allocation, and the control of transportation.

3. The Office of Civil Defense (OCD), under authority of Public Law 920 and Executive Order 10952, will (1) provide the over-all policy, direction, guidance, specified training, and material support as appropriate, (2) provide the specific mission guidance, and (3) direct interregional postattack assigned missions as requested by OCD Regional Directors.

4. The Federal Aviation Agency (FAA), under the authority of Executive Order 11003 and the Federal Aviation Act of 1958, will prepare national emergency plans and develop preparedness programs covering the emergency management of civil aircraft other than air-carrier aircraft to provide for civil defense postattack aerial support requirements.

5. United States Air Force (USAF) will (1) provide to the Civil Air Patrol (CAP) the policy, direction, guidance and material support as required by Public Laws 476 (79th Congress), 557 (80th Congress), 152 (81st Congress), and 368 (83rd Congress; (2) continue support of CAP units as feasible under postattack conditions; and (3) reassign mission priorities as necessary to meet postattack aerial support requirements of civil defense.

6. National Civil Air Patrol (CAP) will (1) provide the preattack direction and guidance to CAP units as required by USAF, OCD, and FAA directives to carry out the civil defense missions assigned to CAP; and (2) continue support of CAP operational units as feasible under the conditions of postattack emergencies.

7. Coordination. All of the above Federal agencies, civilian and military, are mutually responsible for coordination with one another on any matters involving policy, direction, procedures, and guidance related to the CD missions.

Regional Assignments.

1. OCD Regional Offices will (1) provide technical guidance and support to the State Civil Defense Director consistent with policies and directives issued by OCD National, and (2) will direct inter-State postattack assigned CD operations where required.

2. FAA Regional Offices will (1) provide operational and administrative control and support consistent with provisions issued by FAA National to implement the plan for emergency management of non-air-carrier aircraft for CD missions, and (2) give such assistance as practicable for postattack operations.

3. NORAD (CONAD) Regional Commander will (1) insure that preattack SCATER Plans include provision for carrying out essential post-attack flight missions for CD; (2) authorize appropriate preplanned flights that will be required postattack in order to carry out assigned CD missions; (3) give prior approval for preplanned flights to support CD postattack immediate requirements for bomb damage assessment, including aerial radiological monitoring, ground traffic control, fire detection and control, industrial and other national resource support, airlifting urgently needed medical supplies and equipment, and the emergency evacuation of aircraft and aerial radio communications; and (4) approve or delegate authority for approval of those attack and postattack aerial missions required to support CD operations which have not been approved as preplanned flights.

4. Coordination The coordination of preattack plans is the responsibility of the regional OCD and FAA, and the NORAD (CONAD) Regional Commanders. Attack and postattack matters involving inter-State requirements for CD missions will be coordinated between the regional offices concerned.

State Assignments.

1. The State Civil Defense Director will:

   a. Develop or modify agreements with FAA and/or State aeronautical authorities as required to use available non-air-carrier aircraft within the State as required for carrying out assigned CD emergency missions.
   b. Assign areas of responsibility which will accomplish the provision of support to a locality, a county, or larger area.
   c. Provide, while maintaining over-all State control, for direction and control by local CD directors under "cut-off" situations.
   d. Plan for alternate support assigned to areas of responsibility.
   e. Plan for the provision of training and support needed to carry out the missions.
   f. Maintain liaison with FAA and State aeronautical authorities.

g. Arrange, where required, through proper authorities for prior approval of preplanned flights in accordance with the provisions of SCATER.
h. Provide for representatives from FAA, State aeronautical authority, and other organizations as required at the State Emergency Operations Center (EOC).
i. Make provision for carrying out special flight missions that may be required by OCD region.
j. Arrange test exercises for other non-air-carrier aircraft; arrange in conjunction with CAP wing for the annual test exercise authorized by CAP Regulation 55-10.
k. Provide and arrange for the use of non-air-carrier aircraft organizational capabilities, including CAP, to furnish support for other than flight missions.
l. Develop the communications system needed to support air missions through the use of State aeronautical authority facilities, CD facilities and frequencies, CAP facilities, and aeronautical advisory stations.
m. Arrange with the State aeronautical authority for State support of requirements above and beyond that furnished by OCD and other agencies.
n. Direct missions through appropriate channels postattack for CD flight and ground operations as required.
o. Furnish logistical support, from available stock levels, for assigned CD missions during the emergency.

2. State Chief of Aviation will:

a. Assist and advise the State CD Director in the development or modification of agreements for use of non-air-carrier aircraft in support of CD missions.
b. Develop in conjunction with State CD Director guidance material to be used by non-air-carrier aircraft in developing standing operating procedures (SOP's) for carrying out CD assigned missions.
c. Assist the State CD Director in developing a suitable communications system using CAP, CD, and State aeronautical facilities and State aeronautical advisory facilities assigned radio frequencies.
d. Maintain a current listing of non-air-carrier aircraft capabilities and resources and furnish a report to the State CD Director on a quarterly basis.
e. Conduct the training of the personnel under his direct control and provide the training guidance for other personnel required to perform CD missions.
f. Arrange for his presence or a suitable liaison representative at the State EOC in time of emergency.
f. Carry out the postattack operational missions as required by the State CD Director and the State Emergency Transportation Organization (ETO).

3. State Emergency Transportation Organization will:

   a. Assist the State Chief of Aviation and CD Director in developing the plan for use of non-air-carrier aircraft within the State to support CD missions.
   b. Furnish such support as is available for the operation and control of aircraft flying CD missions in an emergency.
   c. Assist the State CD Director in making State financial arrangements for support of postattack CD assigned flight missions.

4. Coordination. All planning for the use of non-air-carrier aircraft within the State for CD missions must be through the ETO. This includes command and control, communications, preplanned flights, delegation of authority below State level, and SOP's. Coordinated plans must be consistent with the restrictions of the SCATER Plan. Postattack coordination must be accomplished between the unit flying the mission and the CD level requesting the mission.

Substate, County and Municipality Assignments.

1. CD Director will:

   a. Develop a support agreement and a field operations plan in conjunction with the commander of the ETO and the local chief of aviation in his area of responsibility.
   b. Assist in the training of monitors and provide other necessary support to carry out the assigned missions.
   c. Maintain liaison with the local ETO in his area of responsibility.
   d. Arrange through appropriate channels to obtain prior approval for preplanned flights from NORAD Regional Commander.
   e. Arrange for representation of the appropriate chief of aviation at the EOC in time of emergency.
   f. Arrange test exercises for non-air-carrier aircraft; arrange in conjunction with CAP units for a minimum of one annual test exercise to test the unit's ability to perform CD support missions.
   g. Provide and arrange for use of CAP personnel and facilities for other than flight missions.
   h. Develop, with the help of the agencies concerned, the communications system needed to support CD missions through the use of CAP, aeronautical authorities, and CD facilities and radio frequencies.
   i. Direct missions through appropriate channels as delegated by State level and postattack CD flight operations as required.
   j. Direct missions for specific flight operations through the ETO as requested by higher authority.
   k. Furnish logistical support, from available stock levels, for assigned CD missions during the emergency.

2. The local chief of aviation will:

   a. Assist and support the ETO in the development or modification of the field operations plans for use of non-air-carrier aircraft in support of CD missions.

b. Assist the CD Director to develop a suitable communications system using CAP, CD, and State aeronautical assigned facilities, radio frequencies, and aeronautical advisory facilities.

c. Maintain a current listing of non-air-carrier aircraft capabilities and resources and furnish a report concerning this listing to ETO and the local CD Director as required.

d. Conduct the training of personnel for performing CD support missions in coordination with the CD Director.

e. Arrange for local chief of aviation or his representative at the EOC/EOC's in times of emergency.

f. Carry out postattack operational missions as requested by the ETO or the CD Director under "cut off" situations.

3. Coordination. All planning for the use of non-air-carrier aircraft for CD missions must be through the ETO. This includes command and control, communications, preplanned flights and SOP's. Coordinated plans must be consistent with the SCATER Plan. Postattack coordination must be accomplished between the unit flying the mission and the CD level requesting the mission.

TRAINING

OCD Responsibilities.

1. OCD is responsible for CD training requirements, policy, general guidance and procedures for carrying out State and local CD aerial monitoring and other support operations.

2. OCD will assist in training selected instructors to provide training for aerial monitors. OCD will assist in the provision of contributions for student expenses and per diem for the training of instructors and for the local training of aerial monitors.

3. OCD will prepare and issue an aerial radiological monitor's manual in coordination with FAA and other agencies concerned.

FAA Responsibilities.

1. FAA is responsible for providing guidance for the appropriate training for execution of CD flight missions.

CAP National Responsibilities.

1. CAP National is responsible for the general guidance and procedures in conjunction with flight training for operations and communications of the CAP. Flight and specialized training other than aerial monitor training is the responsibility of CAP.

State Area and Municipal Civil Defense Responsibilities.

1. State CD units will arrange with OCD National for the training of aerial monitor instructors.

2. CD units will assist as required in the local training of personnel involved in the support of CD missions.

CAP Unit Responsibilities.

1. CAP units are responsible for carrying out the training normal to CAP operations which apply to CD type missions and for specialized training applying to these missions.

COMMUNICATIONS

OCD National will

1. Develop the over-all communications requirements for command and control, to include those required for test exercises, liaison, and emergency operations.

2. Request additional radio frequencies as required for State, county, and local civil defense to net with appropriate FAA facilities.

3. Develop and provide, in coordination with all aviation activities, the reporting procedures to be used in support of CD missions.

State and Local CD will

1. Develop and implement a communications plan for use in aerial support missions.

2. Coordinate above plans with the State aeronautical authority and FAA.

Civil Air Patrol will

1. Provide for communications from CAP units to the equivalent CD unit.

2. Provide for communications to the FAA at equivalent levels.

3. Make arrangements, as required, for the use of AF assigned radio frequencies for CD support missions.

4. Provide available communications facilities, mobile units, and airborne units for CD assigned attack and postattack support.

SUPPORT

Office of Civil Defense will

1. Provide monitoring equipment, ground and aerial, to aviation facilities through the State CD.

2. Approve purchase by the States of equipment under the provisions of the contributions program for use in aerial support missions

and ascertain the eligibility of support equipment for procurement under the terms of the contributions program.

3. Assist in the maintenance and calibration of monitoring equipment granted to the States for use in support of air assigned missions.

4. Direct the States to be prepared to furnish logistical support to air units from available State and local resources during the attack and postattack periods.

<u>U. S. Air Force</u> will

1. Provide CAP major items of equipment, including aircraft, motor vehicles and communications, and necessary supplies and training aids that are excess to the needs of the military departments.

2. Provide to CAP (a) necessary AF liaison and advisory personnel, (b) AF services and facilities needed to carry out CD assigned missions, (c) reimbursement for fuel and lubricants needed to carry out the assigned and approved missions, (d) reimbursement for fuel and oil for training tests, and (e) reimbursement, in time of war, for travel expenses and per diem allowances to members of CAP on assigned missions.

<u>Civil Air Patrol</u> will

1. Obtain major items of equipment, as practicable, which are excess to the needs of the military departments.

2. Obtain support equipment, materials, and supplies from the States which will furnish such support. (NOTE: <u>Request for items of equipment eligible for matching funds under the OCD contributions program may be granted through the State CD Director</u>.)

<u>Other Non-air-carrier Aircraft Units</u> will

1. Obtain support equipment, materials, and supplies from the States which will furnish such support.

2. Request through the State CD Director items of equipment eligible for matching funds under the OCD contributions program.

<u>State and Local CD</u> will

1. Provide air units assigned support missions such equipment, materials, and services as are available through State sources.

2. Approve and forward to OCD for final approval requests for equipment and material eligible for matching funds under the contributions program.

3. Provide logistical support to air units from available resources during attack and postattack periods.

RADIOLOGICAL SERVICE FORMS AND MARKERS

These forms and markers, and the illustrations of their applications are presented for guidance. The State or local Radiological Service may reproduce them as presented, or revise them to suit local requirements.

Inspection, Maintenance and Calibration Log. The illustration in Figure 6 could be printed as the two sides of a single sheet. The directions and sample entries indicate the records needed for control of these necessary procedures.

Radiation Exposure Record. Both sides of this form are shown and its use is illustrated in Figure 7. Folded, the form can be carried as a wallet card. Individual dose records would be necessary as a basis for control of radiation exposure of workers assigned to tasks in fallout areas.

Radiological Reporting Log and Time Conversion Chart. These two items should be printed on the opposite sides of the same sheet. The reporting log, Figure 8a, provides for an orderly record of reported dose rates and doses. Together with the Time Conversion Chart, Figure 8b, it provides a guide to the hours of observations in local time, which will result in an area-wide and nationally synchronized monitoring.

Radiological Log. Reports received at EOC. Figure 9 illustrates a log that may be used to keep an orderly summary of scheduled monitoring reports. It should be noted that each horizontal line presents the chronological radiological history of each monitoring station, and a vertical column would present the radiological situation across the area of responsibility, as of the given observation time. It is suggested that (a) the station designators be arranged in a convenient order; e.g., alphabetical, numerical, grouped by communication nets employed, etc.; (b) messages be logged as received, and promptly forwarded to the plotters; (c) the incoming message itself be used by the plotter(s) in preparation of the analysis; and (d) the incoming messages be filed in groups under the heading of the hour of observation.

Aerial Survey Data Sheet. This form, Figure 10, is intended for use by the aerial monitor and at the EOC. It provides space for both the field data and "surface level" dose rates calculated from the aerial measurements. Field procedures for aerial monitoring, including recording and reporting of data, are described in Annex 1 to Chapter IX.

Monitoring Station Decalcomania. All officially designated monitoring and reporting stations should be designated by the application of the decal illustrated in Figure 11. Decals are available from the Office of Civil Defense.

Radiation Contamination Marker. The standard CD marker for use in marking radiologically contaminated areas is illustrated in Figure 12. It is black and white in color. The dose rate, date, time and person who posted the marker will be recorded on the back side of the marker at the time of posting.

This is the official marker for the United States military services and some countries.

INSPECTION, MAINTENANCE AND CALIBRATION LOG
FOR RADIOLOGICAL INSTRUMENTS

DATE	ACTION	REMARKS	SIGNATURE
8/1/62	inspection	O.K.	John Doe
10/3/62	inspection	O.K. except CD V-715	John Doe
	out for repair	CD V-715, #86376	John Doe
10/15/62	returned	CD V-715, #86376	John Doe
12/2/62	inspection	O.K.	John Doe
1/6/63	batteries replaced		John Doe
1/15/63	calibration	O.K.	John Doe

DIRECTIONS:

1. Keep this log with the instruments.
2. Inspect all radiological instruments every two months. Perform an operational check on survey meters and, if necessary, rezero all dosimeters. Enter the results of the inspection on this log.
3. Initiate action for repair or replacement of inoperable instruments. Enter the appropriate action on this log.
4. Replace batteries annually or sooner, if necessary. Enter replacement on this log.
5. Make instruments available for calibration as required. Enter action on this log.

FIGURE 6 —Inspection Maintenance and Calibration Log.

RADIATION EXPOSURE RECORD

Name JOHN DOE

Address 227 N. Moorland
Battle Creek, Mich.

Soc. Sec. No. 545-26-5535

Date(s) of Exposure(s)	Daily Dose(s)	Total Dose to Date
6/6/62	15	15
6-7-62	5	20
June 9	25	45
6-8-10/62	5	50

DOD FORM ______ DATE __________

FRONT SIDE

Date(s) of Exposure(s)	Daily Dose(s)	Total Dose to Date

BACK SIDE

FIGURE 7 —Radiation exposure record.

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY OF THE ARMY
OFFICE OF CIVIL DEFENSE

RADIOLOGICAL REPORTING LOG

STATION

REPORTED TO

FLASH REPORT (0.5 r/hr. or more)

DATE

TIME

DOSE RATE (r/hr)

TIME SENT TO CONTROL CTR

NOTE: Flash report of fallout will be made as soon as dose rate reaches 0.5 r/hr.

REPORT AS FOLLOWS

1. TIME OF OBSERVATION
2. LOCATION
3. FALLOUT

1st HR THRU 12th HR[3] (Hourly on the hour)

DATE

	TIME	DOSE RATE (r/hr)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

[2]TOTAL DOSE TO

0300 Z ______ [1] ______ r

13th HR THRU 24th HR[3] (Every 3 hours)

DATE

	TIME	DOSE RATE (r/hr)
1		
2		
3		
4		
5		
6		
7		
8		

TAKE OBSERVATIONS AT

0300 Z ______ [1] 0600 Z ______ [1]

0900 Z ______ [1] 1200 Z ______ [1]

1500 Z ______ [1] 1800 Z ______ [1]

2100 Z ______ [1] 2400 Z ______ [1]

[2]TOTAL DOSE TO

0300 Z ______ [1] ______ r

25th HR THRU 48th HR[3] (Every 6 hours)

DATE

	TIME	DOSE RATE (r/hr)
1		
2		
3		
4		

TAKE OBSERVATIONS AT

0300 Z ______ [1] 0900 Z ______ [1]

1500 Z ______ [1] 2100 Z ______ [1]

[2]TOTAL DOSE TO

0300 Z ______ [1] ______ r

If at any time following a period of decay, the dose rate increases materially, file a special report and start new program of observations.

AFTER 48th HR[3]

______ [1] (Daily at 0300Z)

DATE	DOSE RATE (r/hr)	TOTAL DOSE[2] (r)

REPORT DOSE RATES AS FOLLOWS: 1. TIME 2. LOCATION 3. DOSE RATE 4. DOSE TO 0300 Z ______ [1]

[1]*Enter local time from reverse side.* [2]*Total dose read from dosimeter - cumulative from arrival of fallout.* [3]*After flash report.*

OCD FORM 841, MAY 64

Figure 8a -Radiological Reporting Log

TIME CONVERSION CHART
(For Alaska and Hawaii, see footnote)

GREENWICH MEAN TIME	ATLANTIC STANDARD OR EASTERN DAYLIGHT	EASTERN STANDARD OR CENTRAL DAYLIGHT	CENTRAL STANDARD OR MOUNTAIN DAYLIGHT	MOUNTAIN STANDARD OR PACIFIC DAYLIGHT	PACIFIC STANDARD
0100	2100*	2000*	1900*	1800*	1700*
0200	2200*	2100*	2000*	1900*	1800*
0300	2300*	2200*	2100*	2000*	1900*
0400	2400*	2300*	2200*	2100*	2000*
0500	0100	2400*	2300*	2200*	2100*
0600	0200	0100	2400*	2300*	2200*
0700	0300	0200	0100	2400*	2300*
0800	0400	0300	0200	0100	2400*
0900	0500	0400	0300	0200	0100
1000	0600	0500	0400	0300	0200
1100	0700	0600	0500	0400	0300
1200	0800	0700	0600	0500	0400
1300	0900	0800	0700	0600	0500
1400	1000	0900	0800	0700	0600
1500	1100	1000	0900	0800	0700
1600	1200	1100	1000	0900	0800
1700	1300	1200	1100	1000	0900
1800	1400	1300	1200	1100	1000
1900	1500	1400	1300	1200	1100
2000	1600	1500	1400	1300	1200
2100	1700	1600	1500	1400	1300
2200	1800	1700	1600	1500	1400
2300	1900	1800	1700	1600	1500
2400	2000	1900	1800	1700	1600

*Add one day to the local calendar date for equivalent date in GMT. Example: Observed Central Standard Time is 10:00 PM *(2200 CST)* on the 14th day of the month *(142200 CST)*. Expressed as GMT, that time would be 0400Z on the 15th day of the month *(150400Z)*.

NOTE: For central Alaska *(Anchorage)* subtract 2 hours *(0200)* from each entry in the "Pacific Standard" Column. For Hawaii subtract 2 hours and 30 minutes *(0230)* from each entry in the "Pacific Standard" Column.

★ U S GOVERNMENT PRINTING OFFICE 1964 O—739-085

Figure 8b -Time Conversion Chart

RADIOLOGICAL REPORTING LOG

LOCATION DESIGNATOR	NO. OF MONITORS ON DUTY	FLASH REPORT TIME	DATE / TIME / r/hr or r																			

FIGURE 9

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	g. MAP IDENTIFICATION AND SCALE
b. REPORT TO	h. AUTHORIZED MISSION DOSE
c. CONTROLLED BY	i. MISSION DOSE RECEIVED
d. PILOT'S NAME AND ORGANIZATION	j. AIRCRAFT CORRECTION FACTOR
e. MONITOR'S NAME AND ORGANIZATION	k. RADEF INSTRUMENT USED
f. 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									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

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PAGE ____ OF ____ PAGES

Figure 10

EQUIPMENT FOR AERIAL MONITORING MISSION *(Check List)*

CD V-781 Aerial Survey Meter *(less similator unit)*

CD V-715 Survey Meter

CD V-138 Dosimeter *(2 each)*

CD V-730 Dosimeter *(2 each)*

CD V-740 Dosimeter *(2 each)*

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 air-drop

Pencils

Other items as required

A32615

NOTE: Letters are red, and circular field is blue.

Figure 11

Front view of Radiological Contamination Marker

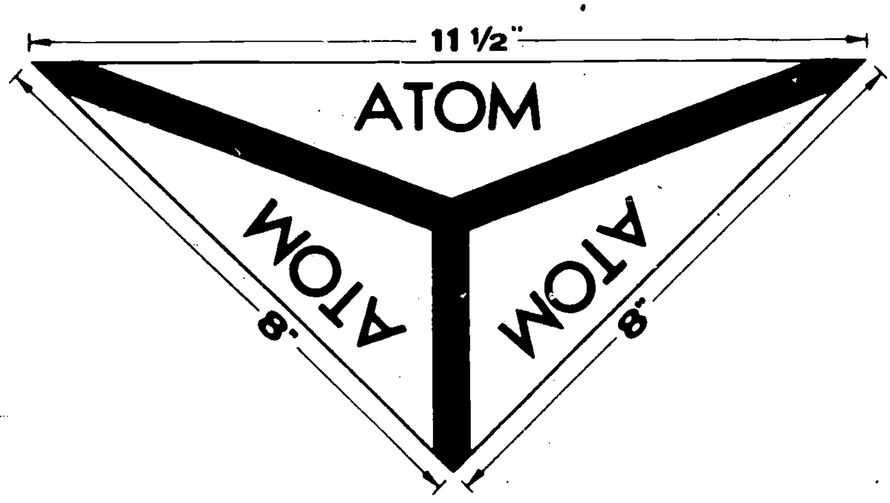

Figure 12

247-884 O - 67 - 8

SAMPLE EMERGENCY INFORMATION FALLOUT ADVISORIES

SAMPLE PREATTACK ADVISORIES

A preattack advisory, based upon UF data, might be worded similar to the following example:

> "The latest wind data indicates that for the next 6 hours--until 4 PM today--fallout will spread from the west toward the east at a speed of about 30 miles per hour across southern New England. Therefore, any nuclear detonations observed in a westerly direction could be an indication that fallout is apt to occur in your area. A bright, sustained flash of light or heavy rumbling would accompany a nuclear detonation and could generally be noticed for distances of 100 miles or more. A bright flash or a heavy rumble from a westerly direction should be considered as suspect. However, the fallout monitors across the Nation are at their posts and, in the event they detect fallout in your area, you will be warned. Keep tuned to your local stations."

The preattack advisory might contain additional information of a general nature such as the following:

> "Do not look directly toward a nuclear detonation. The light from the fireball can seriously damage a person's eyesight."

> "Radioactive fallout is made up of very small pieces or particles of material like ashes, soot, or cinders. In areas of heavy fallout, these particles, because of their great abundance, would generally be visible as they settle through the air or collect on surfaces. Therefore, after a nuclear attack, if abnormal deposits of ashes, soot, or cinders are noted, this should be suspected as being radioactive fallout. All people in the area should seek shelter until the condition can be monitored."

> "If people outside shelter observe a sudden flash that appears to be nearby, they should immediately duck into the shadow of a wall, building, or ditch, and lie face down with arms covering the head until the heat and blast waves have passed over."

Each local advisory will have to be patterned according to whether or not an area is a likely target. For example, people in areas likely to be affected only by fallout should be instructed of specific, simple tasks that they could perform before the arrival of fallout in order to improve their chances of survival. As an example, the advisories might state:

> "If you plan to go to a community or group fallout shelter, carry additional canned or processed food with you. Also, take blankets and extra clothing suitable for the season and any special medicine that you and your family will require during the next two

weeks. However, you are cautioned not to take more than you can conveniently carry as space in shelter will be limited. Before leaving home, be sure that all utilities are turned off and, if freezing temperatures are likely during the next two weeks, it is suggested that you drain your water pipes before departing your home. Keep tuned to your local radio station for further instruction."

"If you have a home shelter that you plan to use, make final preparations for its occupancy at this time. Place blankets and extra clothing in your shelter. Move supplies of all non-perishable foods on hand into your shelter. Supplement your existing water supply by filling bathtubs, laundry tubs, pots, pans, etc. Be sure that your battery-powered radio, necessary medical supplies, sanitary equipment, and other items such as candles, flashlights, extra batteries, toys, books, etc., are in your shelter. Also, have your car readily available in case it is needed for emergency travel. However, keep your car under cover in your garage if it is close to your home, or cover it with some cover similar to canvas, so that it will not become contaminated."

"If you do not have a home shelter and cannot get to a community or group shelter, or cannot share a shelter with a neighbor, spend the time before fallout arrival by implementing some shelter. If your home has a basement, fill in the window wells, or cover the windows completely with earth or sand. Move a heavy table or other supporting framework to the deepest corner of your basement. Pile heavy materials such as books, news-papers, bricks, stones, etc., around and over this table or supporting framework to form an enclosure of heavy, dense mater-ials. When fallout arrives, you and your family should prepare to move under this enclosure and spend as much time there as possible for the next several days. Also, move supplies of food, water, medicines, sanitation equipment, blankets and cloth-ing into the basement near the enclosure. If you do not have a basement, build an enclosure as described above in an interior room of your home and move essential supplies to that area. Moving heavy furniture around the enclosure will provide some additional shielding. Keep tuned to your local radio station for advisories from your local civil defense."

Following is an example of a written type advisory that might be prepared and issued to industry.

"The latest upper wind data indicates that if a surface nuclear weapon attack occurred to our west this afternoon, fallout would spread in the easterly direction at about 30 miles per hour possibly contaminating our area (named by city or county). There are four locations to our immediate west which might be considered as likely targets.

6 hours from an attack on Alpha AFB
4 hours from an attack on Beta AEC Facility
5 hours from an attack on City Gamma
7 hours from an attack on City Delta

However, if weapons are detonated off target or if the wind changes, these arrival times will vary accordingly. More precise data will be issued if weapons are detonated at locations likely to cause fallout in our area."

Local Levels. Use of UF data for fallout advisory purposes is more applicable to State or substate levels. However, some of the larger cities may have a capability for applying these forecasts in their survival operations. The forecasts will be applied at the time of attack based upon the most current "UF" data available and the approximate ground zero location. In a city which has been attacked by a surface nuclear burst, the surviving segments of organized government would issue the fallout advisory, if possible. The Radef Officer is responsible for preparing the advisory, which might be similar to the following and is provided for guidance purposes only:

"This is your City Alpha Civil Defense Advisor. From the nuclear attack on our City at 1250, fallout is expected to spread southeastward at about 25 miles per hour. It is forecast to spread across counties Baker, Charles, Dog, Easy and Fox during the next three hours. All survivors in City Alpha should remain in shelter until further advised. All people within 25 miles to the south and east of City Alpha should immediately seek the nearest shelter. Those beyond 25 miles of City Alpha should continue to their designated shelter areas, unless otherwise advised while enroute, or should complete their shelter preparations and be prepared to move into shelter immediately upon warning of arrival of fallout. Fallout should arrive at City George in about 1 hour at 2:00 PM, EST; at City Harry in about 2 hours at 3:00 PM, EST; and at City Item in about 3 hours at 4:00 PM, EST. People in other cities to the south and east of City Alpha will be warned by their local civil defense offices of the arrival of fallout in their communities. Our next civil defense fallout advisory for City Alpha will be at 2:00 PM, EST. Keep tuned to your local radio station."

This message, of course, is purely illustrative and would have to be modified to fit the time and conditions existing in an attacked city. Cities planning to use fallout forecasts should obtain the volunteer services of a meteorologist from the nearest Weather Bureau office, university, or some other source. These fallout advisories should be prepared by the Radef Officer in collaboration with the control center staff. They will be approved by the highest ranking surviving official of local government and then be released in his name.

A city, which has not been or is not likely to be attacked, would apply fallout advisories differently. The Radef Officer in a nontarget city would apply the UF data to any area of attack within 300 miles of his city. Even if communications should fail, the detonation of a megaton size weapon would generally be visible or otherwise detectable for distances over 100 miles. Though a precise ground zero location may not be known, the general area of detonation may be deduced from knowledge of likely targets in the area and the observed direction of the bright light, nuclear cloud, distant rumble, etc. By applying the UF to reported or deduced ground zero locations, the Radef Officer can make a forecast to determine whether his city is apt to be in a potential fallout area.

If his city is in a potential fallout area, the Radef Officer should prepare an advisory, for release by the mayor, similar to the following which is provided as guidance only:

> "The brilliant flash of light to the northwest 10 minutes ago indicates that City Alpha has probably been attacked. The latest upper wind data indicates that fallout from this attack will spread southeastward toward our city. The fallout is forecast to move at about 25 miles per hour and will reach here at Item City in 3 hours, or about 4:00 PM, EST today. Therefore, we expect about 3 hours to finalize the preparation of our fallout shelters. You should check your home shelter to be sure that it is supplied with sufficient food and water for two weeks as well as medicines, blankets, clothing, and battery-powered radio, spare batteries, flashlights, and other needed equipment on your checklist. Your radiological monitors have been alerted and, as soon as fallout is detected, enter your community or home fallout shelter. If you plan to go to a community shelter, carry a supply of processed foods, needed medicine and clothing with you. There will be scheduled fallout advisories broadcast each hour on the hour by this station. A special warning will be issued when fallout is detected. Repeat, fallout is expected to arrive at Item City in three hours. You should be prepared to occupy your fallout shelter not later than 4:00 PM, EST today. Keep tuned to your Item City radio station for your local civil defense advisories."

This initial advisory, modified to meet specific local needs, should be rebroadcast several times. Further, it should be updated for the scheduled hourly broadcasts.

If the city is <u>not</u> in a likely fallout area, the Radef Officer would prepare an advisory for release by the mayor to the general public similar to the following, which is provided as guidance only:

> "The brilliant flash of light observed to the east 10 minutes ago indicates that City Alpha has been attacked. The forecast indicates that fallout from this attack will spread toward the southwest from City Alpha in a direction away from us and, therefore, should not affect our city of Yorkville. However, we must be prepared in the event there are attacks on other areas upwind from us. Our radiological monitors have been alerted and, in case fallout is detected, you will be immediately warned. You should have your supplies of food, water, medicines, clothing, blankets, battery-

powered radio, monitoring instrument, and other needed items on your checklist ready to move into your community or home shelter in case we are threatened by fallout. Right now it does not appear that our City of Yorkville will be affected by fallout from the attack on City Alpha. However, you are advised to keep tuned to this station for future bulletins regarding the situation. Regular advisories regarding the fallout situation will be broadcast from this station every hour on the hour. If a fallout situation is observed by our monitors in or near this city, a special warning will be issued to go into your fallout shelter. Keep tuned to your City of Yorkville radio station for special civil defense advisories. Our next scheduled fallout advisory will be in one hour at 2:00 PM, EST today."

As in the other case, this initial advisory must be rebroadcast several times.

State Levels. Since fallout from a single multimegaton surface detonation may seriously contaminate several thousand square miles, issuance of fallout advisories, based upon forecasts, can be carried out effectively at State or substate levels. The State Radef Officer is responsible for preparing these advisories for issuance by the Governor or State civil defense director to areas not served by local levels. However, the actual determination of the sector expected to be affected by fallout should be carried out by a competent meteorologist.

After the sector of expected fallout has been determined, a fallout advisory should be prepared for issuance to people in this sector. The advisory might also contain advice on the improvisation of shelter and could be phrased similar to the following which is provided as guidance only:

"An attack on City Alpha early this afternoon is causing radiological fallout to spread southeastward across the State at about 25 miles per hour. The fallout is forecast to spread across counties Baker, Charles and Dog, during the next three hours; and after that it is expected to move eastward across counties George and Jig arriving in the vicinity of City King at about 6 o'clock tonight. Thereafter, it is expected to move northeastward toward Lake Love, arriving there at about midnight. All communities and rural areas, as well as itinerants along this path, are warned to expect fallout during the next 12 hours. All radiological monitors across the State are instructed to maintain continuous monitoring operations. All people keep tuned to your local broadcast stations for fallout advisories and survival instructions. Farmers across the State are advised to get their livestock in barns or under cover before fallout arrives. Your local civil defense office will warn you of the arrival of fallout. If you, personally, have a fallout monitoring instrument, turn it on and check it periodically. You may even be able to see the fallout particles. They will resemble a fine ash, cinders, or sand. In the absence of local instructions to the contrary, make use of available time before arrival of fallout to finalize preparations to occupy your family or community fallout shelter. If you have a home shelter, get two weeks supply of food, water, medicine, clothing, blankets, and other needed items on your checklist into or near the entrance to your fallout shelter. If you plan to use a community shelter, carry with you a supply of processed foods, clothing, blankets and needed medicines to the shelter. If you have not prepared a fallout shelter, and cannot go to a community shelter, improvise as follows:

a. Cover basement window wells and windows with dirt, or sand.

b. Move a sturdy table, framework or build a lean-to in the corner of your basement and pile heavy materials over and around it; the more the better.

c. Move your survival supplies into the basement near the improvised shelter.

d. When fallout arrives, crawl under the improvised shelter and spend as much time as possible there during the next several days.

If you do not have a basement, prepare an improvised shelter in an inner room of your home, using the same method. Keep tuned to your local radio station. As subsequent reports of attack and fallout are received, further fallout advisories will be issued by your civil defense advisor. Scheduled fallout advisories will be issued by this office each hour on the half hour."

A similar advisory would be prepared and issued at State level for each detonation whose fallout is expected to affect that State. In addition to the advisory broadcast from State civil defense headquarters, a top priority brief written message should be prepared by the Radef Officer and transmitted by the State civil defense director to each county in the path of the expected fallout, merely stating "Fallout is expected in your county at about 6:00 PM, EST today." The primary purpose of this is to provide advisory service for the rural areas and smaller communities which may not have well organized and operating civil defense units.

SAMPLE POSTATTACK ADVISORIES

Flash reports of fallout from neighboring communities, especially from the upwind direction, will be of considerable value to the Radef Officer in sharpening up the forecast of fallout arrival time at his community. Based upon Flash reports from neighboring communities, an advisory similar to the following might be prepared:

"The fallout monitors at City Epsilon, 25 miles to the west of our City, Omicron, report that fallout has just occurred at Epsilon. It is spreading eastward at about 30 miles per hour and is expected to arrive here at Omicron in less than one hour, or at approximately 3:45 PM, EST. All people in Omicron who plan to use community shelter should proceed immediately to their assigned shelter. All people who have home shelters should be prepared to go into their home shelters by 3:45 PM today. Our fallout monitors are on the job and warning will be issued again as fallout deposit begins in our western suburbs. Repeating, fallout is now expected to begin in Omicron at 3:45 PM today (in about 50 minutes) and all people are warned to go to community shelter immediately, or to be ready to go into their home shelter by 3:45 PM today. Keep tuned to your local radio station for your civil defense advisories."

Immediately upon the receipt of a Flash report of fallout from any of the monitoring stations within his area, the Radef Officer will prepare a fallout warning for issuance to the general public in and around his area of responsibility. The warning might be worded similar to the following example:

"Fallout has been detected in Omicron and is spreading across our city. Proceed immediately to your fallout shelter and remain there until further advised. All people on the streets or in vehicles in this area, go indoors or get under cover. Seek the best fallout protection available. You will be further advised by your civil defense over this frequency in one hour, at 5:00 PM. In the meantime, go to your fallout shelter immediately and stay there. Keep tuned to your local radio station for your civil defense advisories."

The warning, or one similar to it, will be repeated several times until superseded by a subsequent warning or advisory.

At State level, the warning obviously will be for a larger area but, generally, should be directed only to areas <u>not</u> warned by community or county control centers. At State levels, the warning to the agricultural people might be worded similar to the following:

"This is your State of Able Civil Defense Advisor. Fallout is spreading across the southeastern part of the State of Able. All people in the counties of Baker, Charlie and Dog are warned to immediately seek fallout shelter. If you have a personal or home monitoring instrument, check the intensity of the fallout in your area before venturing from shelter for prolonged periods. If the dose rate exceeds 10 roentgens per hour, time outside of shelter should be held to a few minutes and limited only to those highly essential activities that cannot be postponed for another day. If the dose rate is 100 roentgens per hour or higher, do not leave your shelter under any circumstance. If you do not have a personal monitoring instrument, stay in your shelter until we have had an opportunity to monitor your area from the air. Aerial monitoring operations are planned to be carried out in your area tomorrow. You shall be given more detailed guidance over this station at that time. In the meantime, remain in shelter and, to the extent possible, keep your livestock under cover. If you have a local radio station, keep tuned to it. If not, keep tuned to this station for your State of Able Civil Defense advisories."

This warning should be repeated, and subsequent warnings should be prepared and forwarded by the State Radef Officer to the appropriate AM station for broadcast as more definitive information becomes available at the State EOC.

If dose rates are rising, the type of advisory prepared by the Radef Officer might be similar to the following:

> "This is your City of Easyville Civil Defense Advisor. Reports from the fallout monitoring stations show that the dose rates are increasing across the city of Easyville. The fallout situation is approaching dangerous levels. People in and around the City of Easyville are cautioned to stay in their fallout shelter until further advised. All persons, not in shelter, go immediately into your fallout shelter and stay there. All people on the streets or in vehicles in this area go indoors or get under cover and seek the best fallout protection available. The next fallout advisory will be broadcast over this station in one hour, at 3:00 PM. Keep tuned to this station for your civil defense advisory reports."

As before, the advisory should be repeated 2 or 3 times. It is considered generally inadvisable to inform the public of specific dose rates. These may vary considerably across the city, and the public interpretation and use of this type of information is uncertain. For instance, if the general public were told that the dose rates over the southern portion of a city were 200 r/hr and over the northern portion 10 r/hr, some of the people might attempt an unorganized movement northward. Detailed information of this sort will be of considerable value to the civil defense director in making decisions regarding emergency operations but, during the early period when dose rates are rapidly changing, it would be of questionable value for issuance to the general public. However, recommendations are left to the discretion of the Radef Officer. If there are several families in an area with personal monitoring instruments and if the general public is able to comprehend and not misapply dose rate information, the Radef Officer may elect to include some generalized dose rate data in the advisory. However, he is cautioned not to include a list of dose rate reports from several locations in his area, since this tends to become very confusing to the listeners.

If dose rates begin to level off rather than continue to rise, an advisory similar to the following may be prepared for issuance to the public:

> "Reports from the fallout monitoring stations show that the fallout danger is lessening in City Foxville. However, it is still hazardous and inhabitants of Foxville and its environs should remain in their fallout shelter until further advised. We are maintaining a constant check on the fallout situation and you will be further advised in the next broadcast over this station in one hour, or at 3 PM. In the meantime, stay in your fallout shelter."

In instances of light fallout, after initial warning has been issued on the basis of the Flash reports, dose rates may rapidly drop to less than 0.5 r/hr. In these cases, after there has been sufficient passage of time to be relatively certain that no more fallout is likely, an advisory similar to the following may be prepared for issuance to the public:

"Inhabitants of George City may now leave shelter and return to your homes and to your assigned jobs. However, keep tuned to this station. If the fallout becomes dangerous again, you will be warned to return to shelter. The next scheduled fallout advisory will be at 3:00 PM over this station."

The Radef Officer will exercise considerable judgment before preparing the above type of advisory during the first 24 to 36 hours. This is especially true in areas of high target density where severe and rapidly changing fallout conditions might be anticipated. An advisory of this type, during the first day or two, will generally be restricted to areas of low target density. Further, the decision to release people from group shelters would be made by the civil defense director or mayor, in consultation with all members of his staff.

Hourly advisories similar to the following should continue to be issued to those areas where little or no fallout has been observed:

"This is your Howville Civil Defense Advisor. Reports from the fallout monitoring stations show little or no fallout in Howville. People of Howville are advised to continue with your regular or specially assigned activities. However, keep your radio tuned to this station and be prepared to move into your fallout shelter if necessary. We are watching the situation closely, and will keep you informed. The next scheduled civil defense fallout advisory will be in one hour at 3 PM over this station."

It is impossible to give specific guidelines which will apply in every case. Good judgment will be exercised by the Radef Officer based upon the intelligence available. The dose rate reports will be the primary source of this intelligence. However, the age of the fallout material and its decay characteristics must also be considered in attempting to evaluate the reported dose rates in terms of biological hazard.

SAMPLE ADVISORIES BASED UPON COMPREHENSIVE ANALYSES

In an area of heavy fallout, where dose rates exceed 100 r/hr during the early hours, the Radef Officer might prepare a warning similar to the following, advising the general public very frankly that:

"This is your Nanville Civil Defense Advisor. Reports from the fallout monitoring stations show that our city, Nanville, has a serious fallout situation. People of Nanville are cautioned to remain in your fallout shelter continuously for the next several days and you should be prepared to spend most of the next two weeks in shelter. If you must leave your shelter for emergency purposes, delay such excursions as long as possible and limit them to no more than a few minutes. If you do not have good fallout shelter where you now are, but can reach good fallout shelter in a few minutes time, do so at this time. However, carry your food, water, and other needed supplies with you. The next fallout advisory will be broadcast over this station in 3 hours--at 6:00 AM today."

In an area of moderate fallout (where early dose rates range between 50 and 100 r/hr) the Radef Officer will prepare a warning similar to the following, telling the general public that:

"Reports from the fallout monitoring stations show that our city, Opalville, has a serious fallout situation. People in and around are cautioned to remain in their fallout shelter continuously for at least the next five days. If you must leave your shelter for emergency purposes, limit such excursions to no more than a few minutes. If you do not have good fallout shelter, but can reach good shelter in a few minutes, do so now. However, carry your food, water, and other needed supplies with you. The next fallout advisory will be broadcast over this station in 3 hours--at 6:00 AM today."

When dose rates have decayed to tolerable limits, the Radef Officer might issue an advisory similar to the following:

"Reports from the fallout monitoring stations show that the fallout situation is no longer critical at Petersburg. Residents of Petersburg are advised that you may leave your fallout shelters. However, for the next 12 hours, or until 3:00 PM today, you may resume your regular or special assigned duties. If the fallout situation gets worse, you will again be advised to go into your shelter. Therefore, keep tuned to this station. The next scheduled fallout advisory will be in 3 hours--at 6:00 AM today."

In a heavy fallout area, the scheduled advisory during the period from 12 to 24 hours will be prepared by the Radef Officer similar to the following:

"Reports from the monitoring stations show that the fallout situation is very serious here at Nanville. Dose rates in this area have generally decreased to about 30 r/hr and are continuing to decrease slowly. However, the situation will remain hazardous for several days. People in and around Nanville are cautioned to remain in their fallout shelters continuously for the next ten days. If you must leave your shelter for emergency purposes, delay the excursions as long as possible and limit such excursions from shelter to no more than a few minutes. The next fallout advisory will be in 3 hours--at 9:00 AM today."

During the period 12 to 24 hours after fallout arrival, more thorough monitoring and more careful fallout analysis may reveal significant fallout differences across a community. For example, the northern third of a community may have a serious fallout problem; and the southern third, a light fallout problem; with an intermediate condition existing across the middle third of the city. In this case, the Radef Officer will prepare an advisory similar to the following:

"Reports from the monitoring stations show that a serious fallout condition exists in all areas to the north of 34th Street in Opalville. In the areas north of 34th Street in Opalville, all people should be prepared to remain in their fallout shelter continuously for at least the next four days. If you must leave your shelter for emergency purposes, limit such excursions to no more than a few minutes. To the south of 16th Street in Opalville, the fallout condition is no longer critical and all people south of 16th Street may come out of their shelters. However, you are cautioned to remain in your home or under cover throughout today and tonight. After daybreak tomorrow morning, you may safely leave your homes to carry out routine or assigned tasks in the areas south of 16th Street. However, do not, repeating do not, travel northward any farther than 16th Street. Also, keep in radio contact with this station for special warnings in the event of further fallout. A moderate fallout condition exists from 16th Street northward to 34th Street in Opalville. People in these areas from 16th Street northward to 34th Street are cautioned to remain in their fallout shelters continuously for at least the next two days. Do not leave your shelter in these areas except for emergencies, and then limit your excursions from shelter to no more than a few minutes. You will be kept advised of what to do in order to survive in these fallout areas. The next fallout advisory will be in three hours--at 9:00 AM this morning."

The following sample advisory, although highly idealistic, is an example of the type that the Radef Officer may have to prepare in conjunction with other appropriate officials, to advise the general public to prepare for a postattack remedial movement:

"Reports from the monitoring stations show that Nanville still has a very serious fallout condition. In order to survive it will be necessary for those people without fallout shelter to move from the city. Those people with fallout shelter will not, repeat not, have to move at this time. The movement of people will be carried out in several stages. Those people who have not been able to get into a public or home shelter and who do not have basements in their homes, or have not been able to get into a basement, will leave first. The movement of the people without basements, who are not in shelter, will start in 3 hours--at noon today. Do not start to evacuate before noon. Repeat, do not start to evacuate before noon. The evacuation of people with basements, but without good fallout shelter, will begin at 9 o'clock tomorrow morning. People in basements should not, repeat not, plan to evacuate until tomorrow morning.

"The evacuation routes out of the city will be northward on Route 34 to Paulstown and Route 60 to Quick City. No southbound traffic will be permitted on these routes. All lanes will be used for northbound traffic and speed will be controlled at 30 m.p.h. There is only light fallout at Paulstown and Quick City, and arrangements have been made for your reception and care at these locations. However, before you evacuate, pack your remaining supplies of food, required blankets, clothing and medicine in your car to take with you. Also, take your battery-powered radio and monitoring instrument if you have one. If you do not have an automobile for evacuation, you will be picked up in buses or trucks after 4 PM today. All city streets will be checked by bus or truck between 4 and 8 PM. The drivers will move slowly down the streets tooting their horns. If you do not have personal transportation, remain in your home until you hear the horns tooting after 4 PM today. Bring only one suitcase or large bag with you; no more than you can conveniently carry. Bring only food and necessary clothing and medicine.

"Evacuation of people without basements, but with cars, will begin in three hours, at noon today. The evacuation of these people will be in two stages. Those in the northern half of the city will evacuate between noon and 2 PM, and those in the southern half of the city will evacuate between 2 PM and 4 PM today. In the meantime, do not leave your homes except to pack your automobiles and do not evacuate prior to the scheduled time or you will be turned back. Specific details will now be given to those people in the northern half of the city who will begin evacuation at noon. (These detailed instructions will be prepared by the police or movement control officers.) Detailed instructions for those people in the southern half of the city who begin their evacuation at 2 PM will be broadcast over this station at one o'clock this afternoon.

"Detailed instructions for those people without cars who will be evacuated by bus or truck after 4 PM will be broadcast over this station at 3 o'clock this afternoon.

"Detailed instructions for people with basements who will begin evacuation at 9 AM tomorrow will be broadcast over this station at 6 o'clock tomorrow morning. In the meantime, remain in your homes or home basements except to pack your car for evacuation."

During the three hour period before evacuation actually starts, this advisory should be broadcast many times. Also, after the evacuation gets underway, the advisory should be updated with the specific detailed instructions for the next group scheduled to evacuate. Subsequent advisories should provide assurance to those in fallout shelter who do not evacuate, that they are not being abandoned. Further, those people in fallout shelter should be informed each 6 hours of the fallout situation in general terms, and they should be strongly encouraged to remain in shelter.

After 48 hours in areas of light fallout, the advisory could be made part of the daily news bulletins and might be worded similar to the following:

"The reports from the monitoring stations show that there is no fallout problem here in Paulstown or in the immediate surroundings. You may continue with your regular or special assigned duties both indoors and outside without danger from fallout. However, you are cautioned not to travel southward or northward. There is considerable fallout at dangerous proportions to the south in and around Nanville as well as in Seegar County to the north. The area of little or no fallout extends from about 50 miles west of Paulstown to 70 miles east of Paulstown."

However, in heavy fallout areas where survival remains a problem, fallout advisories will be issued at least each 12 hours on a scheduled basis. Although dose rate reports will be available only once a day, these reports can be extrapolated for 12 hours for preparing advisories. Advisories to the general public in these cases will be prepared by the Radef Officer similar to the following:

"Reports from the monitoring stations show that the fallout situation at Nanville continue to be serious. You are cautioned to remain in your fallout shelters continuously for two more days. If the fallout radiation continues to decrease at its present rate, you may spend an hour or two out of shelter in your home or in lesser shielded areas of buildings housing community shelter on Thursday. The fallout monitors are watching the situation closely, and we shall keep you advised. The next scheduled fallout advisory will be broadcast in 12 hours, at noon, over this station."

At a slightly later period, in areas of initially heavy fallout, an advisory similar to the following might be released:

"Although dose rates are continuing to decrease, Nanville still has a serious fallout problem. You are cautioned to spend at least 8 hours per day in your shelter. If your assigned duties are inside a building, you may spend 8 hours per day on your job. Of the remaining 8 hours a day, do not spend more than 2 hours out of doors per day. If your work is outdoors, you may spend 6 hours a day on your outdoor job, 8 hours per day in your shelter, and the remaining 10 hours indoors. Do not exceed those time limits out of shelter and outdoors or you are likely to become ill."

The specific numbers in each case will have to be computed by the Radef Officer on the basis of the observed dose rates and his forecast of the future ERD of the people involved.

Warnings similar to the following may have to be prepared by the Radef Officer, in conjunction with public health officials, where contamination of water supplies is involved.

"Radioactive fallout has contaminated the public water supply in the reservoir. However, the water currently in the mains, and in the pipes and tanks in your home is safe. Fill your water jars and other containers with water at this time. It is calculated that the water coming from the mains to your homes will be safe for at least two more hours--until 4 o'clock this afternoon. By 4 o'clock this afternoon, you are advised to turn off the main water valve coming into your home. This will keep the contaminated water from flowing into the pipes in your home. It is not practical to turn off the water at the pumping station since pressure must be maintained in the mains for fighting any fires which may develop. Therefore, you must turn off the main water valve coming into your home no later than 4 PM today. If you turn off the main water valve by 4 PM, the water in your hot water tank will not become contaminated and will be safe for drinking purposes. Therefore, fill your water jars and other containers with water during the next 2 hours and then turn off the valve to the water pipes coming into your home."

Also, as food supplies in shelters become exhausted and people begin to forage for additional foodstocks, warnings of the following type will be prepared by the Radef Officer in conjunction with the public health officer:

"Food supplies brought into the home or community shelter after the arrival of fallout may be contaminated. If these food supplies were in a closed package, can or carton, they are all right for consumption. However, you should carefully wipe all dust from these containers before opening them. If the food is not tightly wrapped, and if it is of a shape and texture that permits it, brush or wash it thoroughly before eating. This will remove most of the contamination. Also, if you suspect that the food is contaminated with fallout and you cannot wash it, check it carefully with a CD V-700 monitoring instrument if you have one available. However, do not throw food away, since decay of radioactivity may cause the food to become suitable for human consumption in a few days."

Warnings similar to the following will have to be prepared and issued by the Radef Officer under special situations:

"Although the fallout situation has materially lessened and you are at liberty to leave your fallout shelters, there are still a few small dangerous areas around the city. These dangerous areas, called "hot spots," have been evacuated and are posted with triangular shaped fallout markers. You are cautioned to stay clear of these areas. There are six of these "hot spots," and they are in the following locations: (followed by a list of the locations)."

SAMPLE CONDENSED TABLE TO SHOW RADEF COMMUNICATIONS TRAFFIC

A full discussion of reporting requirements, schedules and techniques is presented in Chapter 5. The following table, or outline, is intended to show in convenient reference form general recommendations for scheduled radiological reports.

It should be noted that reports of mobile monitoring performed in support of emergency protective and recovery operations will be equally important. However, there will be many types of mobile monitoring missions, performed when the need for information justifies the added exposure of the monitors. Obviously, no schedule can be presented for such monitoring, but the added communications traffic should be provided for.

Monitoring Stations to Emergency Operations Center.

1. Operational Readiness Report - only once when station is manned, instruments checked and station is ready for operations.

2. Flash Report - only once, the first time when observed, unsheltered dose rate equals or exceeds 0.5 r/hr.

3. Dose Rate Reports - first 12 hours, hourly.
   - 13 - 24 hours, each 3 hours (based upon observations at 0300, 0600, 0900Z, etc.).
   - 25 - 48 hours, each 6 hours (based upon observations at 0300, 0900, 1500 and 2100Z).
   - After 48 hours, daily (based upon observations as of 0300Z).

4. Dose Reports - outside unsheltered accumulated dose reports from all official reporting stations, daily (measurement at 0300Z).
   - accumulated dose of monitors at monitoring station, daily at 0300Z.

5. Special Reports - from all monitoring and reporting stations whenever a decreasing dose rate reverses trend and increases materially.
   - from shelter monitors (a) whenever dose rate inside shelter reaches or exceeds 10 r/hr and (b) within any two days period of shelter the dose is 75 r.

Local EOC to State EOC

1. Flash Reports - once, based upon flash reports from local monitoring stations.

2. Dose Rate Reports - (single report, representative of local area).

- firs 24 hours, each 6 hours (based upon observations at 0300, 0900, 1500, 2100Z).
- 24 - 48 hours, each 12 hours (based upon observations at 0300 and 1500Z).
- after 48 hours, daily (based upon observations as of 0300Z).

Local EOC to Neighboring Communities.

1. Flash Reports - as previously agreed.

2. Dose Rate Reports - as previously agreed.

State EOC to OCD Regional Office.

1. Flash Reports - summary showing spread of fallout across State.

2. Dose Rate Analysis - (in coded form or by facsimile) first 24 hours, each 12 hours (based upon observations as of 0300, and 1500Z).
   - after 24 hours, daily (based upon observations as of 0300Z).

State EOC to Local EOC.

1. Flash Reports - selected reports as appropriate to alert local EOC of approaching fallout.

2. Dose Rate Reports - selected dose rate reports as appropriate to advise local EOC of dose rates in neighboring communities.

State EOC to Neighboring States and Provinces.

1. Flash Reports - as previously agreed.

2. Dose Rate summaries or analyses - as previously agreed.

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TECHNICAL GUIDANCE
DOSE RATE AND DOSE CALCULATIONS

This Annex is primarily concerned with effective means for accomplishing those radiation dose rate, dose, and ERD calculations that may be required of Radiological Service staff personnel. Considered first are those procedures which would be based on monitored data only and would not require the assumption that a theoretical decay scheme was applicable.

For convenience, all tables, charts, and figures, which can serve as calculation aids, are grouped at the end of this Annex.

FORECASTING DOSE RATES

As previously indicated, the theoretical decay scheme may be inapplicable or may grossly misrepresent the decay characteristics from a specific weapon. To forecast dose rates, <u>it is recommended tha the observed dose rate histories at representative unsheltered locations be plotted and the plots be extrapolated to a limited future time.</u>

For technical reasons, 3 X 3 cycle logarithmic graph paper is recommended. The horizontal axis will represent the time elapsed after the detonation judged to have contributed the major fraction of the fallout. The time range is H + 1 hr to H + 1000 hr. It is suggested that local time be laid out below the H+ hour scale. The vertical scale can designate dose rates, usually from 1 to 1000 r/hr, but through the range 0.1 to 100 r/hr in areas of relatively low contamination. The data entered in the example EOC Radiological Log have been plotted on the graph (Figure 13). It may be noted that the deposition of fallout seems to have been somewhat irregular, but that from about H + 11 hrs. (point b) to the latest report at H + 20 hrs. (point c) decay appears to have been relatively orderly, as indicated by the nearly straight line segment bc. Provided that there is not significant additional fallout, it may be assumed that the decay characteristics will remain similar for a period of time equal to the period of observed orderly decay. Specifically, bc representing observed dose rates over a period of 9 hours may be extended for an additional 9 hours (dotted line cd) with a reasonable degree of confidence. Forecasts farther into the future than the length of the observed period of orderly decay may be necessary but should be considered as a very rough estimate, subject to revision as more monitored data become available. <u>Forecasts are for planning feasible times and conditions for taking emergency action. Monitoring must verify the intended conditions before the action is initiated.</u>

COMPUTING EQUIVALENT RESIDUAL DOSE (ERD)
(From <u>Measured</u> Doses)

The basic equation for computing the ERD at any time t, resulting from a brief measured dose D, and an illustrative example were presented in Table 4 on page 3-31. For ready reference, the basic equation and a table of the values of powers of 0.975 are included as Table 7 in the calculation aids at the end of this Annex.

Many of the calculations presented in this Annex are carried to three significant figures to illustrate the small amount of computational error resulting from short cut methods. For actual planning or operations, carrying calculations beyond two significant figures is probably meaningless and a waste of time.

It is re-emphasized that the basic equation is directly applicable only to a dose received over a short period of time, for example one day. Where an individual has been exposed to doses of varying magnitude at irregular intervals over a larger period, separate calculations would be required for the ERD's, resulting at a future time of interest, from each of the doses. That would be a time consuming process and, for practical application, acceptable short cuts are required.

The ERD Calculator. Figure 14 is printed copy of a calculator which may be locally reproduced. Three prints are required; the first is trimmed around the outer circle, the second around the intermediate circle; and the third around the inner circle. The resultant three disks are carefully centered and loosely riveted or grommeted through the center so that they may be rotated relative to each other. It should be noted that with the index (arrow) of the innermost scale set to any dose of interest the ERD's which would result after any chosen number of days appear directly opposite the chosen time. Conversely, from the same setting it is possible to determine the number of days necessary for the brief dose to be reduced to a desired ERD. Reading from the desired ERD, on the DOSE scale, inward to the DAYS scale gives the length of the necessary recovery period.

The ERD Nomogram. Figure 15 is a nomogram which is also an effective tool for rapid computation of the ERD. The scale at the bottom refers to time in days after exposure. The scale on the right side pertains to a brief, initial dose (shock dose or dose spread over one to four days). The scale on the left pertains to equal daily exposures in r/hr subsequent to the initial dose. The curved, quasi-horizontal lines between the two vertical dose scales refer to the equivalent residual dose. On the nomogram, a line has been drawn from 50 r on the right vertical scale to 5 r/day on the left vertical scale for illustrative purposes. This line indicates the ERD for a situation in which the individual is exposed to a brief dose of 50 r followed by subsequent exposures of 5 r/day. At 10 days his ERD is 70 r; and at 30 days it is 120 r. After about 95 days, the ERD would be 200 r. If the individual has had no initial brief exposure, but was exposed to a dose of 5 r/day, a line from zero on the right vertical scale to 5 r/day on the left vertical scale would represent the ERD at various times in the future. In this example, the ERD after 20 days would be about 60 r and after 60 days it would be about 150 r.

If the individual had an initial dose and no subsequent exposure, the line from the point on the vertical scale at the right, that represents the initial dose, to the zero point on the vertical scale at the left would indicate the ERD at various times. For example, with an initial dose of 150 r and no subsequent exposure, the ERD after 20 days would be 105 r and after 60 days it would be about 48 r. To avoid disfiguring the nomogram, a transparent straightedge is aligned with the points of interest and values are read from its edge rather than from a drawn line.

ERD Equivalent to Prolonged Exposure. Several exposure doses occurring over a period of a few days may be treated as a single dose without excessive error. It is recommended that the doses so grouped extend over a period no longer than one week, and that the total dose be considered equivalent to a single exposure received at the time when approximately half of the total dose had been received. For example: Assume that the ERD is to be calculated for a time 14 days after the start of the following exposures received on consecutive days: 95 r, 15 r, 50 r, 22 r, 10 r, 5 r, and 3 r (total 200 r), and note that the time periods for partial recovery from each dose are respectively 14, 13, 12, 11, 10, 9, and 8 days. Calculating separately, the ERD's resulting from the respective exposures would be about 76 r, 13 r, 42 r, 19 r, 9 r, 4.5 r and 2.8 r (total ERD of about 166 r at 14 days after start of exposure). For the simplified calculation, examine the exposure schedule and note that half of the 200 r total dose had been received by the end of the second day. From the second day to the 14th day is 12 days; the effective recovery time to be used with the total dose, 200 r. The ERD 12 days after a brief 200 r exposure would be 167 r, in close agreement with 166 r, the sum of the ERD's calculated from the separate exposures. If exposures extend over a period longer than one week, the exposures can be separated into two or more groups and for each group, the total can be used with an effective date appropriate to that group, to calculate the part of the ERD resulting from that group of exposures.

CALCULATIONS BASED ON THEORETICAL DECAY CHARACTERISTICS

The following is an extract from DASA RA-3 938.22, "In view of the rather large variability in the measured rate of decay of fallout debris, which is not subject to weathering, attempts to predict the decay of actual fallout fields on the basis of any given decay law or curve are almost certain to be grossly inaccurate."

The $t^{-1.2}$ law and equations derived from it have been used in the preparation of many types of charts, graphs, nomograms, and calculators. Most of these devices are convenient for calculations of dose rates or doses required in the preparation of tests, exercises, studies of the types of problems likely to be encountered postattack, etc. In an actual postattack situation, the Radef Officer would necessarily make forecasts of the probable effects of a fallout radiation environment and recommend remedial action based on those forecasts. In some instances it would be necessary to use criteria based on $t^{-1.2}$ calculations. However, the Radef staff member must realize the limitations of such criteria and roughly adjust them to reflect variations from $t^{-1.2}$ decay characteristics.

Figure 16 illustrates the variations in theoretical decay characteristics when the exponent of t has values other than -1.2. It should be noted that when the exponent is large; e.g., -1.35, the dose rate decreases more rapidly than when it is small; e.g., -1.05. All three plots are given the value of 1,000 at H + 1 and over a period of a few hours have diverged only a little. However, by H + 100 hours the plots have diverged greatly and show dose rates of 2 r, 4 r, and 8 r, respectively. At later times the percentage variations would be still greater.

From a logarithmic plot of measured dose rates, the slope of any section of the curve (value of the exponent of t) can be readily determined. For example, on Figure 16, the slope of the segment "ac" is equal to the length of the vertical line, "ab", divided by the length of the horizontal line, "bc", or 27/16 in. divided by 20/16 in. ≐ 1.35. On Figure 13, the slope of the plot segment "bc" could be evaluated to determine whether decay characteristics (and resultant data) would more closely approximate those of a $t^{-1.05}$, $t^{-1.2}$, or a $t^{-1.35}$ equation.

Figures 17 and 18 are nomograms based on the $t^{-1.2}$ decay law, and may be used for planning purposes.

To use the DOSE RATE NOMOGRAM (Figure 17) connect a known dose rate in the "Dose Rate at H + t" column with the corresponding time in the "Time After Burst" column. Note the reading on the "Dose Rate at H + 1" column. Connect this reading with the time of the unknown dose rate on the "Time After Burst" column and read the answer from the "Dose Rate at H + t" column.

Example:	GIVEN:	The dose rate in an area at H + 12 is 50 r/hr.
	FIND:	The dose rate in this area at H + 18.
	SOLUTION:	Using a straightedge, connect 50 r/hr on the "Dose Rate at H + t" column with 12 hours on the "Time After Burst" column and read 970 r/hr on the "Dose Rate at H + 1" column. Pivot the straightedge to connect 970 r/hr on the "Dose Rate at H + 1" column with 18 hours on the "Time After Burst" column and read the answer from the "Dose Rate at H + t" column.
	ANSWER:	31 r/hr.

To use the "Entry Time - Stay Time - Total Dose" nomograms (Figure 18), connect two known quantities with a straightedge and locate the point on the "D/R_1" column where the straightedge crosses it. Connect this point with a third known quantity and read the answer from the appropriate column.

Example (Total Dose):

GIVEN:	The dose rate in an area at H + 8 is 10 r/hr.
FIND:	The total dose received if a person enters this area at H + 10 and remains for four hours.
SOLUTION:	Find the dose rate at H + 1 (120 r/hr) as described in the preceding paragraph. Using a straightedge, connect four hours on the "Stay Time" column with ten hours on the "Entry Time" column. Find .21 on the "D/R_1" column. Connect .21 on the "D/R_1" column with 120 r/hr on the "Dose Rate at H + 1" column. Read the answer from the "Total Dose" column.
ANSWER:	25 r.

Example (Entry Time):

GIVEN: Dose rate in an area at H + 10 is 12 r/hr. Stay time is 3 hours and the mission dose is established at 50 r.

FIND: The earliest entry time into the area.

SOLUTION: Find the dose rate at H + 1 (190 r/hr) as described previously. Using a straightedge, connect 50 r on the "Total Dose" column with 190 r/hr on the "Dose Rate at H + 1" column. Find .26 on the "D/R_1" column. Connect .26 on the "D/R_1" column with 3 hours on the "Stay Time" column. Read the answer from the "Entry Time" column.

ANSWER: 6 hours.

ERD Calculations - Fallout Environment. Figure 19 is a graphical presentation of the ERD's that would result from continuous unshielded gamma radiation exposure in a fallout field producing a radiation intensity of 1 r/hr at H + 1, provided that the decay followed the $t^{-1.2}$ law. ERD's are plotted for selected times of arrival of fallout, or entry into the fallout radiation field. Values for intermediate entry times can be approximated by interpolation. It should be noted that each of the family of curves has a maximum value, and that the number of days between the start of exposure and the attainment of the maximum is greater for late entry than for early entry into the field.

The symbol G will be used for values of the complex function read from the graphs, and Gmax will be used for maximum values of G. The expression r/hr_1 is used as an abbreviation of r/hr at H + 1.

For H + 1 dose rate values other than 1 r/hr, multiplication of the actual or calculated H + 1 dose rate by the G value read from the graph for the time of interest, yields the ERD for the given field and time of interest, provided the total ERD is not so great as to cause serious incapacitation or death. Example: Determine the maximum ERD of an unprotected person in an area where the effective arrival time of fallout was H + 6 hrs. and the calculated H + 1 dose rate was 160 r/hr. The curve for entry at 6 hrs. (E = 6 hr.) has a maximum value of about 1.65 $\frac{ERD}{r/hr_1}$. Then, $r/hr_1 \times G_{max}$ = Maximum ERD, or 100 r/hr X 1.65 = 165, the maximum ERD. It may also be of interest to note that for this particular fallout arrival time (or entry into the field) the maximum occurs about 10 days after the weapon detonation.

Figure 20 is included to illustrate the variations in ERD calculations that would result when the decay characteristics are materially different from the commonly used $t^{-1.2}$ law. When the slope of the plot of observed dose rates varies significantly from -1.2, the plot may be extrapolated back to H + 1 hr. to obtain an effective H + 1 dose rate for use in conjunction with the Figure 19 chart. Comparison of the actual slope of the plot with the exponent values shown in Figure 20 will indicate whether the $t^{-1.2}$ calculation over or under estimates the ERD, and the general order of the magnitude of that variation. For example, if the slope were found to be -1.3, the resultant ERD's would be between those indicated by the $t^{-1.2}$ and $t^{-1.35}$ curves and would be materially less than indicated by the $t^{-1.2}$ calculations.

The above example and the following paragraphs (Nos. 1 through 6) illustrate several types of ERD calculations and present summaries of the procedures used for each type. Several of the examples were chosen to illustrate "near maximum" levels of contamination under which given actions would be feasible.

1. ERD in a Decaying Fallout Radiation Field - Summary

   a. Assume an effective arrival time of fallout and the degree of contamination (r/hr at H + 1).
   b. On graph (Figure 19), refer to the curve for the assumed entry or fallout arrival time (interpolate as required).
   c. $ERD_{max} = G_{max} \times r/hr_1$ and would occur at the time that the appropriate E curve reaches a maximum.
   d. ERD at any future time, G_t

      From the graph, read the value of G, from the appropriate E curve, for the required day.

      $ERD = G_t \times r/hr_1$

ERD - Continuing Shelter Occupancy. The dose rate and resultant dose, within a shelter, would bear a simple relationship to the unsheltered dose rate and dose, provided that the protection factor (PF) and reduction factor (RF)* of the shelter did not change too greatly with changes of the effective gamma radiation energy, with time. Where the protection factor is only an estimated value based on the location of occupants within a given type of structure, the variation of the PF would be of minor importance in the crude estimate of unmeasured dose within the shelter. Where the total dose within the shelter is measured and the unshielded dose is also known, the average PF can be used in computing the ERD without major error even though the apparent decay of dose rates in shelter would vary to some extent from the decay of the unsheltered dose rate.

For such approximation of the sheltered ERD, the effective dose rate in shelter is taken as r/hr_1 (sheltered) = r/hr_1 (unsheltered) times the reduction factor (RF). Example: r/hr_1 (unsheltered) was 1,500 r/hr and the estimated PF was 50 (RF = 0.02). Fallout arrived at H + 3 hrs. (0.125 days). Estimated G_{max} by interpolation between the E-1-1/2 hr. and the E-6 hr. curves is about 2.1 and would occur on the 8th or 9th day. The estimated maximum ERD in shelter would be $r/hr_1 \times RF \times G_{max}$ = maximum ERD, or 1,500 $r/hr_1 \times 0.02 \times 2.1 = 63$ maximum ERD, or an estimated maximum ERD of 60 to 65 occurring at about 8.5 days.

* "Protection Factor" (PF) has been previously defined. For convenience of calculation, the reciprocal of the protection factor called the "Reduction Factor" (RF), is used. For example, a shelter having a protection factor of 50 would have a reduction factor of 1/50, or 0.02.

By the end of 14 days in shelter the additional dose would be nearly equal to the partial recovery during that period and the ERD would still be nearly equal to its maximum value.

2. ERD in Shelter

a. Assume entry or fallout arrival time and r/hr_1.
b. Calculate protection factor (PF) of structure.
c. From appropriate curve (Figure 19), read value of G_{max}, or G_t for desired time t, as required.
d. $ERD_{max} = (G_{max})\ (r/hr_1)\ (RF)$
e. $ERD_t = (G_t)\ (r/hr_1)\ (RF)$

ERD - Part-time Shelter. It may be necessary to estimate the resultant ERD if previously unexposed workers were brought into an area to spend a given number of hours on the job and the remainder of the day in shelter. Such computation should not be attempted for entry times earlier than H + 4 days since the earlier dose rates are changing rapidly and the average dose rate for the day cannot be assumed to be the dose rate for the fraction of the day out of shelter. With the above limitations, ERD - part-time shelter may be expressed as:

3. ERD - part-time Shelter

a. $$ERD_{max} = \frac{(G_{max})\ r/hr_1}{24} \left[(t_1)\ (RF_1) + (t_2)\ (RF_2)\right] \quad \text{Equation (1)}$$

Where t_1 equals the number of hours per day spent in an area where the reduction factor is RF_1, and t_2 equals the remaining hours of the day spent in an area where the reduction factor is RF_2.

b. The ERD for any time, t, can be expressed by substituting G_t for G_{max}.

Example: Required, the maximum ERD of previously unexposed personnel brought into an area 14 days postattack, r/hr_1 was 750 r/hr. The average shielding on the job is estimated to give $PF_1 = 2$, or $RF_1 = 0.5$ and the protective factor of the shelter is 50 (PF_2), or RF_2, is 0.02. Daily time on the job (plus travel), t_1, is 8 hours and time in shelter is 16 hours. From Figure 19, for entry time of 14 days, G_{max} is about 0.24, then:

Substituting in equation (1) above

$$ERD_{max} = \frac{(0.24)\ (750)}{24} \left[(8)\ (0.05) + (16)\ (0.02)\right]$$
$$= 7.5\ (4 + 0.32) = 32.4 \text{ r, maximum ERD}$$

Protection Factor Required on the Job. Equation (1), above, can be solved for any one of the controllable variables; e.g., t_1, ($t_2 = 24 - t_1$), RF_1, RF_2, or G_{max}.

The radiation reduction factor on the job (RF_1) can be thought of as reduction due to shelter combined with reduction due to decontamination. By solving for RF_1, it becomes possible to evaluate the adequacy of on-the-job shielding. If better protection is needed, the feasibility of any necessary decontamination can then be examined. The equation (2), below, presents the solution of equation (1) for RF_1.

4. Protection Factor Required on the Job, (PF_1) - Previously Unexposed Personnel

$$RF_1 = \frac{24\ (ERD_{max})}{(G_{max})\ (r/hr_1)\ (t_1)} - \frac{(t_2)\ (RF_2)}{t_1} \qquad \text{Equation (2)}$$

Where ERD_{max} = allowable maximum ERD, G_{max} is the maximum value of G_{max} for the chosen time of entry, and the remaining symbols have the same meanings as above.

Example: Required to know the RF (including decontamination) necessary for standing watch for food warehouses to prevent looting, beginning at H + 4 days. Shift plus other time out of shelter = 10 hours/day.

RF in shelter = 0.10; r/hr_1 = 1000

Allowable maximum ERD = 100

$$RF_1 = \frac{(24)\ (100)}{(0.495)\ (1000)\ (10)} - \frac{(14)\ (0.10)}{10}$$

$$= 0.485 - 0.14$$

= 0.345, the allowable reduction factor on-the-job (equivalent to PF = 2.9)

Determining Earliest Entry Time - Previously Unexposed Personnel

Solve for G_{max} and, from chart, read entry time.
Equation (1), solved for G_{max}, yields:

$$G_{max} = \frac{(24)\ (ERD_{max})}{[r/hr_1]\ [(t_1)\ (RF_1) + (t_2)\ (RF_2)]} \qquad \text{Equation (3)}$$

Example 1: Required the earliest time to begin an operation under the following conditions: r/hr_1 = 1000 r/hr; shielding on job (PF_1) = 2; off-duty shelter protection (PF_2) = 20; allowable ERD_{max} = 100; hours per day in shelter = 14; on job and in transit 10 hours.

From Equation (3)

$$G_{max} = \frac{(24)\ (100)}{1000\ [(10)\ (0.5) + (14)\ (0.05)]} = \frac{24}{(10)\ (5 + 0.7)}$$

$$= \frac{24}{(10)\ (5.7)} = \frac{24}{57} = 0.421$$

The 0.421 value of G_{max} would lie about midway between the E-4 days and the E-7 days curves, at about E- 5-1/2 days - the required entry time. The maximum would occur at about H + 34 days.

If earlier entry time is necessary, the period out of shelter (length of shift) could be decreased or, if decontamination were feasible, the resultant increase of PF_1 would increase G_{max}, corresponding to an earlier entry time.

Example 2: Assuming that decontamination would result in a reduction of the radiation field to 20% of the previous value (equivalent to an additional PF of 5, which is combined with the on-the-job shielding), the reduction would be 1/2 of 1/5; i.e., 1/10, or the equivalent to a protection factor of 10.

Substituting the new value of Equation (3), $G_{max} = 1.41$

From chart interpolation (Figure 19), this corresponds to an entry time of 0.4 days (0.6 hours) and the maximum ERD would occur on about H + 12 days.

It may be interesting to note that, as compared to the ERD of 100, which recognizes partial recovery, the total dose in example 1 at the end of 34 days (the time of maximum ERD) would be about 135 r. In example 2, total dose up to the time of maximum ERD (at H + 12 days) would be about 111 r. Although the second dose is smaller, it would be received over a much shorter period of time, and would be more nearly equivalent to an acute or shock dose. Also, the total dose for example 2 to H + 34 days would be approximately equal to the dose for example 1 to H + 34 days. However, with the decontamination assumed in example 2, the mission could have been begun very early, H + 0.4 days as compared to H + 5-1/2 days, and includes 5 extra days work. Further, continuation of the mission beyond H + 34 days would result in smaller additional dose increments to the personnel working in the decontaminated area (Example 2) than to those under the conditions in Example 1.

5. Determining Earliest Entry Time - Unexposed Personnel

a. Assume appropriate values for: the maximum acceptable ERD; hours per day on the job and in shelter; protection (or reduction) factors in shelter and on the job; and the r/hr_1 dose rate.
b. Substitute in Equation (3) and solve for G_{max}.
c. Evaluate the permissible entry time from Figure 19.
d. If earlier entry is required, compute the reduction factor to be expected from decontamination.
e. Calculate a new RF by multiplying the reduction factor of on-the-job shielding by the decontamination reduction factor.
f. Using the new RF, recalculate the re-entry time allowable following decontamination.

Earliest Entry Time: Shelter Followed by Work - Shelter Regimen

Calculation of entry time to assure compliance with a planned maximum ERD is necessarily only an approximation because of the several complex variables involved. Even when exposure is related to the changing environmental dose in a simple manner the combination of recovery of incremental dose with progressive changes of dose rate is complex. A change from one degree of protection, in shelter, to a different degree of protection, a composite of protection on the job and protection during off-duty hours, makes precise calculation impractical.

However, approximations are feasible for certain typical patterns of shelter-work programs. It can be noted from the ERD graph, Figure 19, that the values of the ERD do not vary rapidly in the period near the maxima. In other words, the time of near maximum ERD's is not very critical. Also, it may be noted that a major fraction of the dose in shelter is received during the first day or two. For these reasons, it will be assumed that for emergency workers expected to perform duties outside of shelter during the first four days of the postattack period, the dose in shelter will be equivalent to a shock dose received at H + 2 days, and the time of the maximum ERD for that part of the dose received while on the work schedule will occur at 21 days, the maximum point on the E-2 days curve. Procedures for initiation of duties out of shelter at a later time will be presented later.

The ERD at 21 days resulting from the dose in shelter is assumed to be equivalent to the calculated 4 day shelter dose with recovery from H + 2 days to H + 21 days, or 70% of the 4 day shelter dose. Then, assuming a given maximum allowable ERD for the emergency personnel, the maximum allowable ERD minus 70%* of the estimated 4 day dose in shelter will be the allowable additional maximum ERD for performance of the work function. See Section 5, above, for calculation of earliest entry time.

Example Assumptions: Dose in shelter to H + 2 hours (dosimeter reading) is 7.5 r, as compared to an unsheltered dose of 750 r; unsheltered dose rate at H + 12 hrs = (equivalent to r/hr_1 = 750 r/hr) and decay is assumed to approximate $t^{-1.2}$ decay; desired work schedule is 10 hours on the job and in transit with $PF_1 = 2$, or $RF_1 = 0.5$, and 14 hours in quarters with $PF_2 = 50$, or $RF_2 = 0.02$. What is the earliest time to begin performance of tasks without exceeding a maximum allowable ERD of 100 r?

Dose in shelter to H + 4 days = 7.5 r + $\frac{\text{dose in shelter}}{\text{unsheltered dose}}$ ($t^{-1.2}$ calculated dose based on 34 r/hr at H + 12 for the period H + 12 hours to H + 4 days) =

* The ERD calculator, or nomogram (Figures 14 and 15) may be used, or the basic equation (Table 7) may be used for calculating the ERD resulting from this short term exposure. Note that from a short term dose of 100 r, with recovery for 19 days (H + 2 days to H + 21 days) the ERD would be about 70 r, or 70 percent of the short term dose.

$$7.5 + \frac{7.5\ (800)}{750} = 7.5\ r + 8\ r = 15.5\ r.$$

ERD at 21 days from shelter dose = 70% of 15.5 r = about 11 r.
Allowable ERD for work regime = 100 - 11 = 89 r.

From Equation (3):

$$G_{max} = \frac{(24)\ (89)}{(750)\ [(10)\ (0.5) + (14)\ (0.02)]}$$

$$= \frac{(24)(89)}{(750)\ (5 + 0.28)} = \frac{(24)\ (89)}{(750)\ (5.28)} = 0.54$$

Interpolating between E-2 days and E-4 days curves, on chart, earliest time to start work is slightly less than 3-1/2 days.

If the situation had allowed earlier initiation of the work schedule, the actual dose in shelter would be less than that assumed for 4 days and the effective time of an equivalent shock dose would be earlier than the assumed H + 2 days, allowing for slight additional recovery. Both provide minor safety factors.

For less urgent work, to be initiated during the period H + 4 days to H + 10 days, the method would be similar except that, for safety, the shock dose equivalent to the shelter dose might be assumed to occur at H + 3 days and the maximum ERD's for the work portion of the exposure would occur at about H + 40 days.

6. Earliest Entry Time - Shelter Followed by Work-Shelter Regimen

a. Assume values for r/hr_1 (or equivalent dose rate at later time), ERD_{max}, t_1, t_2, RF_1, RF_2, and effective time of arrival of fallout.

b. Calculate the 4 day dose in shelter (unsheltered 4 day dose by $t^{-1.2}$ law, times RF_2), to be treated as a shock dose received on H + 2 days.

c. Assume that, on the average, the work regime would start on H + 2 days. From the E-2 days curve the continuing work regime fraction of the total dose would reach a maximum at about H + 21 days.

   During the period H + 2 days to H + 21 days, partial recovery from the early in-shelter dose (from b, above) would result in an ERD (shelter dose fraction) = about 70% of the in-shelter dose, at H + 21 days.

d. Subtract the 70% of the in-shelter dose from the total allowable ERD to obtain the allowable ERD for the work-shelter regime.

e. Solve Equation (3) for G_{max}, using the reduced value of the allowable ERD from d, above.

f. By interpolation on Figure 19, determine the mission earliest entry time equivalent to the calculated value of G_{max}.

Decontamination-Effect on Earliest Entry Time

Example Assumptions: the same as in the previous example, except that decontamination would reduce the environmental dose rate to 20% (1/5) of the previously assumed rate at work. From that reduction, the dose rate on the job would be decreased from 1/2 of the environmental dose rate to 1/5 of 1/2, or 1/10, equivalent to a new $RF_1 = 0.1$. Then, from Equation (3), the above

$$G_{max} = \frac{(24)\ (89)}{750\ [(10)(0.1) + (14)\ (0.02)]} = \frac{(24)\ (89)}{(750)\ (1.28)} = 2.22$$

Interpolation from the chart indicates a possible entry time of about 0.14 days (less than 3-1/2 hours), a time previous to the H + 12 hours when the nature of the hazard was evaluated. This means that theoretically the work might be started at the earliest convenient time following decontamination without exceeding the allowable ERD = 100.

Decontamination - Effect on Earliest Entry Time - Shelter Followed by Work-Shelter Regimen

g. Estimate the reduction factor to be expected from decontamination at the work site, and multiply the decontamination RF by the at work shielding RF to obtain a new value for RF_1.

h. Using the new RF_1, solve equation (3) for G_{max} and from Figure 19 re-evaluate the earliest entry time.

For the conditions assumed in the last example, and provided the early start of the particular work warranted the expenditure of time, materials, and exposure of decontamination personnel, the work could be started as soon as decontamination was accomplished.

In the choice of assumptions to be used in the examples, an attempt was made to present a fairly representative and realistic situation; e.g., it was assumed that the dose rate would be plotted over a period of several hours (to H + 12) to determine that major deposition of fallout was complete, and to observe the decay characteristics to determine whether or not they were sufficiently close to the $t^{-1.2}$ characteristics to warrant use of that decay system. Also, if decontamination activities were to be started much before H + 12 (34 r/hr), the additional radiation dose penalty to be accepted by decontamination personnel would be substantial. Even at, or soon after H + 12, the dose to decontamination personnel would be high and could be justified only if there were an urgent need for early performance of a function such as manning a public utility installation or the reduction of potential exposure of a large group of people in inadequate shelter.

Limitations. The calculations are based upon assumed $t^{-1.2}$ decay characteristics which may not be applicable to a postattack situation. If decay were less rapid than $t^{-1.2}$, the start of the work schedule should be deferred longer, if more rapid, work could be started sooner. In any case, the records of measured worker exposures should be periodically evaluated and work-shelter schedules altered, if necessary, to prevent over-exposure.

SHELTER AND REMEDIAL EVACUATION DOSES

The ERD curves, Figure 19, are applicable only when the personnel dose bears a simple constant relationship to the environmental dose. When a person moves from one degree of shelter protection to another, when the regimen changes from continuous shelter occupancy to one of part-time out of shelter, or when he moves to an area contaminated to a different degree, the curves are no longer directly applicable. However, they can be an aid in the analysis of the potential dose.

> <u>Example</u> A study of the feasibility of remedial evacuation from a shelter in an area of nearly maximum probable fallout contamination. Assumptions: $r/hr_1 = 5000$; effective fallout arrival time = 1.5 hours; RF of shelter = 0.01; protection factor during organized evacuation by truck or bus = 1.5, or RF of truck = 0.67. For the period in shelter, $ERD_{max} = (r/hr_1)$ (RF for shelter) (G_{max}) = (5,000) (0.01) (2.7) = 135 r, the maximum occurring on H + 7 days, when the unsheltered dose rate would have a value of about 11 r/hr. The dose rate would be relatively constant, dropping to about 9 r/hr during the following 24 hours. Evacuation to relatively close, less contaminated areas, would be feasible at this time but to avoid excessive exposures during evacuation would necessarily be well planned and executed. See calculated evacuation doses below.

After an additional week in shelter, biological repair would have outweighed the additional sheltered dose to such an extent that G, on the E-1-1/2 hr. curve would have dropped slightly from the maximum value of 2.7 to about 2.5 and the calculated ERD would then be (5,000) (0.01) (2.5), or 125 r. This part of the situation is little better than the ERD of 135 at the end of the first week. However, the unsheltered dose would be down to about 4.7 r/hr and would allow greater latitude in evacuation procedures.

> <u>Subexample 1</u>. Evacuation at one week. Assumptions: Loading time --evacuees unprotected for no more than 15 minutes (1/4 hour); relatively steep dose rate gradient at right angles to effective wind direction at time of fallout, but acceptable roads and locations of reception areas may require an oblique path through (assumed) uniformly decreasing dose rates to a reception area at a distance of 100 miles by road, which had an r/hr_1 of 100 r/hr (now 0.22 r/hr); with virtually empty roads in fallout areas, average speed could be at least 40 m.p.h. (2-1/2 hours travel time).
>
> Loading dose = (r/hr) (time) = (11) (1/4) = 2.75 r
>
> Average travel dose rate = average of dose rates at initial shelters and at destination = $\frac{11 + 0.22}{2}$ = 5.6 r/hr

Travel dose = (average r/hr) (RF) (t) = (5.6) (.67) (2.5) = 9.1 r

ERD to time of evacuation = 135

Total ERD at end of evacuation, about 147 r

At the reception area, housed above ground in a typical home RF = 0.5, the new maximum ERD for the dose received at that location only would be (r/hr_1) (RF) (G_{max} for E-7 days) = (100) (0.5) (0.36) = 18 r, and the maximum for that part of the dose received at the new location would be reached at H + 36 days. Even without the additional recovery from the 147 r ERD at the end of evacuation at H + 7 days, 147 + 18, or 165 r, would not equal the 200 r ERD estimated maximum dose that may be accepted without many instances of incapacitation.

It is of interest to note that because there would have been little time for bodily repair of the cumulative radiation dose to the end of evacuation, the ERD (147 r) is little less than the total exposure dose of about 153 r. Also, if necessary, transport to more distant reception areas or at lower speed would be possible without exceeding the 200 r, maximum ERD.

Subexample 2. Evacuation at two weeks. Assumptions: same as subexample 1. Unsheltered dose rate at end of two weeks--4.7 r/hr.

ERD at end of 2 weeks in shelter	125 r
Loading dose (4.7) (1/4)	1.2
Travel dose $\frac{4.7 + 0.1}{2}$ (0.67) (2.5)	4.0
Total ERD	130.2 r

Although at first glance evacuation at 14 days appears to be the better, it must be realized that, since the ERD's of the two groups immediately after evacuation are for time periods of different length, the ERD's are not directly comparable. More valid comparison can result from computed ERD's and total doses to a later time, such as H + 30 days.

Comparative ERD's at H + 30 days

H + 7 days evacuation	
ERD_{30} of dose in shelter *	81
ERD_{30} loading and evacuation dose* 2.75 + 9.1 (with 23 day recovery: H + 7 days to H + 30 days)	7.7
ERD_{30} new environmental dose G at 30 days, E-7 day curve, = 0.35 (100) (0.5) (0.35)	17.5
Total ERD_{30}	106.2

*Calculation method not shown. See Table 10 and Figures 14 and 15.

The (approximate) 106 r ERD may be compared to the total dose of 176 r for this regimen.

H + 14 days evacuation	
ERD_{30} of dose in shelter*	89.1
ERD_{30} loading and evacuation dose* 1.2 + 4.0 (with 16 days for recovery; H + 14 days to H + 30 days)	4.0
ERD_{30} new environmental dose G at 30 days, E-14 day curve = 0.195 (100) (0.5) (0.195)	9.7
Total ERD_{30}	102.8

The (approximate) 103 r ERD may be compared to the total dose of 171 r for this 30 day regimen.

*Calculation method not shown. See Table 7 and Figures 14 and 15.

Summary. The above illustrative examples are based upon the $t^{-1.2}$ decay scheme and the ERD concept of gradual partial repair of radiation injury by the human body. Actual decay of radioactive fallout contamination may vary considerably from the assumed decay scheme and, if fallout originated from two or more weapons detonated at different times, application of the principle would be very complex and time consuming. Also, the numerical values employed in the ERD calculations must be considered as approximations. In a postattack situation, the safety of remedial operations would necessarily be based on repeated measurement of radiation doses and dose rates.

However, application of the above principles appears to have sufficient validity to warrant confidence in their application to preattack studies of the feasibility of performing various postattack operations.

The illustration chosen indicates that even in the most highly contaminated areas to be expected, perhaps as high as 10,000 r/hr at H + 1 hour, good shelter for a week or two, followed by remedial evacuation can control the radiation exposure of people to such a degree that virtually none need be incapacitated. It is evident that the shelter protection factor of 100 would be inadequate as the H + 1 dose rate is increased from the 5,000 r/hr_1 of the example to 10,000 r/hr_1. However, the added shielding to increase the protection factor from 100 to 200, and keep the dose in shelter the same, would be equivalent to only about 2 additional inches of concrete, or 3 inches of earth. At higher H + 1 dose rates, and with an equivalent evacuation time, the dose during evacuation would be correspondingly raised.

It is apparent from a study of the example that the time chosen for remedial evacuation from highly contaminated areas is not critical provided enough time is spent in suitable shelter to allow the unsheltered dose rate to decrease to such an extent that the dose during evacuation can be tolerated.

In this example there was little advantage in remaining the second week in shelter. With better shelter protection, the second week in shelter would add little to the dose received there and the relative advantage of remaining longer in shelter to reduce the evacuation dose would be more apparent.

The actual time chosen for remedial evacuation will be dependent upon the adequacy of supplies available in the shelter area, the time required to organize the evacuation in the difficult postattack situation, the degree of contamination of the reception area, the evacuation load and the availability of transportation.

One should remember that all exposure to radiation is harmful, and exposures should be kept as low as practicable. From this illustration it is clear that where shelter is only moderately good, a large fraction of the radiation dose is received by the person while in shelter. Better shelter than that used in the illustration would materially reduce the total exposure.

Remedial Movement from Poor Shelter. Following are two examples of the total exposures that would be encountered in carrying out the early postattack remedial evacuation of personnel from poor shelter to an area of lesser contamination:

1. Assumptions

   Shelter PF = (RF = 0.10)
   Contamination equivalent to 1300 r/hr at H + 1 hr: Effective arrival time of fallout is H + 3 hours. Radioactive decay is approximated by the $t^{-1.2}$ law. Reception area available at one hour travel distance - typical space available is private homes, having average PF = 2 (RF = 0.5).

   Reception area having contamination equivalent to 25 r/hr at H + 1 hour.

   PF in transit = 1.5; RF = 0.67

2. Analysis of shelter situation

Time	Dose in shelter (based on RF X unsheltered r/hr, -- (0.1) (1300 r/hr) = 130 r/hr)	Unsheltered dose rates
H + 12 hrs.	125 r	67 r/hr
H + 18 hrs.	160 r	41 r/hr
H + 24 hrs.	175 r	29 r/hr
H + 2 days	230 r	13 r/hr
H + 3 days	250 r	7.9 r/hr
H + 5 days	270 r	4.2 r/hr
H + 7 days	280 r	2.8 r/hr
H + 10 days	300 r	1.8 r/hr
H + 14 days	330 r	1.2 r/hr

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For the example chosen, the dose that would be received as a result of continued shelter occupancy would result in incapacitation of shelterees. The maximum ERD during the shelter period would be about 285 r, and would occur on the eighth or ninth day (130 r/hr_1 X G_{max} E 3 hrs.).

During the early hours, unsheltered doses would be so high as to make organization and execution of remedial evacuation to a distant reception area hazardous to both operational personnel and evacuees. Also, the possibility of arrival of additional fallout from more distant or later detonations would require consideration. If feasible, movement to a better shelter close enough to require only a short time in transit would be the best temporary expedient. However, remedial evacuation from the area after a week or two in the second shelter would be necessary unless there were extensive decontamination, or unless a regime were adopted under which a large fraction of a person's time were spent in shelter for an extended period.

3. Example evacuation at H + 12 hours. Perhaps the earliest time at which evacuation requiring 1 hour travel could be effectively organized would be at about H + 12 hours. Assumptions of 1 and 2, above, are used.

Dose in shelter to H + 12 hrs. =	125 r
Unsheltered dose rate at H + 12 = 67 r/hr	
Dose rate at reception area at arrival (H + 13 hrs) = 1.2 r/hr	
Evacuation dose = average dose rate X time period of evacuation X vehicle reduction factor = $\frac{(67\ r/hr + 1.2\ r/hr)}{2}$ (1 hr.) (0.67) =	22.8 r
Environmental dose at reception area from H + 13 hr. to H + 4 days = unsheltered dose X RF of new quarters = (25) (0.5) =	12.5 r
Total early "shock" dose, to H + 4 days	160 r

The four day dose will be assumed to be equivalent to an equal shock dose received on H + 1 day since more than half of the exposure occurred before that time.

The maximum ERD due to the new environment (25 r/hr X effective RF X G max.) = (25) (0.5) (0.48) = 6 r and would occur at about H + 25 days.

The 6 r would not be added to the 4 day dose because partial repair of the 160 r would be continuing while the 6 r ERD was building up toward the maximum.

By the end of 25 days the ERD would be about 109 r.

4. Example evacuation at H + 24 hours. Other assumptions and methods are the same as in 3, above.

Dose in shelter to H + 24	175 r
Evacuation dose $\frac{(29 + 0.56)}{2}$ (1 hr.) (0.67) =	9.9 r
Dose from H + 25 hrs. to H + 4 days = (17) (0.5) =	8.5 r
Total 4-day Dose	193.4 r

ERD (new environment), the same as in 3, above, 6 r max.

By H + 25 days the ERD would be about 130 r.

5. Evaluation at the later time results in a calculated effective dose, greater by about 33 r. However, the greater penalty to shelterees should be weighed against the feasibility of organizing evacuation at an earlier hour and the potential hazards of earlier action. At the later hour, the exposures of operational personnel conducting the evacuation would be less than half of exposures at the earlier hour. Also, there would have been a longer period for receipt of reports on fallout from other detonations which might affect the evacuation route or the reception area.

FIGURE 13

DOSE RATE HISTORY CURVE FOR ____________________

____

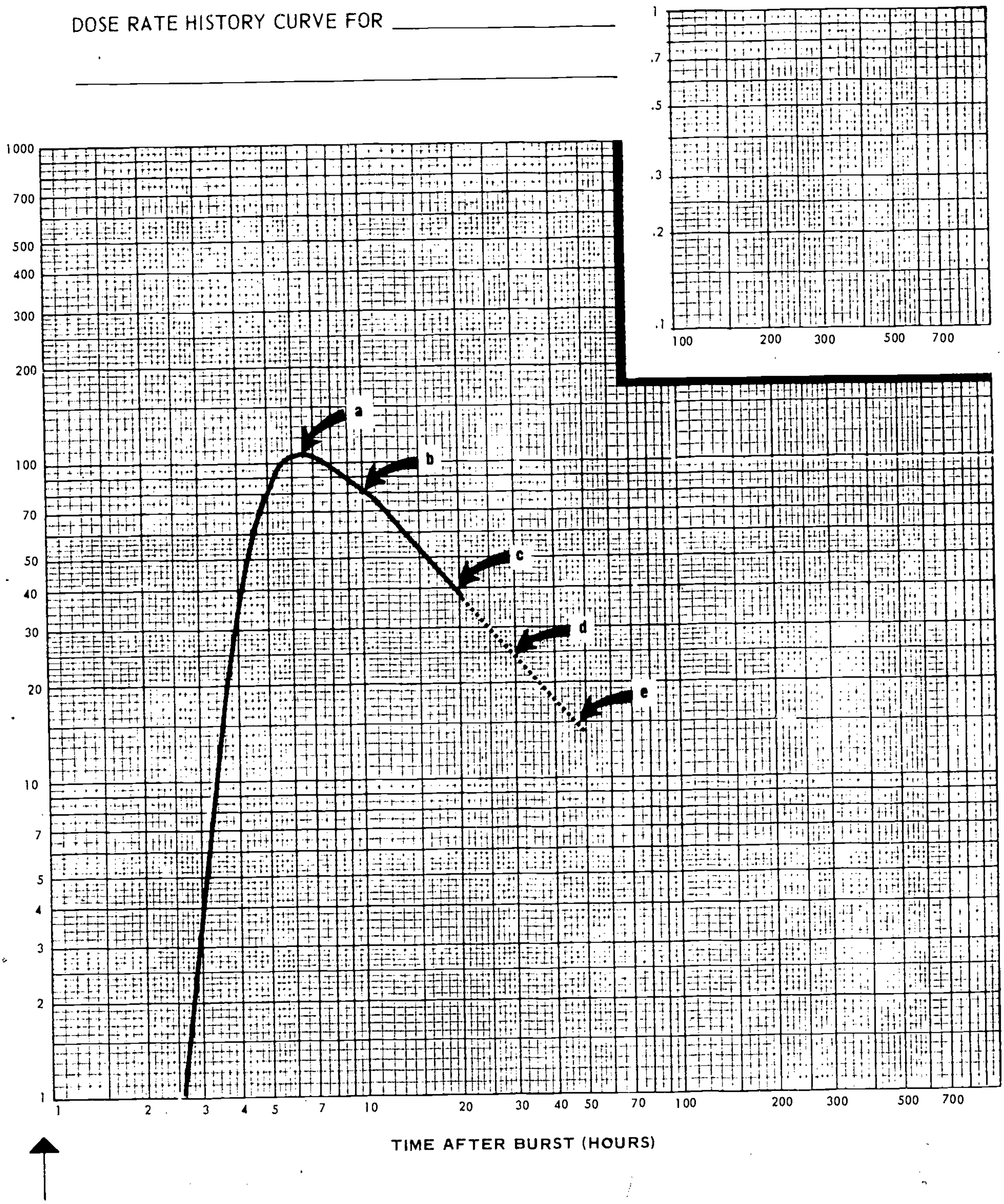

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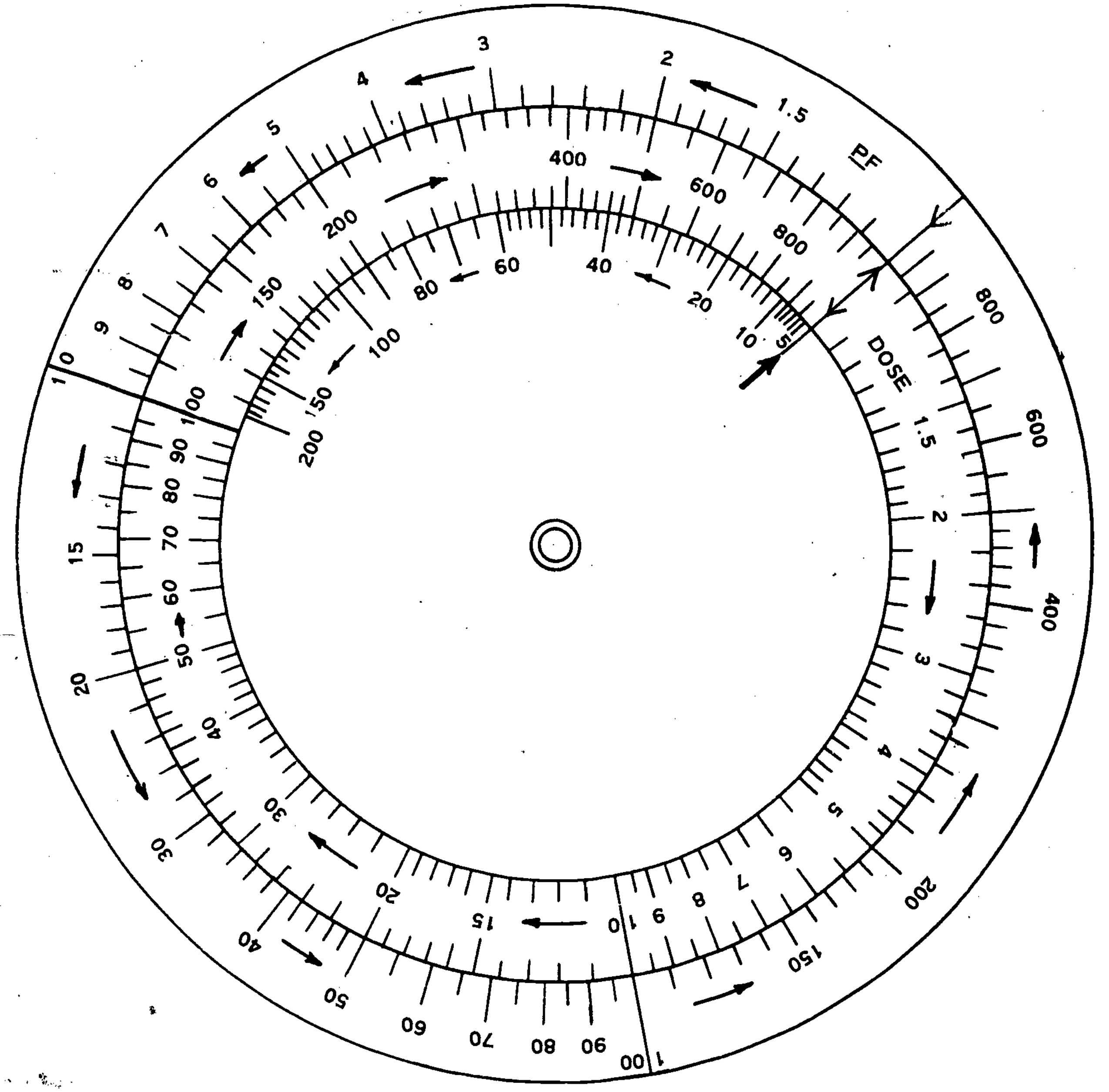
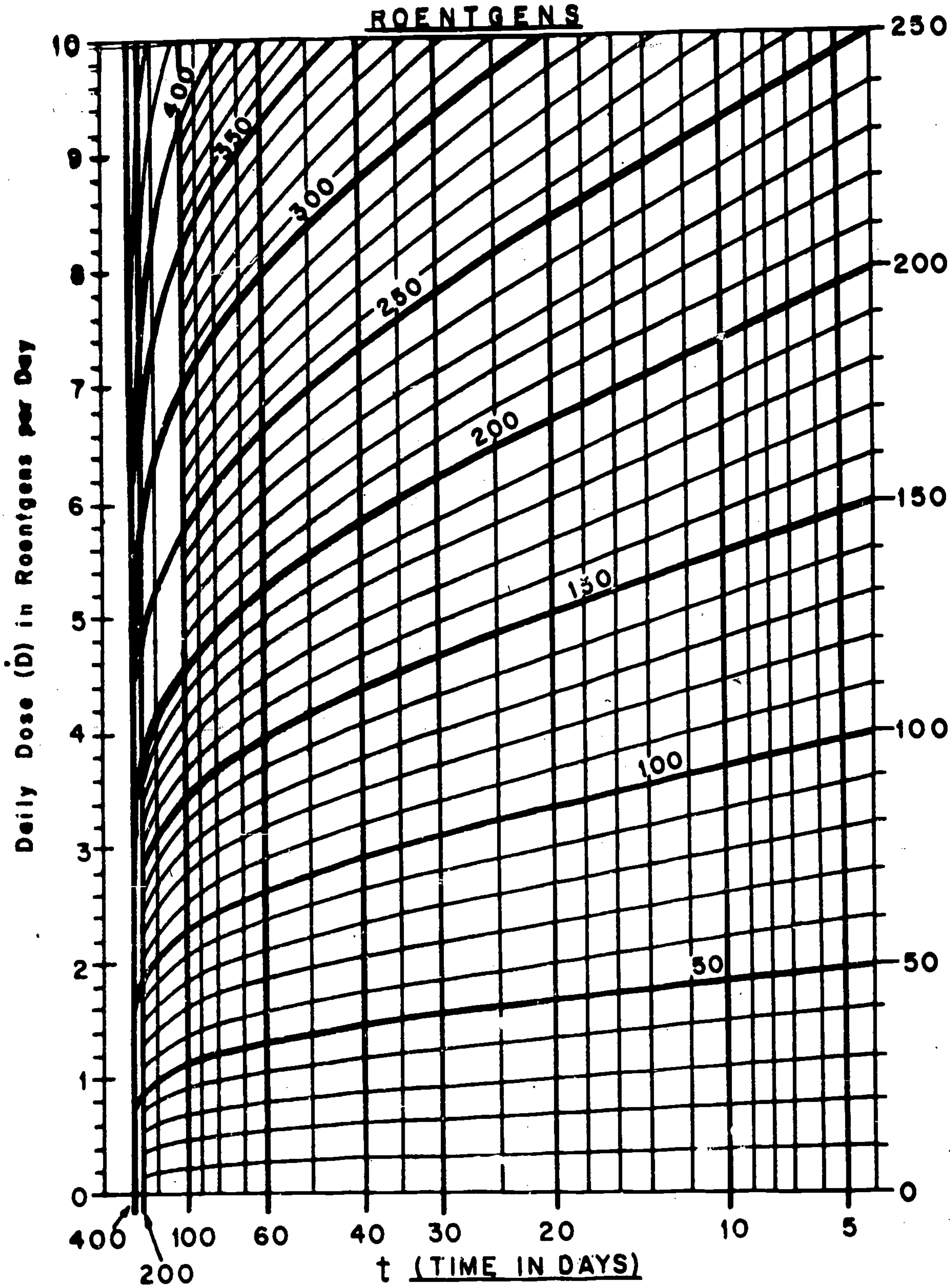
FIGURE 14

COPY for ERD Calculator



EQUIVALENT RESIDUAL DOSE

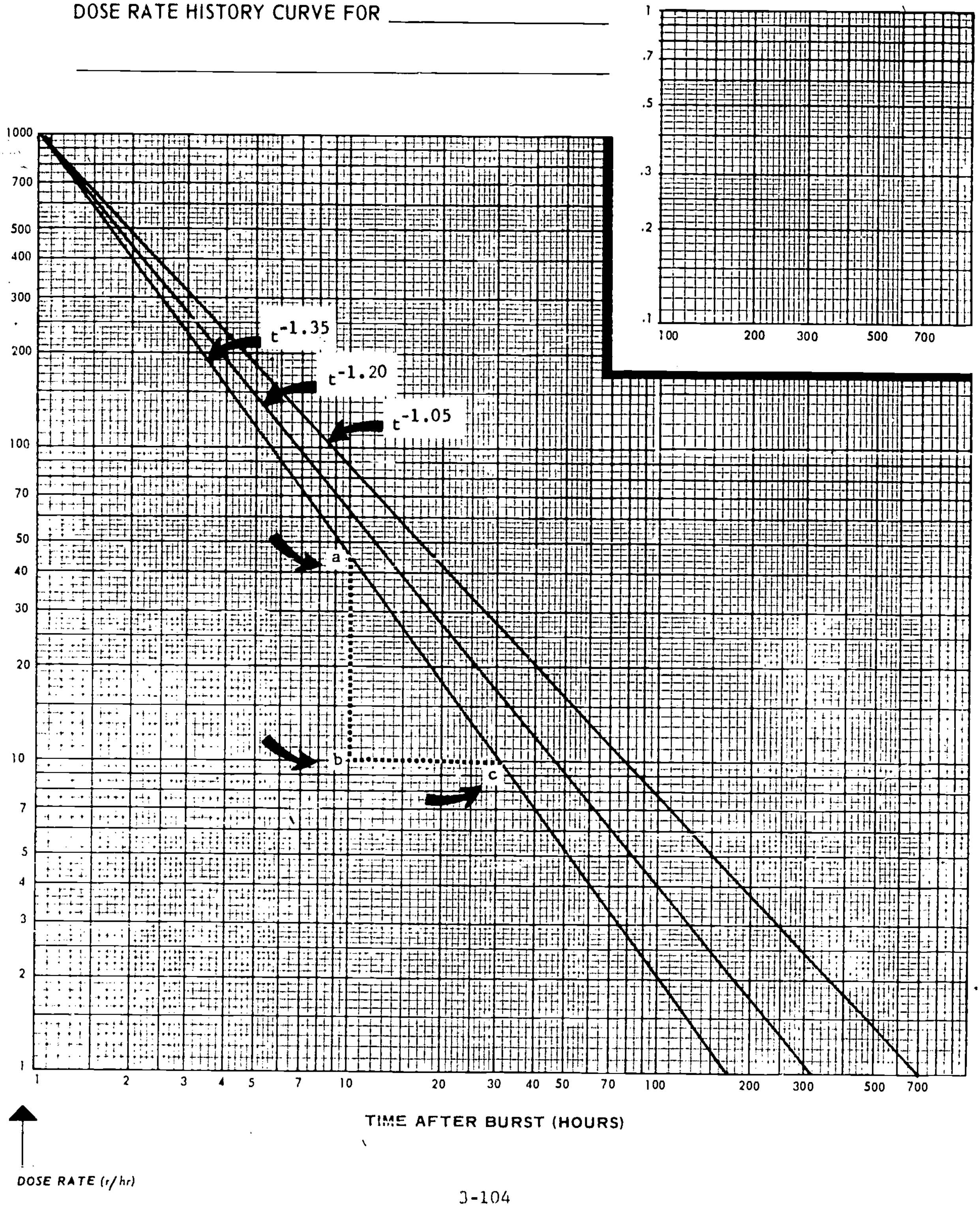


2.5%

FIGURE 16

DOSE RATE HISTORY CURVE FOR ______________________

____



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FOR PLANNING PURPOSES
Based on $t^{-1.2}$ Decay Law

DOSE RATE NOMOGRAM

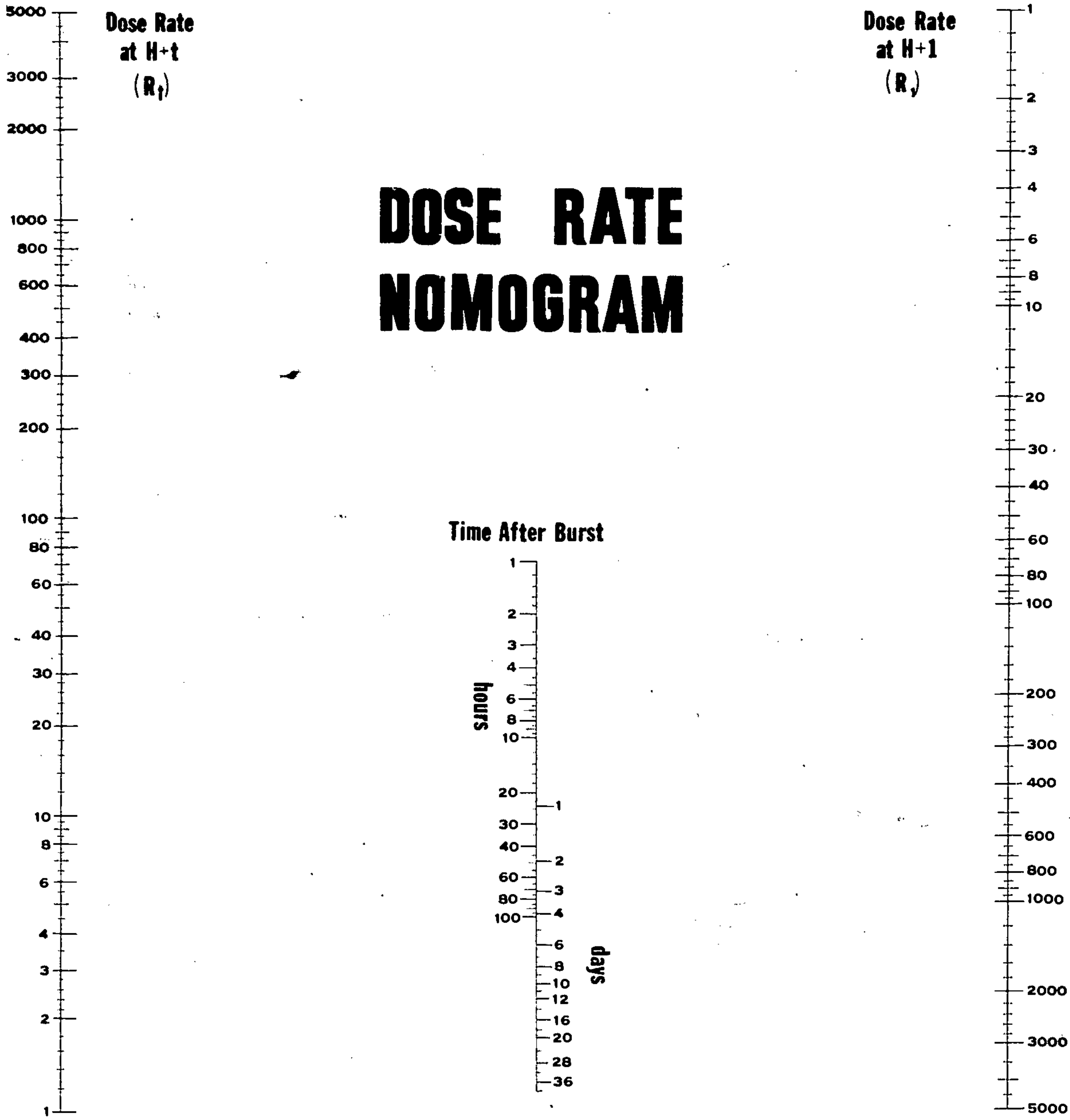


FIGURE 18

FOR PLANNING PURPOSES
Based on $t^{-1.2}$ Decay Law

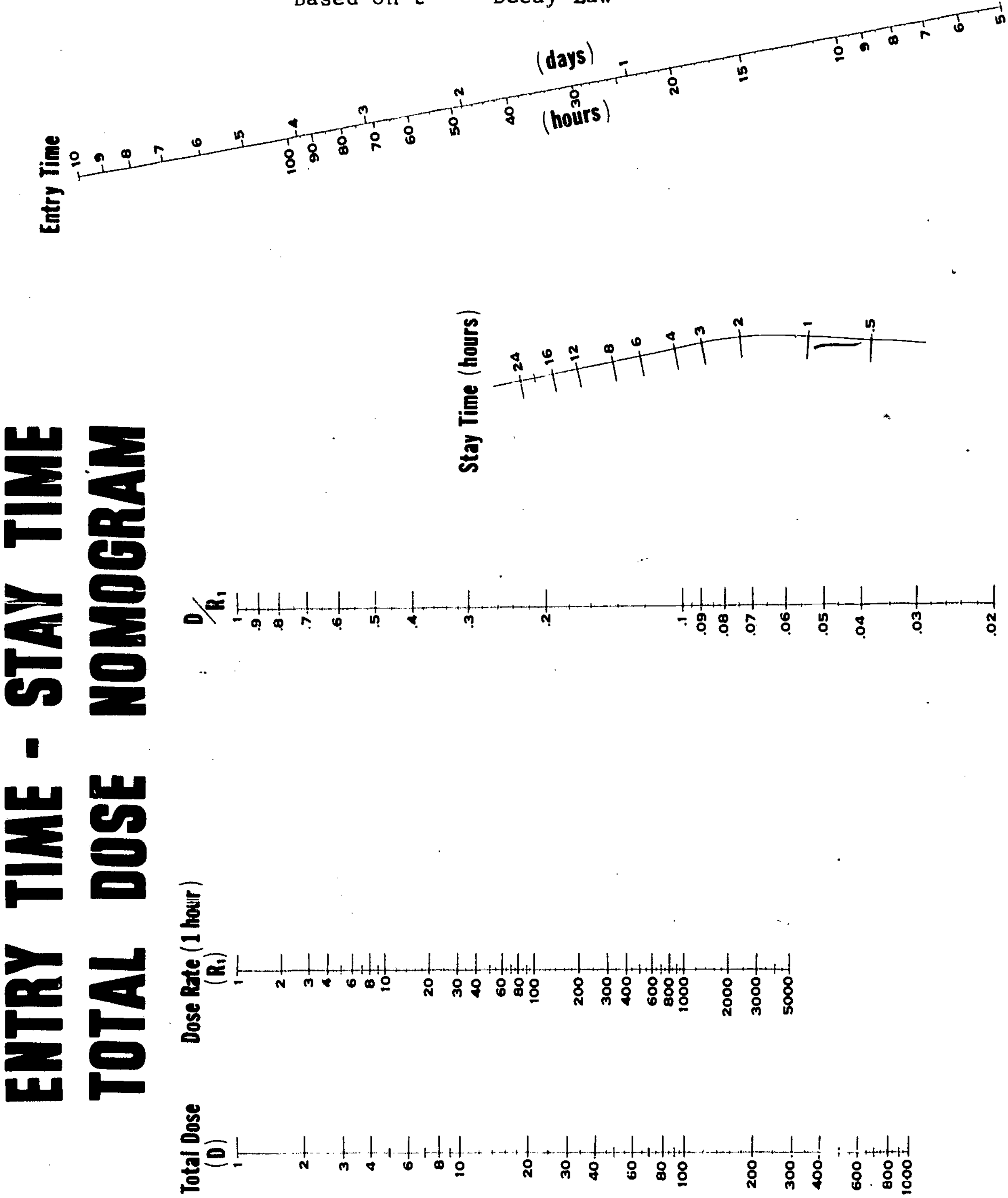
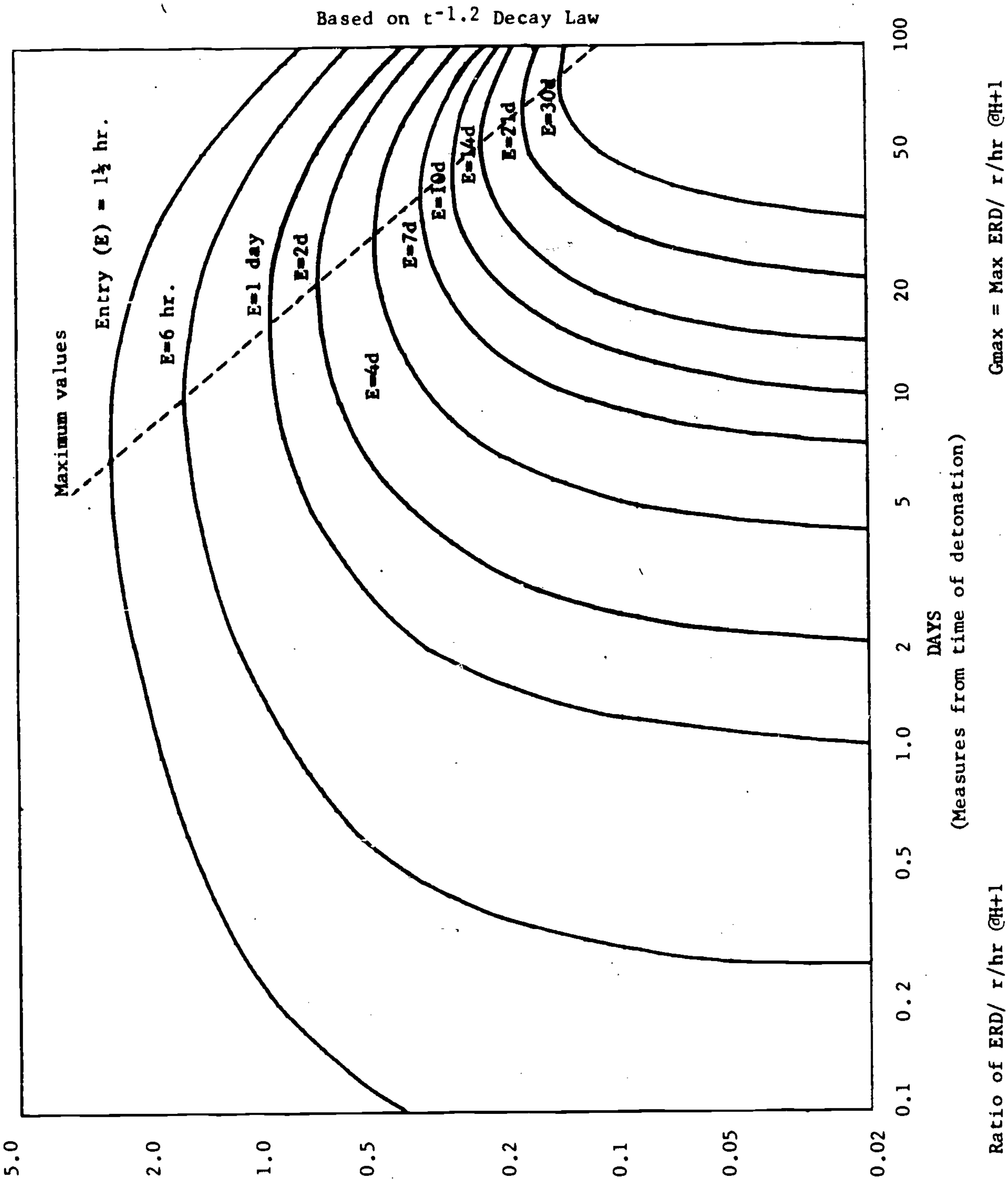


FIGURE 19

FOR PLANNING PURPOSES

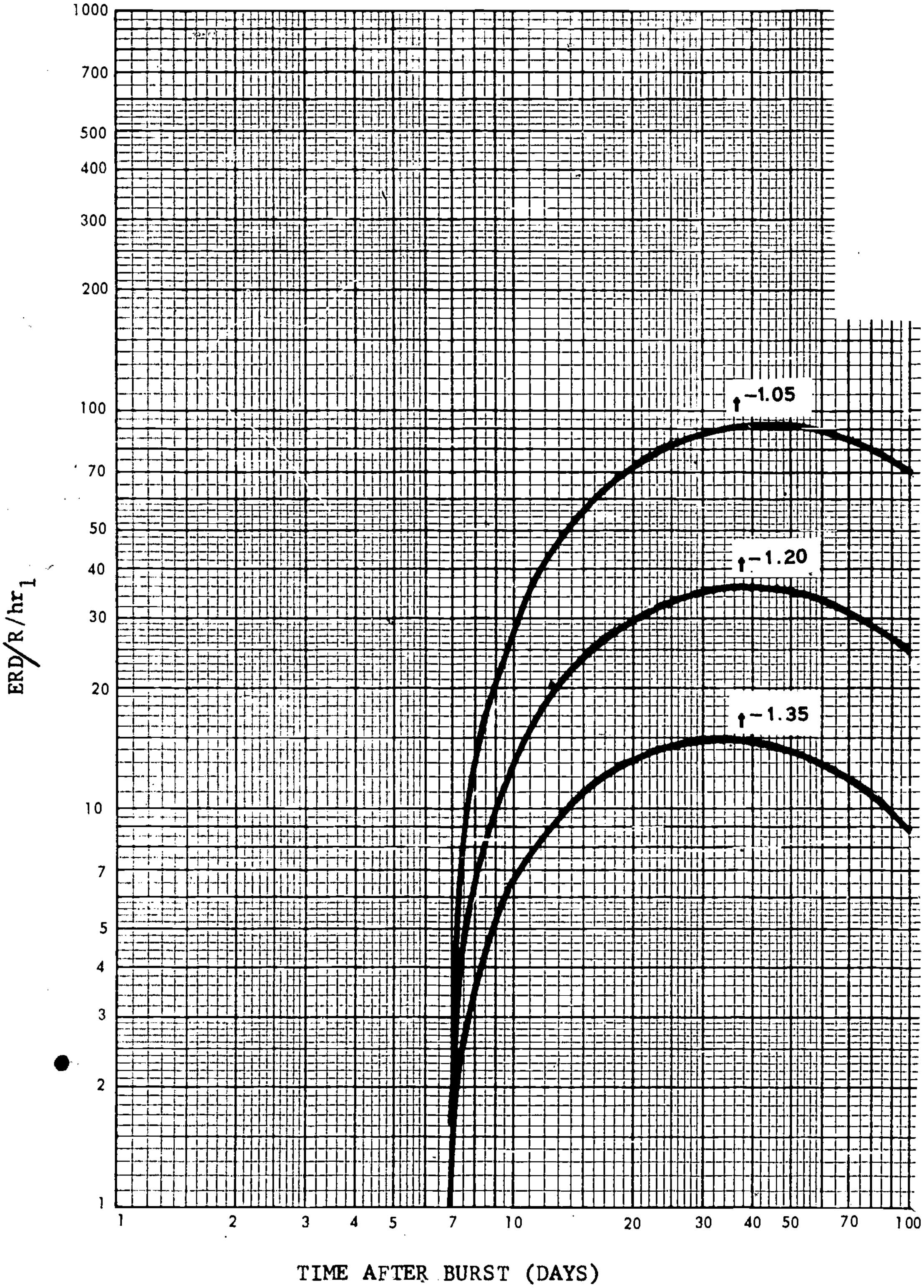
Based on $t^{-1.2}$ Decay Law



G or $\frac{\text{ERD}}{\text{r/hr}}$ @H+1

ERD/R/hr_1 RATIOS - ENTRY TIME 7 DAYS

Decay Characteristics $t^{-1.05}$, t^{-120}, $t^{-1.35}$



CALCULATION OF ERD RESULTING FROM A SHORT-TERM RADIATION DOSE

At "t" days after a short-term exposure of "D" roentgens, the equivalent residual dose (ERD) is expressed by the following basic equation:

$$ERD = 0.1D + 0.9\ (0.975)^{t-4}$$

Numerical Values - Powers of 0.975

Power	Value	Power	Value
1	0.975	22	.573
2	.951	24	.544
3	.927	26	.517
4	.904	28	.492
5	.881	30	.468
6	.859	32	.444
7	.837	34	.422
8	.816	36	.401
9	.796	38	.382
10	.776	40	.363
11	.757	45	.320
12	.738	50	.282
13	.719	55	.248
14	.701	60	.218
15	.684	65	.193
16	.667	70	.170
17	.650	80	.132
18	.634	90	.102
19	.618	100	.079
20	.602	110	.061

C H A P T E R I V

MONITORING AND SURVEY PROCEDURES

This Chapter has not been prepared. The requirement for it is being reconsidered because of its similarity to sections of Chapter Nos. 3 and 9 of this Guide. If the Chapter is not needed, it (FG-E-5.4) will be left open for assignment to another subject area as future requirements dictate.

C H A P T E R V

RADIOLOGICAL REPORTING PROCEDURES

The civil defense programs receiving major emphasis are concerned with protection against fallout radiation. A system for measuring radiation and reporting appropriate data is necessary to support these programs.

At the local level, authorities must direct the activities of the general populace and personnel engaged in survival and recovery missions. Information on the arrival of fallout is required promptly. Very detailed radiological information is required by those directing unsheltered operations. The first day or two postattack when the radiation intensity is changing rapidly, frequent reports will be necessary.

At higher levels of government, radiological reports are needed chiefly for use in situation evaluation and in planning support activities. These functions do not require particularly detailed or frequent reports.

The reporting schedules and procedures outlined in this chapter are designed to provide the minimum acceptable radiological intelligence at each level of government. However, adaptation to meet special requirements is permissible provided that each level generates the data required by the next higher level of government.

This chapter provides guidance concerning specific procedures for:

1. The reporting of fallout information from monitoring stations, public shelters, surface, mobile, and aerial monitoring teams to the local emergency operations center (EOC).
2. The reporting of fallout information from the local EOC to neighboring communities.
3. The reporting of fallout information from the local EOC to the State EOC.
4. The reporting of fallout information from the State EOC to neighboring States or Provinces.
5. The reporting of fallout information from the State EOC to Office of Civil Defense regional level.
6. The reporting of fallout information from OCD regional level to national level.
7. The reporting of fallout information to lower echelons.
8. The reporting of fallout information from Federal facilities, civilian and military.

TERMINOLOGY

The following descriptions of selected terms are included to insure understanding of the sense in which they are used in this chapter.

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Monitoring Station. A center of on-station and (usually) mobile radiological monitoring and reporting operations, established in compliance with OCD criteria and equipped with instruments granted by OCD. "Fixed Monitoring Station" and "Operational Monitoring Station" have been used synonymously.

On-station Monitoring and Reporting. Measurement and reporting of unshielded radiation dose rates and doses at a standard location in close proximity to the monitoring station. Reports of on-station monitoring, from appropriately dispersed monitoring stations, can provide a rough picture of the radiological situation before extensive field operations are feasible.

Mobile Monitoring. Monitoring to determine the radiological situation over points, routes, or areas of interest. It may be initiated when the requirement for more detailed data warrants the resultant radiation exposure of the monitors. The amount of monitoring detail should be consistent with the purpose(s) for which the data is required.

Aerial Monitoring. A special form of mobile monitoring, separately implemented because of unique requirements for equipment, personnel and training.

Shelter Monitoring. Monitoring directed primarily toward evaluation of the radiological situation within shelters and the hazards associated with emergency missions by shelterees. Before the conclusion of the shelter period, some monitors will be reassigned to monitoring in support of emergency missions and after the shelter period, most monitors will support recovery operations.

Flash Report. A flash report is a high priority report usually "triggered" by an occurrence of great importance, and limited to bare details such as what, when, and where. As used ' re, "flash report" means a flash report of the arrival of fallout.

Summary Report. As used here, a summary (or collective) report is a single report stating the dose rate or doses at each of many locations, or dose rates representative of each of many areas.

REPORTING TO THE EMERGENCY OPERATIONS CENTER

The monitors at monitoring stations and at selected public shelters, as well as mobile and aerial monitors, will report fallout information to the local EOC, or to a collection center for relay to the EOC, in accordance with the local radiological plan. Selected State stations may also be required to report directly to the State EOC. Data reported will consist of:

1. Readiness reports.
2. Flash reports.
3. Dose rate reports.
4. Accumulated radiation dose reports.

Readiness Reports. In time of emergency, monitors at each monitoring station and selected public shelters will submit to the EOC one operational readiness report as soon as at least one monitor has reported for duty, batteries have been inserted, and instruments are found to be operable. The message, generally by voice (telephone or radio), will be brief, prefaced by the monitoring station's call letters or numbers (previously assigned by the local Radiological Defense Officer), and followed by the single word, "OPERATIONAL." If a written message is transmitted, the format will be: eee OPERATIONAL, where eee represents the station's call letters or numbers. Subsequently, if the state of operational readiness should change, the monitor will report the situation immediately to the radef staff at the EOC.

Flash Reports. When the radiation intensity initially reaches or exceeds 0.5 r/hr, one flash report will be made immediately by the monitor to the EOC. The verbal message will be brief and include the time of observation in local time, the station's preassigned letter or number designator, and the single word "FALLOUT." The message in written format would be: tttt eeeFALLOUT, where tttt represents the local standard time when the fallout intensity was observed to reach or exceed 0.5 r/hr; and eee identifies the station.

Dose Rate Reports. After the flash report, monitoring stations, some of them located at selected public shelters, will measure the outside, unsheltered dose rate at least once each 3 hours for the subsequent 24 hours and report this dose rate information to the local EOC. The 3-hour reports will be based on monitoring observations taken at 0300Z, 0600Z, 0900Z, 1200Z, 1500Z, 1800Z, 2100Z, and 2400Z. (See Time Conversion chart, reproduced in the Handbook for Radiological Monitors, Chapter 9). From 24 hours through 48 hours after the flash reports, monitoring stations will report dose rate information to the EOC at least once each 6 hours, based upon fallout observations taken at 0300Z, 0900Z, 1500Z, and 2100Z. After 48 hours subsequent to the flash report, dose rate reports will be submitted to the EOC once daily, based upon observations taken at 0300Z. Although dose rate observations are taken at synchronized hours across the nation, reports into the EOC must be on a staggered basis in order not to overload existing communications facilities. Also, it may be more efficient for reports to be on a "challenge" or roll call basis, in accordance with normally used voice communications procedures--particularly where several monitoring stations report over the same communications network.

Further, where required locally, dose rate observations may be taken more frequently than indicated. For example, the radiological reporting log (see Chapter 9) provides for hourly dose rate reports during the first 12 hours after the flash reports. However, the actual frequency of reporting beyond that required to meet the needs of higher levels of government is left optional to meet local requirements.

The dose rate report, generally by voice, will be brief and include the time of observation and the monitoring station's call letters, followed by the actual dose rate report in roentgens per hour (r/hr). In written format the message form will be: tttt eee rrr, where tttt indicates the time of dose rate observations (local time), eee identifies the station, and rrr is the observed dose rate in roentgens per hour.

Dose rates which equal or exceed 1 r/hr will be reported to the nearest whole r/hr. For example, 1.4 r/hr would be reported as "001;" 11.6 r/hr as "012;" 125.4 r/hr as "125." In areas where the dose rates have exceeded 1 r/hr, but have decayed to less than 1 r/hr, they will be expressed in tenths, hundredths, or thousandths of r/hr as required. For example, 1/10 r/hr would be reported as ".100;" 50 mr/hr as ".050."

Radiation Dose Reports. A report of the outside, unsheltered, accumulated radiation dose will be forwarded once daily to the local EOC, based upon dosimetric measurements made at 0300Z each day after fallout arrives. This report, verbal or written, may be appended to the 0300Z dose rate report, and the combined message format would be: tttt eee rrr dose rrrr(r). The word dose is included in the message to separate the dose rate from the dose and reduce the possibility of confusion. The total outside, unsheltered radiation dose accumulated to date will be expressed as whole roentgens in 4 or 5 numbers as required. For example, a dose of 90 r would be reported as "0090;" 380 r as "0380;" 2050 r as "2050;" 12050 r as "12050." The report will be forwarded to the EOC daily for the first 6 days postattack, or longer if required by the Radef Officer.

Sample reporting logs for use at the monitoring stations and recording logs for use at the EOC are contained in Chapter 3.

Reporting from Mobile and Aerial Monitoring to EOC. Mobile and aerial monitoring missions will not be performed at synchronized hours. Rather, they will be performed as required and as conditions permit. The characteristics of such monitoring missions are so variable that reporting formats and modes of reporting will necessarily be varied. In some instances the report may consist of a map or sketch with dose rates recorded thereon. When monitoring points can be identified by name, the report may be made in summary form. Generally, the report will be written and then hand carried or relayed to the EOC. Each report of mobile or aerial monitoring must include:

1. Date and times (local standard time).
2. Locations where the dose rate readings were made.
3. Dose rate values at the indicated locations.
4. Elevation of the plane (for aerial monitoring).

Special Reports. If at any time a monitor at the monitoring station detects a marked increase in dose rate following a period of 3 or more hours of decay, a special report will be filed indicating the approximate time that the dose rate began to increase, and the monitoring sequence specified to follow the initial flash report will be repeated.

The public shelter monitor, in coordination with the shelter manager, will report to the radef staff at the EOC if at any time during the shelter period the in-shelter dose rate reaches or exceeds 10 r/hr, or if within any two-day period of shelter the dose reaches 75 r. The Radef Officer, in coordination with the civil defense director, will advise the shelter manager on action to be taken.

SHELTER RADIATION REPORTS

Shelter monitors will report to shelter managers in accordance with the shelter SOP's. Routine reports of the shelter radiation situations will be included in the shelter managers' comprehensive reports to the EOC, in accordance with established procedures.

REPORTING FROM LOCAL EOC TO NEIGHBORING COMMUNITIES

The local EOC will furnish flash reports and subsequent dose rate reports to neighboring communities in accordance with reciprocal agreements. Upon receipt of flash reports from at least two local monitoring stations, a report will be sent to neighboring communities. The reporting procedures and message format previously indicated for monitoring stations will also apply for the exchange of flash reports between neighboring communities.

Neighboring communities will exchange reports of dose rates representative of their areas each three hours during the first 24 hours after the flash report; each six hours during the period 24-28 hours subsequent to the flash report; and once daily thereafter. The concept of "dose rate representative of an area" is discussed in Annex 1. However, the frequency of reporting between neighboring communities is optional and may be modified as appropriate. Reporting procedures and message format as indicated for reporting from local EOC to State EOC will also apply for neighboring communities, as described below.

REPORTING FROM LOCAL EOC TO STATE EOC

Political subdivisions will send flash reports to State level through State designated channels when fallout is first detected in their jurisdiction. The message will be in the following format: ddtttt eee(e)FALLOUT, where dd is the day of the month; tttt is the time in Greenwich mean time (Z); eee(e) is the letter or number designator previously assigned to the local area by the State Radef Officer; and the word FALLOUT indicates that dose rates within the political jurisdiction have been observed to reach or exceed 0.5 r/hr.

Dose rate reporting procedures will be in accord with State plans, urban governments usually reporting through the county and/or other intermediate civil defense organizations. This is essential in large States to combine the data from many small areas into abbreviated analyzed reports which will neither overload communications to the State level nor exceed State data handling capabilities.

As a minimum, political subdivisions will submit dose rate reports representative of the fallout situation across their respective local areas each 12 hours during the first 48 hours subsequent to the flash report. The dose rate reports will be based upon fallout observations taken at 0300Z and 1500Z. Reports from intermediate fallout observations taken at 0900Z and 2100Z may also be forwarded to State level if the State has a requirement for this additional information. Additional dose rate reports beyond the minimum indicated above will be optional within each State. Further, if required at State level and if communications capability exists to handle the increased traffic load, local level may forward more than one dose rate report at each reporting time in order to provide more precise definition across the area.

If only one dose rate report is forwarded at a time, the message format will be: ddtttt eeee rrr, where ddtttt indicates the day and time in GMT; eeee is the location designator; and rrr is the observed dose rate representative of the political jurisdiction at the indicated time.

If several dose rate reports are forwarded from a relatively large local area (e.g., a county), the message may contain a collective of dose rate reports from communities within the county; and the message format would be: ddtttt eeeerrr ffffrrr ggggrrr, etc., where ffff, gggg, etc., are designators previously assigned by the State Radef Officer for other communities in the local (county) area where the EOC is at a location designated eeee.

If a State finds that, from a considerable area of the State, there have been no radef reports, this could indicate that no monitoring stations or EOC's in the area were operational; that there was general failure of communications in the area; or that dose rates had not reached or exceeded 0.5 r/hr. If there is reasonable doubt that the area has no significant fallout, the State Radef Officer should request verification of an "0" fallout situation from two or three selected EOC's in the area.

If a State requires more precise definition of the dose rate condition across a small county or a large municipal area, the message format could be expanded to indicate the dose rate representative of the situation near the geographical center of the area, and the dose rates representative of the northern, eastern, southern, and western limits of the area. In this case, the message format would be: ddtttt eeee rrr rrrN rrrE rrrS rrrW, where the letters, N, E, S, W, designate the four cardinal limits of the area, and the rrr preceding each letter would be the dose rate at that location. The first rrr indicates the dose rate representative of the center of the area designated by eeee. A sample message of this type might be: 220300 ABXY120 300N 140E 080S 160W, which would mean that on the 22nd day of the month at 0300GMT the dose rate in the central section of the community designated ABXY was 120 r/hr; 300 r/hr in the northern section of the community; 140 r/hr to the east; 80 r/hr to the south; and 160 r/hr in the western section of the community.

The frequency of reporting dose rate information from local to State level will be influenced by the State's requirements for this information, and by the availability of postattack communications for radef traffic. A State's requirements placed upon local level for dose rate information should be realistic, taking into account the limitations of postattack communications and the State's capability to process and actually use voluminous amounts of fallout information from local levels. As an absolute minimum, local level must report dose rate information to State level twice daily during the first 48 hours, based upon observations at 0300Z and 1500Z; and thereafter, once daily based upon observations at 0300Z.

REPORTING FROM STATE EOC TO NEIGHBORING STATES AND PROVINCES

Neighboring States will exchange general situation summaries describing the spread of fallout across the State during the attack period and through 12 hours thereafter. The situation summaries should be in written format, using clear language, and time expressed in GMT. The report should reflect the spread of fallout as of 0300 and 1500 GMT. States and Provinces along the United States/Canada border are required to exchange similar situation summaries that are necessary to describe the spread of fallout within the area extending from the border for 50 miles into the United States, and from the border for 50 miles into Canada. A sample message from North Dakota to its neighboring States and to Manitoba might be: "FALLOUT SPREADING E FROM MINOT TOWARD GRAND FORKS 232100Z AT 30 MPH."

During the attack period and through 24 hours thereafter, neighboring States are required to exchange situation summaries describing dose rate conditions as of 0300 and 1500 GMT. After 24 hours postattack, dose rate summaries will be exchanged once daily, based upon fallout observations taken at 0300 GMT. Similarly, States and Provinces along the United States/Canada border are required to exchange situation summaries describing dose rate conditions in the area extending from the border for 50 miles into the United States and from the border for 50 miles into Canada. A sample situation summary from Michigan to its neighboring States and to Ontario might be: "FALLOUT FROM ATTACK ON DULUTH CAUSING DOSE RATES 50 TO 100 R/HR 240300Z IRONWOOD TO MARQUETTE TO SAULT STE. MARIE." In some cases the situation summary might be just a collection of dose rate reports, such as the following, which might be sent from New York State to its neighboring States, and to Ontario: "DOSE RATES 230300Z BUFFALO 110 R/HR, ROCHESTER 90 R/HR, SYRACUSE 65 R/HR, UTICA 200 R/HR, ALBANY 160 R/HR."

REPORTING FROM STATE EOC TO OCD REGIONAL LEVEL

During the first 12 hours subsequent to attack, each State shall forward to the appropriate OCD regional level one radef situation summary report, indicating the spread of fallout across the State. The report will be brief and condensed, and will reflect the conditions at either 0300 or 1500 GMT, whichever occurs first, after significant spread of fallout within the State. The above sample summary report from North Dakota is illustrative.

Also, each State shall forward to the appropriate OCD regional level collectives of dose rate reports from the political jurisdictions. During the first 24 hours postattack, two sets of dose rate collectives will be transmitted, based upon fallout observations taken at 0300Z and 1500Z. Subsequent to 24 hours postattack, a dose rate collective will be forwarded once daily, based upon fallout observations taken at 0300Z. The collectives will be in written teletypewriter message format, prefaced by the OCD Region to which the report is made, and the State from which the collective message originates; and the date and time of the fallout observations upon which the collective message is based. This preface will be followed by the collective dose rate reports, using the three-letter location designators in Annex 2 to this chapter. To the extent feasible and based upon the representative dose rate reports from the political subdivisions, each State will transmit one dose rate report in its collective for each of the three-letter designators listed in Annex 2. However, where a significant fraction of the State has not experienced significant fallout, the message will include a brief description of the "clear" area. This will eliminate the requirement for reporting zero dose rates from extensive areas. A sample report might be: "TO OCD REGION FOUR FROM INDIANA TIME OF DOSE RATE OBSERVATION 220300GMT, LOA 120, LOC 100, LOF 060, LOH 100, LOJ 035, LOL 020, LOP 140, LOS 060, LOW 018, LOZ 120, LPC 090, LPF 010, LPI 040, etc. NO SIGNIFICANT FALLOUT IN SOUTHERN HALF OF INDIANA."

If dose rate reports for specific locations are required, the OCD Region will request the appropriate State civil defense office to furnish the required information.

States along the United States/Canada border should forward fallout reports from the indicated Canadian locations as data become available.

If subsequent surface mobile or aerial radiological surveys indicate significant variations that cannot be readily interpolated from the dose rate collectives, the collective message should be supplemented by a brief condensed word description of the anomalous area, with an indication of the degree of radiation intensity, and the location and dimension of that area.

REPORTING FROM OCD REGIONS TO OCD NATIONAL

The collective data reports received from the States will be promptly relayed to national level by priority message. Ideally, the reports from all States of a region would be relayed consecutively as a combined message. However, the report to national level should not be significantly delayed because of missing or incomplete reports from the States.

REPORTING FROM HIGHER TO LOWER ECHELON LEVELS

The OCD Regions will provide technical guidance to the States where required, and will also furnish to the States pertinent fallout reports available to the region but not available to the States. This might include reports from the ZI Army Commander, or reports submitted through OCD warning channels from Canadian Provinces. Similarly, State level will furnish technical guidance to political jurisdictions where required. Also, States will furnish to local political jurisdictions information concerning the over-all statewide radiation hazard. At local levels, the Radiological Defense Officer at the EOC will be expected to furnish technical guidance to the monitors at monitoring stations and at the public shelters in order to minimize radiation hazards for monitors and for other individuals.

SYSTEMS FOR COMMUNICATIONS

Fallout information from State to OCD Region and to OCD national levels will be primarily by means of NACOM I and NACOM II. However, for flash fallout type information where voice circuits would be appropriate, NAWAS may be used. For the reporting of fallout information from the political jurisdiction to State levels, intrastate police, fire conservation, highway patrol and maintenance, or other communications media including commercial facilities may be used. This includes State and local portions of NAWAS and RACES where appropriate. To increase the reliability of the reporting system, the local and State radiological defense plans should provide for the use of alternate communication services in reporting fallout information from local to State levels.

USE OF DESIGNATOR SYSTEM

The three-letter designators in Annex 2 will be used for transmission of dose rate reports from State to OCD regional levels. The primary purpose of this to conserve transmission time.

REPORTING RESPONSIBILITIES OF MONITORING STATIONS IN FEDERAL AGENCY FACILITIES

All Federal monitoring stations (civilian and military) are required to report fallout information to local government in time of emergency. The frequency of reporting and the reporting procedures are to be worked out between the Federal personnel at each Federal monitoring station and the appropriate local authorities. Generally, the reporting procedures will be consistent with the procedures indicated above for monitoring stations to report to the local EOC. Local government will use the Federal reports and other fallout reports to evaluate its over-all local radiation hazard, and will use the combined reports as a basis for reporting flash information and representative dose rate reports to State level.

In addition to reporting to local government, installations of the civil and military weather services, and the Federal Aviation Agency, in time of emergency, will monitor and report dose rate information hourly over the appropriate weather collection teletypewriter systems, appended to the hourly meteorological report. The U.S. Weather Bureau, the Navy Weather Service, and the FAA will report over teletypewriter service "A;" and the USAF Air Weather Service will report over the "AACS" teletypewriter system. However, the FAA will relay the Air Weather Service reports over teletypewriter service "A" as appropriate.

In most instances where installations of Federal agencies need monitoring reports from local government, they should make the required arrangements with appropriate local authorities, in coordination with the State Civil Defense Director. Where feasible, the Federal agency should arrange for a representative to regularly contact the local emergency operating center in time of emergency to coordinate Federal field facility operations with local government. For agencies having extensive organizations throughout the States, minor modification of procedures is appropriate. By Executive Order 10998, the U.S. Department of Agriculture has been assigned responsibilities which will make it desirable that its USDA Defense Boards receive summaries of fallout information from the local government, originating from local monitoring stations and from surface mobile and aerial monitoring operations.

THE REPRESENTATIVE DOSE RATE CONCEPT

The amount of radiological information to be reported to higher levels of government is limited by consideration of the functions to be served, the communications load, and the loads involved in processing, analyzing, and evaluating the data. At State levels and above, the type of data required for planning and directing support functions can be representative of each subarea rather than the "block-by-block" information necessary at the local level for controlling exposures while directing personnel in the field.

Ideally, the dose rate "representative" of an area might be thought of as the average of measurements, made at equally spaced grid points, if the area were a fairly smooth flat field with no structures. Necessarily, the on-station monitoring at many monitoring stations will reflect the shielding by any massive structures nearby; that is, the measured dose rate is not "unshielded." Further, measurements made over or near the borders of extensive paved areas such as streets, parking lots, or landing strips may fail to be representative because of lateral transport of the fallout particles by wind or rain. Measurements at such locations have value for "on-the-scene" operations, but may seriously misrepresent the general situation--and little, if any, weight should be given to reports of this type in determining the dose rate representative of an area.

There should be positive identification of those stations from which reports are to be used in determining the representative dose rate. Criteria for their selection include:

1. The "standard location" for measuring unsheltered dose rates is a broad, unpaved area; e.g., a park, a grassy area of an airport, or an area in a residential or rural area that is remote from massive structures or bodies of water.

2. The selected stations are relatively evenly distributed over the area.

To determine the representative dose rate:

1. Assemble the dose rates reported from the selected stations.

2. Discard for this purpose any readings which quite obviously represent a small hot spot, monitoring error, etc.

3. Average the remaining dose rates. (Do not carry calculations beyond two significant figures; e.g., any average between 255 and 265 would be reported as 260.)

ASSIGNED THREE-LETTER DESIGNATORS FOR STATE REPORTING OF FALLOUT INFORMATION

The following is a list of three-letter designators which will be used in reporting representative dose rate information from the States to OCD Regions, and forwarding these data to national level. This system for designating locations is specified primarily to reduce the radef communications load well below that resulting from use of place names or any other known location designator system. Also, this designator system will facilitate plotting of radef data by manual means which will be employed either as the basic plotting method or as "backup" for machine plotting which may be programed.

OCD REGION ONE

Designator	*City*
	QUEBEC
AAB	St. Hyacinthe
AAM	Thetford Mines
AAV	St. Pamphile
	NEW BRUNSWICK
ABC	Edmunston
ABP	Hartland
ABX	St. George
	MAINE
ACA	Clayton Lake
ACG	Fort Kent
ACT	Caribou
ADQ	Houlton
ADY	Jackman
AEH	Dover-Foxcroft
AEI	Milo
AEM	Millinocket
AFQ	Farmington
AFY	Skowhegan
AGE	Bangor
AGI	Old Town
AHJ	Alfred
AHM	Saco
AHU	S. Paris
AIC	Auburn
AID	South Windham
AII	Portland
AIM	Bath
AIQ	Augusta
AJB	Wiscasset
AJE	Rockland
AJL	Belfast
AJP	Ellsworth
AJR	Bar Harbor

Designator	*City*
	VERMONT
AKB	Winooski
AKC	Burlington
AKI	St. Albans
AKQ	Morrisville
AKW	Newport
ALO	Middlebury
ALW	Montpelier
AMI	St. Johnsbury
ANN	Woodstock
ANT	Manchester
ANW	Bennington
	NEW HAMPSHIRE
AOD	Lancaster
APB	Conway
APD	Claremont
APH	Lebanon
APO	Plymouth
APR	Laconia
AQA	Keene
AQJ	Concord
AQO	Nashua
AQR	Exeter
AQU	Dover
AQW	Portsmouth
	MASSACHUSETTS
ARE	Pittsfield
ARM	Westfield
ASB	Springfield
ASD	Amherst
ASE	Chicopee Falls
ASQ	Worcester
ATG	Bedford

Designator	*City*
ATV	Boston
AUA	S. Weymouth
AUO	Gloucester
AUS	North Attleboro
AUZ	New Bedford
AVE	Plymouth
AVG	Woods Hole
AVI	Falmouth
AVX	Nantucket
	CONNECTICUT
AWL	Litchfield
AWO	Bridgeport
AWZ	New Haven
AXE	Hartford
AXI	Windsor Locks
AXM	Middletown
AYB	Norwich
AYR	Brooklyn
	RHODE ISLAND
AZE	Greene
AZM	Hillsgrove
AZO	Providence
AZR	Quonset Point
AZY	Block Island
	NEW YORK
BAL	Massena
BAQ	Malone
BBN	Plattsburg
BBU	Oswego
BCB	Watertown
BCG	Lowville
BCO	Blue Mountain Lake
BCZ	Glens Falls

Designator	City
	NEW YORK—Con.
DBN	Niagara Falls
BDT	Buffalo
BEG	Albion
BES	Mt. Morris
BFB	Rochester
BFE	Canandaigua
BFM	Penn Yan
BFZ	Wolcott
BGC	Seneca Falls
BGK	Auburn
BGP	Syracuse
BGV	Cortland
BHJ	Rome
BHN	Utica
BHV	Cobleskill
BIK	Fultonville
BIV	Saratoga Springs
BJB	Albany
BJF	Stillwater
BJL	Troy
BKB	Ellicottsville
BKM	Belmont
BKQ	Hornell
FLI	Elmira
BLO	Ithaca
BLT	Owego
BMB	Binghamton
BMJ	Norwich
BMR	Walton
BMU	Oneonta
BOL	Ellenville
BOZ	Newburgh
BPM	Poughkeepsie
BPS	White Plains
BQH	Manhattan
BQI	Bronx
BQJ	Richmond
BQK	Kings
BQL	Queens
BRG	Hempstead
BRU	Bellport
BSH	Westhampton
	NEW JERSEY
BTI	Belvidere
BTQ	Newton
BTU	Somerville
BTZ	Morristown
BUP	Newark
BVA	Teterboro
BVE	Jersey City
BVP	Moorestown
BVX	Trenton
BWF	Wrightstown
BWU	Freehold
BWV	Lakehurst
BWW	Lakewood
BXS	Clayton
BXV	Millville
BYS	Atlantic City
	PUERTO RICO
BZA	Aguadilla
BZB	Isabela
BZC	Arecibo
BZD	Manati
BZE	Orocovis
BZF	San Juan (International Airport)
BZG	Fajardo
BZH	Cayey
BZI	Humacao
BZJ	Caguas
BZK	Mayaguez
BZL	Ponce
BZM	San Juan (CD Zone)
	VIRGIN ISLANDS
BZV	St. Thomas
BZY	Christiansted
BZZ	Hamilton

OCD REGION TWO

OHIO

Designator	City
CAA	Bryan
CAE	Paulding
CAG	Defiance
CAK	Wauscon
CAN	Napoleon
CAQ	Ottawa
CAU	Bowling Green
CAY	Findlay
CBC	Toledo
CBH	Fremont
CBK	Tiffin
CBN	Port Clinton
CBR	Sandusky
CBU	Norwalk
CBX	Elyria
CCA	Medina
CCD	Cleveland
CCJ	Akron
CCP	Painesville
CCR	Chardon
CCU	Ravenna
CCW	Jefferson
CDB	Warren
CDD	Youngstown
CDG	Van Wert
CDJ	Celina
CDM	Wapakoneta
CDO	Sidney
CDR	Lima
CDV	Bellefontaine
CDY	Kenton
CEC	Upper Sandusky
CEF	Marion
CEH	Bucyrus
CEK	Delaware
CEN	Mt. Gilead
CEQ	Mansfield
CET	Mt. Vernon
CEV	Ashland
CEY	Wooster
CFC	Millersburg
CFF	Coshocton
CFJ	Canton
CFN	New Philadelphia
CFQ	Carrollton
CFT	Cadiz
CFW	Lisbon
CFY	Steubenville
CGD	Greenville
CGG	Baton
CGK	Eaton
CGS	Troy
CGV	Xenia
CGX	Springfield
CHB	Urbana
CHE	Marysville
CHH	London
CHK	Washington, C. H.
CHO	Columbus
CHV	Circleville
CIA	Lancaster
CIF	Newark
CII	Logan
CIN	New Lexington
CIQ	Zanesville
CIT	McConnelsville
CIW	Cambridge
CJA	Caldwell
CJF	Woodsfield
CJJ	St. Clairsville
CJO	Hamilton
CJQ	Cincinnati
CJX	Lebanon
CKA	Batavia
CKE	Wilmington
CKI	Georgetown
CKM	Hillsboro
CKQ	West Union
CKU	Portsmouth
CKZ	Waverly
CLB	Chillicothe
CLF	Jackson
CLL	Ironton
CLP	McArthur
CLV	Gallipolis
CMA	Athens
CMH	Pomeroy
CMO	Marietta

PENNSYLVANIA

Designator	City
CNA	Erie
CNE	Meadville
CNK	Franklin
CNO	Tionesta
CNR	Warren
CNZ	Ridgeway
COC	Smithport
COG	Emporium
COL	Coudersport
COP	North Bend
COS	Wellsboro
COW	Ralston
COZ	Towanda
CPD	LaPorte
CPH	Montrose
CPL	Tunkhannock
CPO	Scranton
CPV	Honesdale
CPZ	Milford
CQE	New Castle
CQI	Beaver
CQM	Mercer
CQR	Butler
CQV	Kettanning
CQY	Clarion
CRC	Indiana
CRG	Brookville
CRL	Clearfield
CRO	Houtzdale
CRU	Bellefonte
CSC	Lewiston
CSH	Lock Haven
CSM	Mifflintown
CSR	Williamsport
CSX	Middleburg
CTB	Lewisburg
CTG	Sunbury
CTK	Danville
CTP	Bloomsburg
CTW	Pottsville
CUA	Wilkes-Barre
CUG	Jim Thorpe
CUL	Allentown
CUT	Stroudsburg
CUZ	Easton
CVE	Washington
CVK	Waynesburg
CVP	Pittsburgh
CVZ	Uniontown
CWC	Greensburg
CWM	Somerset
CWQ	Edensburg
CWT	Bedford
CWZ	Hollidaysburg
CXD	Huntingdon
CXH	McConnellsburg
CXM	Chambersburg
CXR	New Bloomfield
CXW	Carlisle
CYA	Gettysburg
CYG	Harrisburg
CYO	York
CYR	Lebanon
CYV	Lancaster
CZA	Reading
CZG	West Chester
CZJ	Norristown
CZN	Media
CZS	Doylestown
CZU	Philadelphia

KENTUCKY

Designator	City
DAA	Louisville
DAG	La Grange
DAI	Bedford
DAK	Carrollton

OCD REGION TWO—Continued

KENTUCKY—Con.

Designator	City
DAM	New Castle
DAQ	Shelbyville
DAS	Warsaw
DAT	Burlington
DAW	Owenton
DBA	Frankfort
DBE	Covington
DBI	Williamstown
DBK	Georgetown
DBR	Falmouth
DBU	Cynthiana
DBX	Paris
DCB	Brooksville
DCE	Mt. Olivet
DCH	Carlisle
DCK	Maysville
DCN	Flemingsburg
DCP	Owingsville
DCR	Morehead
DCV	Vanceburg
DDA	Grayson
DDF	Greenup
DDJ	Catlettsburg
DDN	Morganfield
DDQ	Dixon
DDT	Henderson
DDY	Calhoun
DEB	Owensboro
DEE	Hartford
DEJ	Hawesville
DEN	Hardinsburg
DEQ	Leitchfield
DEU	Brandenburg
DFA	Elizabethtown
DFD	Shepherdsville
DFH	Hodgenville
DFM	Bardstown
DFQ	Taylorsville
DFT	Springfield
DFX	Lebanon
DGB	Lawrenceburg
DGF	Harrodsburg
DGJ	Danville
DGN	Versailles
DGR	Stanford
DGV	Nicholasville
DGY	Lancaster
DHA	Lexington
DHE	Richmond
DHH	Mt. Vernon
DHL	Winchester
DHO	Mt. Sterling
DHR	Irvine
DHV	McKee
DHY	Stanton

Designator	City
DIC	Frenchburg
DIF	Beattyville
DII	Booneville
DIL	Campton
DIO	Jackson
DIS	West Liberty
DIV	Sandy Hook
DIY	Salyersville
DJB	Hindman
DJF	Paintsville
DJH	Prestonsburg
DJK	Louisa
DJN	Inez
DJQ	Pikeville
DJU	Hickman
DJZ	Wickliffe
DKC	Bardwell
DKE	Clinton
DKI	Paducah
DKO	Mayfield
DKS	Smithland
DKV	Benton
DKY	Murray
DLC	Marion
DLF	Eddyville
DLK	Princeton
DLN	Cadiz
DLR	Madisonville
DLU	Hopkinsville
DLX	Greenville
DMA	Elkton
DMD	Russellville
DMG	Morgantown
DMJ	Franklin
DMK	Bowling Green
DMH	Brownsville
DMQ	Scottsville
DMU	Munfordville
DMY	Glasgow
DNC	Tompkinsville
DNE	Greensburg
DNI	Edmonton
DNL	Burkesville
DNP	Campbellsville
DNR	Columbia
DNU	Jamestown
DNY	Albany
DOD	Liberty
DOG	Monticello
DOK	Somerset
DON	Whitley City
DOP	Williamsburg
DOT	London
DOW	Barbourville
DPA	Manchester
DPD	Pineville

Designator	City
DPI	Hyden
DPL	Harlan

WEST VIRGINIA

Designator	City
DQA	Wheeling
DQD	Moundsville
DQJ	Parkersburg
DQO	Elizabeth
DQS	St. Marys
DQV	Harrisville
DQY	Middlebourne
DRD	New Martinsville
DRH	West Union
DRL	Weston
DRP	Clarksburg
DRS	Buckhannon
DRV	Fairmont
DRY	Grafton
DSC	Philippi
DSF	Morgantown
DSJ	Kingwood
DSM	Parsons
DSQ	Petersburg
DSU	Keyser
DSY	Moorefield
DTB	Romney
DTF	Berkeley Spgs
DTI	Martinsburg
DTN	Charles Town
DTT	Huntington
DUA	Pt. Pleasant
DUE	Hamlin
DUH	Winfield
DUK	Ripley
DUO	Charleston
DUU	Spencer
DUX	Grantsville
DVB	Clay
DVE	Glenville
DVI	Sumersville
DVM	Sutton
DVQ	Webster Springs
DVT	Elkins
DWA	Franklin
DWH	Wayne
DWL	Williamson
DWP	Logan
DWU	Madison
DWZ	Welch
DXD	Pineville
DXJ	Fayetteville
DXQ	Beckley
DXY	Princeton
DYG	Hinton
DYM	Union
DYS	Lewisbury
DZJ	Marlinton

Designator	*City*
	VIRGINIA
EAC	Monterey
EAG	Staunton
EAK	Harrisonburg
EAQ	Woodstock
EAT	Luray
EAX	Stanardsville
EBA	Madison
EBD	Winchester
EBH	Front Royal
EBK	Washington
EBR	Orange
EBU	Berryville
EBX	Culpeper
ECB	Warrenton
ECF	Leesburg
ECL	Spotsylvania
ECO	Manassas
ECU	Stafford
ECZ	Fairfax
EDD	Bowling Green
EDM	Alexandria
EDQ	King George
EDT	Montross
EEA	Newcastle
EEE	Covington
EEI	Warm Spgs.
EEL	Fincastle
EEP	Lexington
EEW	Amherst
EEZ	Lovingston
EFD	Appomattox
EFH	Charlottesville
EFL	Buckingham
EFO	Palmyra
EFR	Cumberland
EFV	Louisa
EGA	Amelia
EGE	Powhatan
EGI	Goochland
EGM	Chesterfield
EGS	Richmond
EHD	Hanover
EHG	King William
EHL	Charles City
EHP	New Kent
EHS	King & Queen CH
EHU	Tappahannock
EHY	Warsaw
EID	Saluda
EIH	Gloucester
EIM	Heathsville
EIR	Lancaster
EIV	Mathews
EJA	Accomac
EJF	Eastville
EJO	Jonesville
EJT	Wise
EJZ	Gate City
EKD	Clintwood
EKK	Grundy
EKN	Lebanon
EKR	Abingdon
EKX	Tazewell
ELB	Marion
ELF	Independence
ELJ	Bland
ELQ	Wytheville
ELV	Pulaski
EMA	Pearisburg
EMG	Hillsville
EMN	Christiansburg
EMQ	Floyd
EMT	Stuart
EMY	Salem
ENI	Rocky Mount
ENL	Martinsville
ENO	Bedford
ENR	Chatham
ENX	Rustburg
EOA	Halifax
EOD	Charlotte CH
EOH	Farmville
EOK	Boydton
EOO	Lunenburg
EOT	Nottoway
EOY	Lawrenceville
EPB	Dinwiddie
EPE	Emporia
EPH	Petersburg
EPM	Hopewell
EPP	Sussex
EPT	Courtland
EPW	Surry
EPZ	Williamsburg
EQC	Isle of Wight
EQG	Yorktown
EQK	Denligh
EQN	Suffolk
EQT	Portsmouth
EQW	Hampton
ERR	Princess Anne
	MARYLAND
ESA	Oakland
ESE	Cumberland
ESK	Hagerstown
ESR	Frederick
EST	Olney
ESY	Rockville
ETH	Westminster
ETL	Ellicott City
ETQ	Towson
ETU	Baltimore
EUD	Bel Air
EUK	Chestertown
EUO	Centerville
EUT	Elkton
EVC	La Plata
EVO	Upper Marlboro
EVT	Leonardtown
EVW	Prince Frederick
EWB	Annapolis
EWH	Hoopersville
EWM	Eastern
EWQ	Cambridge
EWW	Crisfield
EWY	Denton
EXA	Princess Anne
EXL	Salisbury
EXR	Snow Hill
EXV	Ocean City
	DELAWARE
EYA	Middletown
EYH	Harrington
EYM	Laurel
EYW	Dover
EZE	Wilmington
EZO	Georgetown
	DISTRICT OF COLUMBIA
ERU	Washington, D.C.

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OCD REGION THREE

TENNESSEE

Designator	*City*
FAB	Tiptonville
FAH	Dyersburg
FAL	Union City
FAO	Alamo
FAR	Trenton
FAW	Dresden
FBA	Huntingdon
FBE	Paris
FBI	Camden
FBM	Dover
FBP	Waverly
FBR	Erin
FBV	Clarksville
FBZ	Charlotte
FCE	Centerville
FCH	Ashland City
FCK	Springfield
FCN	Franklin
FCR	Nashville
FCY	Gallatin
FDE	Murfreesboro
FDH	Lebanon
FDL	Hartsville
FDN	Lafayette
FDR	Woodbury
FDV	Carthage
FDY	Smithville
FEC	Gainesboro
FEG	Celina
FEJ	Cookeville
FEN	Sparta
FEQ	Spencer
FET	Livingston
FEX	Byrdstown
FFA	Jamestown
FFD	Crossville
FFH	Wartburg
FFN	Huntsville
FFQ	Kingston
FFS	Loudon
FFY	Jacksboro
FGA	Clinton
FGF	Knoxville
FGM	Maryville
FGP	Maynardville
FGT	Tazewell
FGW	Rutledge
FGZ	Dandridge
FHC	Sevierville
FHH	Morristown
FHK	Sneedville
FHO	Newport
FHS	Rogersville
FHU	Greeneville
FHY	Jonesboro
FIB	Erwin
FIF	Blountville
FIH	Elizabethton
FIK	Mountain City
FIO	Memphis
FIX	Covington
FJA	Ripley
FJE	Somerville
FJG	Brownsville
FJJ	Bolivar
FJM	Jackson
FJQ	Henderson
FJT	Selmer
FJX	Lexington
FKC	Savannah
FKF	Decaturville
FKJ	Linden
FKL	Waynesboro
FKP	Hohenwald
FKS	Lawrenceburg
FKV	Columbia
FKY	Pulaski
FLB	Lewisburg
FLE	Shelbyville
FLH	Fayetteville
FLK	Lynchburg
FLO	Manchester
FLR	Winchester
FLU	McMinnville
FLX	Altamont
FMA	Jasper
FME	Dunlap
FMH	Pikeville
FMK	Chattanooga
FMQ	Dayton
FMT	Cleveland
FMV	Decatur
FNA	Athens
FNE	Benton
FNM	Madisonville

NORTH CAROLINA

Designator	*City*
FOA	Burnsville
FOC	Bakersville
FOF	Newland
FOI	Boone
FOL	Jefferson
FOO	Lenoir
FOR	Sparta
FOU	Wilkesboro
FOX	Taylorsville
FPB	Dobson
FPE	Yadkinville
FPH	Mocksville
FPL	Danbury
FPO	Winston-Salem
FPT	Wentworth
FPX	Greensboro
FQB	Graham
FQD	Yanceyville
FQG	Hillsboro
FQJ	Roxboro
FQM	Durham
FQP	Oxford
FQS	Henderson
FQV	Louisburg
FQY	Warrenton
FRA	Nashville
FRC	Rocky Mount
FRE	Halifax
FRH	Tarboro
FRK	Jackson
FRN	Williamston
FRS	Windsor
FRQ	Winton
FRU	Gatesville
FRX	Plymouth
FRZ	Edenton
FSC	Hertford
FSE	Elizabeth City
FSH	Camden
FSK	Columbia
FSM	Currituck
FSO	Manteo
FSR	Murphy
FSU	Robbinsville
FSY	Hayesville
FTB	Bryson
FTD	Franklin
FTG	Sylva
FTI	Waynesville
FTL	Marshall
FTO	Brevard
FTQ	Asheville
FTV	Hendersonville
FTY	Columbus

Designator	*City*
FUB	Marion
FUD	Rutherfordton
FUF	Morganton
FUI	Shelby
FUN	Newton
FUP	Lincolnton
FUS	Gastonia
FUV	Statesville
FUY	Charlotte
FVD	Concord
FVG	Salisbury
FVI	Lexington
FVL	Albermarle
FVN	Troy
FVQ	Asheboro
FVU	Carthage
FVX	Pittsboro
FVY	Sanford
FWA	Lillington
FWD	Raleigh
FWI	Smithfield
FWL	Goldsboro
FWO	Wilson
FWR	Snow Hill
FWU	Kingston
FWW	Greenville
FXB	Washington
FXE	New Bern
FXH	Bayboro
FXJ	Swanquarter
FXP	Monroe
FXR	Wadesboro
FXU	Rockingham
FXX	Laurinburg
FYA	Raeford
FYF	Lumberton
FYI	Fayetteville
FYM	Whiteville
FYP	Elizabethtown
FYT	Clinton
FYX	Southport
FZA	Kenansville
FZD	Burgaw
FZH	Wilmington
FZL	Jacksonville
FZQ	Trenton
FZU	Beaufort

MISSISSIPPI

Designator	*City*
GAB	Tunica
GAD	Hernando
GAG	Senatobia
GAJ	Batesville
GAM	Oxford
GAQ	Holly Springs
GAU	Ashland
GAX	New Albany
GBB	Ripley
GBF	Corinth
GBJ	Booneville
GBN	Iuka
GBS	Cleveland
GBW	Clarksdale
GBY	Marks
GCA	Charleston
GCE	Greneda
GCH	Water Valley
GCK	Coffeeville
GCO	Pittsboro
GCR	Walthall
GCS	Pontotoc
GCU	Houston
GCX	Tupelo
GDA	West Point
GDD	Aberdeen
GDG	Fulton
GDL	Greenville
GDQ	Indianola
GDU	Belzoni
GDZ	Greenwood
GEE	Lexington
GEK	Carrollton
GEO	Winona
GET	Kosciusko
GEX	Ackerman
GFC	Louisville
GFH	Starkville
GFP	Macon
GFT	Columbus
GGA	Mayersville
GGD	Rolling Fork
GGI	Vicksburg
GGN	Yazoo City
GGS	Raymond
GGV	Jackson
GHD	Canton
GHK	Brandon
GHO	Carthage
GHS	Forest
GHW	Philadelphia
GIB	Decatur
GIF	DeKalb
GIL	Meridian
GIS	Natchez
GIW	Fayette
GJA	Port Gibson
GJF	Meadville
GJK	Hazlehurst
GJP	Brookhaven
GJT	Monticello
GJX	Mendenhall
GKC	Prentiss
GKH	Raleigh
GKN	Collins
GKS	Bay Springs
GKW	Laurel
GLA	Quitman
GLG	Waynesboro
GLL	Woodville
GLS	Liberty
GLZ	Magnolia
GMC	Tylertown
GMF	Columbia
GMJ	Poplarville
GMM	Purvis
GMP	Bay St. Louis
GMT	Hattiesburg
GNA	Gulfport
GND	Wiggins
GNH	New Augusta
GNP	Leakesville
GNS	Lucedale
GNW	Pascagoula

ALABAMA

Designator	*City*
GOA	Tuscumbia
GOD	Russellville
GOH	Florence
GOM	Moulton
GOP	Decatur
GOT	Athens
GOX	Huntsville
GPB	Guntersville
GPG	Scottsboro
GPK	Fort Payne
GPR	Vernon
GPU	Hamilton
GPY	Fayette
GQG	Double Springs
GQL	Jasper
GQP	Cullman
GQT	Oneonta
GQX	Gadsden
GRB	Anniston
GRG	Center
GRL	Heflin
GRQ	Carrollton
GRV	Tuscaloosa
GSA	Centerville
GSF	Birmingham
GSM	Columbiana
GSU	Pell City
GSY	Rockford
GTD	Talladega
GTJ	Ashland
GTO	Dadeville
GTR	Wedowee

OCD REGION THREE—Continued

ALABAMA—Con.

Designator	*City*
GTV	Lafayette
GUB	Livingston
GUF	Eutaw
GUK	Linden
GUP	Greensboro
GUT	Marion
GUX	Selma
GVD	Hayneville
GVH	Platville
GVM	Montgomery
GVW	Wetumpka
GWA	Tuskegee
GWI	Opelika
GWL	Seale
GWQ	Butler
GWU	Chatom
GWY	Grove Hill
GXC	Monroeville
GXG	Camden
GXL	Greenville
GXP	Luverne
GXS	Troy
GXV	Union Springs
GXY	Ozark
GYC	Clayton
GYH	Abbeville
GYL	Mobile
GYT	Bay Minette
GYX	Brewton
GZB	Evergreen
GZH	Analusia
GZM	Elba
GZQ	Geneva
GZT	Dotham

SOUTH CAROLINA

Designator	*City*
HAA	Walhalla
HAG	Pickens
HAM	Anderson
HAR	Greenville
HAY	Laurens
HBD	Spartanburg
HBK	Gaffney
HBQ	Union
HBV	Newberry
HCB	York
HCG	Chester
HCL	Winnsboro
HCP	Lancaster
HCU	Camden
HDD	Chesterfield
HDG	Darlington
HDK	Bennettsville
HDN	Dillon
HDS	Abbeville
HDV	McCormick
HDY	Greenwood
HEC	Edgefield
HEF	Saluda
HEJ	Aiken
HEN	Lexington
HEQ	Columbia
HEV	Orangeburg
HFA	St. Matthews
HFJ	Sumter
HFN	Bishopville
HFR	Manning
HFU	Kingstree
HFZ	Florence
HGF	Marion
HGK	Georgetown
HGO	Conway
HGW	Barnwell
HGZ	Allendale
HHC	Hampton
HHG	Bamberg
HHL	Ridgeland
HHP	Walterboro
HHU	Beaufort
HHY	St. George
HIF	Moncks Corner
HIN	Charleston
HIU	McClellanville

FLORIDA

Designator	*City*
HJA	Pensacola
HJH	Milton
HJL	Crestview
HJP	DeFuniak Springs
HJU	Bonifay
HJY	Panama City
HKE	Chipley
HKJ	Marianna
HKN	Wewahitchka
HKQ	Blountstown
HKT	Bristol
HKW	Quincy
HLB	Crawfordville
HLF	Tallahassee
HLN	Monticello
HLQ	Perry
HLT	Madison
HLX	Mayo
HMC	Live Oak
HMF	Jasper
HMJ	Lake City
HMQ	Lake Butler
HMU	Macclenny
HMY	Starke
HND	Jacksonville
HNK	Green Cove Springs
HNP	Fernandina
HNT	St. Augustine
HOA	Apalachicola
HOF	Cross City
HOJ	Trenton
HON	Bronson
HOU	Gainesville
HOZ	Ocala
HPJ	Palatka
HPN	Bunnell
HPT	DeLand
HQI	Brooksville
HQN	Inverness
HQR	Dade City
HQW	Bushnell
HRA	Tavares
HRF	Orlando
HRM	Kissimmee
HRR	Sanford
HRV	Titusville
HSD	Clearwater
HSK	Bradenton
HSP	Tampa
HTD	Bartow
HTH	Wauchula
HTM	Sebring
HTV	Vero Beach
HUA	Fort Pierce
HUF	Sarasota
HUQ	Punta Gorda
HUU	Arcadia
HUZ	Fort Myers
HVF	LaBelle
HVK	Moore Haven
HVO	Okeechobee
HVT	Stuart
HVX	W. Palm Beach
HWG	Everglades
HWU	Fort Lauderdale
HXA	Miami
HXN	Key West

CANAL ZONE

Designator	*City*
HYA	Cristobal
HYH	Escobal
HYS	Empire
HYZ	Panama

GEORGIA

Designator	*City*
IAA	Trenton
IAD	Lafayette
IAH	Summerville
IAN	Ringgold
IAQ	Rome
IAX	Dalton
IBA	Calhoun

Designator	*City*
IBD	Chatsworth
IBI	Ellijay
IBP	Jasper
IBL	Canton
IBS	Blue Ridge
IBV	Dawsonville
IBY	Cumming
ICB	Dahlonega
ICE	Blairsville
ICH	Gainsville
ICL	Cleveland
ICO	Haiwassee
ICR	Clarksville
ICU	Homer
ICY	Clayton
IDD	Toccoa
IDG	Carnesville
IDJ	Hartwell
IDO	Cedartown
IDR	Buchanan
IDV	Carrollton
IDZ	Dallas
IEC	Cartersville
IEG	Newnan
IEK	Douglasville
IEN	Marietta
IER	Fayetteville
IEU	Roswell
IEX	Atlanta
IFF	Jonesboro
IFI	Decatur
IFL	McDonough
IFO	Conyers
IFR	Lawrenceville
IFV	Covington
IFZ	Winder
IGC	Monroe
IGF	Jefferson
IGH	Madison
IGK	Watkinsville
IGN	Athens
IGR	Danielsville
IGV	Greensboro
IGZ	Lexington
IHC	Elberton
IHG	Crawfordville
IHJ	Washington
IHN	Warrenton
IHQ	Lincolnton
IHT	Thomson
IHW	Appling
IIA	Augusta
IIK	Franklin
IIO	Lagrange
IIT	Hamilton
IIY	Greenville
IJG	Talbotton
IJN	Zebulon
IJS	Thomaston
IJX	Griffin
IKC	Barnesville
IKJ	Knoxville
IKN	Jackson
IKR	Forsyth
IKV	Monticello
ILD	Macon
ILJ	Gray
ILN	Eatonton
ILR	Jeffersonville
ILU	Milledgeville
ILY	Irwinton
IMC	Sparta
IMH	Sandersville
IMK	Wrightsville
IMO	Gibson
IMS	Louisville
IMW	Swainsboro
INA	Waynesboro
INF	Millen
INK	Sylvania
INO	Georgetown
INS	Columbus
INZ	Cusseta
IOC	Lumpkin
IOG	Preston
IOJ	Buena Vista
IOM	Ellaville
IOP	Butler
IOS	Americus
IOV	Oglethorpe
IOZ	Ft. Valley
IPC	Perry
IPF	Vienna
IPI	Cordele
IPP	Hawkinsville
IPT	Cochran
IPX	Abbeville
IQA	Eastman
IQD	Dublin
IQI	McRae
IQM	Alamo
IQQ	Saperton
IQU	Mt. Vernon
IQY	Hazelhurst
IRC	Lyons
IRG	Reidsville
IRO	Claxton
IRR	Statesboro
IRK	Hinesville
ISA	Clyde
ISD	Springfield
ISH	Savannah
ISN	Fort Gaines
ISQ	Blakely
ISU	Cuthbert
ISY	Morgan
ITA	Dawson
ITE	Newton
ITH	Leesburg
ITK	Albany
ITQ	Camilla
ITV	Sylvester
ITY	Ashburn
IUD	Tifton
IUH	Fitzgerald
IUL	Ocilla
IUO	Nashville
IUS	Douglas
IUX	Pearson
IVC	Alma
IVH	Baxley
IVM	Waycross
IVR	Blackshear
IVW	Nahunta
IWB	Jesup
IWG	Ludowici
IWP	Brunswick
IWV	Darien
IXA	Donalsonville
IXG	Colquitt
IXN	Bainbridge
IXT	Cairo
IXZ	Thomasville
IYF	Moultrie
IYM	Quitman
IYR	Adel
IYV	Valdosta
IZD	Lakeland
IZI	Statenville
IZN	Homerville
IZS	Folkston
IZY	Woodbine

OCD REGION FOUR

MINNESOTA

(Ontario—See Region 6 North Dakota.)

Designator	*City*
JAB	Hallock
JAF	Warren
JAM	Roseau
JAQ	Baudette
JAU	Big Falls
JAX	International Falls
JBB	Crookston
JBF	Red Lake Falls
JBJ	Thief River Falls
JBN	Bagley
JBS	Kelliher
JBZ	Virginia
JCC	Ely
JCH	Isabella
JCN	Grand Marais
JCS	Moorehead
JCW	Ada
JDC	Mahnomen
JDH	Detroit Lakes
JDN	Park Rapids
JDR	Bemidji
JDY	Walker
JEC	Grand Rapids
JEH	Duluth
JEQ	Two Harbors
JEU	Breckenridge
JFA	Fergus Falls
JFF	Wadena
JFJ	Brainerd
JFN	Atkin
JFS	Moose Lake
JFW	Wheaton
JGA	Elbow Lake
JGE	Morris
JGI	Alexandria
JGM	Glenwood
JGR	Long Prairie
JGV	Little Falls
JGY	St. Cloud
JHD	Foley
JHH	Milaca
JHL	Mora
JHQ	Cambridge
JHU	Pine City
JIC	Ortonville
JIH	Madison
JIM	Granite Falls
JIQ	Montevideo
JIV	Benson
JJA	Willmar
JJG	Olivia
JJJ	Litchfield
JJN	Glencoe
JJQ	Buffalo
JJZ	Chaska
JKG	Elk River
JKJ	Shakopee
JKN	Anoka
JKR	Minneapolis
JKY	St. Paul
JLK	Stillwater
JLO	Hastings
JLT	Ivanhoe
JLY	Marshall
JMC	Redwood Falls
JMH	New Ulm
JMM	Gaylord
JMR	St. Peter
JMV	Mankato
JNA	LeCenter
JNF	Faribault
JNJ	Red Wing
JNN	Wabasha
JNR	Pipestone
JNV	Luverne
JOA	Slayton
JOE	Worthington
JOI	Windom
JOL	Jackson
JOO	St. James
JOS	Fairmont
JOW	Blue Earth
JPA	Waseca
JPE	Albert Lee
JPQ	Mantorville
JPL	Austin
JPS	Rochester
JPY	Preston
JQG	Winona
JQM	Caledonia

WISCONSIN

Designator	*City*
JRA	Superior
JRD	Dairyland
JRF	Hayward
JRJ	Washburn
JRL	Ashland
JRN	Hurley
JRT	Grantsburg
JRW	Balsam Lake
JRZ	Shell Lake
JSB	Barron
JSG	Ladysmith
JSM	Phillips
JSP	Rhinelander
JST	Eagle River
JSV	Crandon
JSZ	Florence
JTB	Hudson
JTD	Ellsworth
JTG	Menomonie
JTI	Durand
JTL	Eau Claire
JTP	Chippewa Falls
JTS	Neillsville
JTV	Medford
JTY	Merrill
JUB	Wausau
JUE	Stevens Point
JUH	Antigo
JUL	Shawano
JUO	Green Bay
JUS	Oconto
JUV	Marinette
JUY	Kewaunee
JVB	Sturgeon Bay
JVE	Alma
JVJ	Whitehall
JVL	LaCrosse
JVP	Black River Falls
JVS	Sparta
JVX	Mauston
JVZ	Wisconsin Rapids
JWB	Friendship
JWE	Wautoma
JWG	Montello
JWI	Waupaca
JWK	Green Lake
JWN	Oshkosh
JWQ	Appleton
JWS	Fond du Lac
JWV	Chilton
JWX	Manitowoc
JXA	Sheboygan
JXE	Viroqua
JXG	Richland Center
JXK	Baraboo
JXN	Portage

Designator	*City*
JXQ	Juneau
JXW	West Bend
JXZ	Port Washington
JYC	Prairie du Chien
JYE	Lancaster
JYJ	Dodgeville
JYM	Darlington
JYQ	Monroe
JYT	Madison
JZA	Janesville
JZF	Jefferson
JZI	Elkhorn
JZL	Waukesha
JZO	Milwaukee
JZV	Racine
JZX	Kenosha

MICHIGAN
(Ontario)

KAA	Beardmore
KAD	Longlac
KAG	Hearst
KAJ	Kapuskasing
KAM	Timmins
KAS	Haileybury
KAV	Port Arthur
KAY	Nipigon
KBB	Terrace Bay
KBG	Jamestown
KBJ	Chapleau
KBO	Sault Ste. Marie
KBR	Blind River
KBU	Espanola
KCA	North Bay
KCG	Burk's Falls
KCM	Whitney
KCP	Bancroft
KCS	Pembroke
KCV	Renfrew
KCY	Ottawa
KDB	Hawkesbury
KDE	Wiarton
KDK	Arthur
KDN	Collingwood
KDQ	Toronto
KDT	Lindsay
KDW	Port Hope
KDZ	Havelock
KEC	Belleville
KEF	Kingston
KEI	Smiths Falls
KEL	Cornwall
KES	Chatham
KFE	Kitchener
KFH	Simcoe
KFK	Hamilton
KFN	Niagara Falls

MICHIGAN

Designator	*City*
KGB	Bessemer
KGF	Ontonagon
KGI	Houghton
KGN	Sidnaw
KGR	Eagle River
KGV	L'Anse
KGZ	Marquette
KHI	Sault Ste. Marie
KHR	Crystal Falls
KHU	Iron Mountain
KHZ	Northland
KIC	Menominee
KIG	Escanaba
KIM	Munising
KIP	Manistique
KIT	Newberry
KIW	St. Ignace
KIZ	Drummond
KJM	Charlevoix
KJW	Petoskey
KKB	Cheboygan
KKH	Rogers City
KKN	Beulah
KKT	Leland
KKZ	Traverse City
KLE	Bellaire
KLO	Kalkaska
KLT	Gaylord
KLZ	Grayling
KME	Atlanta
KMI	Mio
KMM	Alpena
KMQ	Harrisville
KMT	Manistee
KMZ	Ludington
KNF	Baldwin
KNL	Reed City
KNR	Cadillac
KNX	Lake City
KOD	Harrison
KOJ	Roscommon
KOP	Gladwin
KOV	West Branch
KPB	Standish
KPH	Tawas City
KPN	Hart
KPT	Muskegon
KPZ	White Cloud
KQF	Big Rapids
KQL	Stanton
KQR	Mount Pleasant
KQX	Ithaca
KRD	Midland
KRI	Bay City
KRN	Saginaw

Designator	*City*
KRT	Caro
KRZ	Bad Axe
KSF	Sandusky
KSL	Grand Haven
KSR	Allegan
KSX	Grand Rapids
KTD	Hastings
KTJ	Ionia
KTP	Charlotte
KTV	St. Johns
KUB	Lansing
KUE	Mason
KUH	Corunna
KUN	Howell
KUT	Flint
KUZ	Lapeer
KVF	Pontiac
KVL	Mt. Clemens
KVR	Port Huron
KVX	St. Joseph
KWD	Cassopolis
KWJ	Paw Paw
KWP	Kalamazoo
KWV	Centerville
KXB	Battle Creek
KXE	Marshall
KXH	Coldwater
KXN	Hillsdale
KXT	Jackson
KXZ	Adrian
KYF	Ann Arbor
KYL	Monroe
KYR	Detroit

ILLINOIS

LAA	Galena
LAD	Morrison
LAF	Mt. Carroll
LAK	Freeport
LAN	Dixon
LAP	Oregon
LAS	Rockford
LAW	Belvidere
LBB	Sycamore
LBD	Woodstock
LBG	Yorkville
LBJ	Geneva
LBM	Wheaton
LBP	Waukegan
LBV	Chicago
LCF	Oquawka
LCH	Aledo
LCK	Rock Island
LCM	Monmouth
LCQ	Galesburg
LCT	Cambridge

OCD REGION FOUR—Continued

ILLINOIS—Con.

Designator	City
LCW	Toulon
LCZ	Princeton
LDC	Lacon
LDG	Ottawa
LDJ	Pontiac
LDM	Morris
LDP	Joliet
LDS	Kankakee
LDV	Watseka
LEA	Carthage
LEF	Macomb
LEI	Rushville
LEL	Lewistown
LEN	Havana
LEQ	Peoria
LEV	Pekin
LEY	Lincoln
LFB	Eureka
LFD	Bloomington
LFG	Clinton
LFL	Urbana
LFP	Paxton
LFS	Danville
LFW	Quincy
LFZ	Mt. Sterling
LGB	Pittsfield
LGE	Winchester
LGH	Virginia
LGK	Jacksonville
LGN	Petersburg
LGQ	Springfield
LGW	Taylorville
LGY	Decatur
LHB	Shelbyville
LHE	Monticello
LHH	Sullivan
LHK	Tuscola
LHN	Charleston
LHR	Paris
LHW	Hardin
LHZ	Carrollton
LIE	Jerseyville
LIH	Carlinville
LIL	Edwardsville
LIO	Hillsboro
LIS	Greenville
LIW	Vandalia
LJA	Effingham
LJE	Louisville
LJI	Toledo
LJM	Newton
LJP	Olney
LJS	Marshall
LJV	Robinson
LJZ	Lawrenceville
LKE	Waterloo
LKH	Belleville

Designator	City
LKO	Carlyle
LKS	Nashville
LKV	Pinckneyville
LKZ	Salem
LLD	Mt. Vernon
LLH	Benton
LLL	McLeansboro
LLP	Fairfield
LLT	Carmi
LLX	Albion
LMB	Mt. Carmel
LMG	Chester
LMJ	Murphysboro
LMN	Jonesboro
LMT	Mounds City
LMW	Cairo
LND	Marion
LNH	Vienna
LNL	Metropolis
LNO	Harrisburg
LNT	Golconda
LNW	Elizabethtown
LNY	Shawneetown

INDIANA

Designator	City
LOA	Gary
LOC	Valparaiso
LOF	LaPorte
LOH	Knox
LOJ	Winamac
LOL	South Bend
LOP	Plymouth
LOS	Rochester
LOW	Goshen
LOZ	Warsaw
LPC	Columbia City
LPF	Lagrange
LPI	Albion
LPL	Fort Wayne
LPQ	Angola
LPT	Auburn
LPX	Kentland
LQA	Fowler
LQD	Williamsport
LQG	Rensselaer
LQI	Lafayette
LQM	Monticello
LQQ	Frankfort
LQT	Logansport
LQW	Kokomo
LQY	Peru
LRB	Tipton
LRE	Wabash
LHR	Marion
LRL	Huntington
LRO	Hartford
LRR	Bluffton
LRU	Decatur
LRY	Portland
LSB	Covington
LSE	Newport
LSH	Rockville
LSL	Brazil
LSO	Crawfordsville
LSS	Greencastle
LSW	Danville
LSZ	Lebanon
LTC	Indianapolis
LTI	Noblesville
LTL	Franklin
LTO	Greenfield
LTQ	Shelbyville
LTT	Anderson
LTW	Rushville
LUA	Muncie
LUE	Newcastle
LUG	Connersville
LUJ	Winchester
LUM	Liberty
LUP	Richmond
LUS	Terre Haute
LUV	Sullivan
LUZ	Bloomfield
LVD	Spencer
LVH	Bloomington
LVL	Bedford
LVQ	Martinsville
LVU	Nashville
LVX	Brownstown
LWB	Columbus
LWH	Scottsburg
LWL	Vernon
LWP	Greensburg
LWS	Madison
LWW	Versailles
LWZ	Brookville
LXD	Vevay
LXI	Lawrenceburg
LXL	Rising Sun
LXP	Mt. Vernon
LXS	Vincennes
LXW	Princeton
LYA	Evansville
LYG	Petersburg
LYK	Boonville
LYN	Washington
LYR	Rockport
LYU	Jasper
LYY	Shoals
LZB	Cannelton
LZE	Paoli
LZH	English
LZL	Salem
LZP	Corydon
LZT	New Albany
LZX	Jeffersonville

OCD REGION FIVE

Designator	City
	NEW MEXICO
MAA	Shiprock
MAB	Newcomb
MAC	Aztec
MAD	Chaco Canyon
MAE	Dulce
MAF	Haynes
MAG	Gallina
MAH	Abiquiu
MAI	Tierra Amarillo
MAK	Costilla
MAM	Taos
MAO	Dawson
MAP	Springer
MAR	Raton
MAS	Valley
MAT	Des Moines
MAV	Gladstone
MAX	Clapham
MAY	Clayton
MBA	Tohatchi
MBC	Gallup
MBD	Crownpoint
MBE	La Ventana
MBN	Cubero
MBT	Albuquerque
MBZ	Bernalillo
MCA	Los Alamos
MCC	Santa Fe
MCE	Lamy
MCI	Mora
MCK	Las Vegas
MCM	Anton Chico
MCO	Wagon Mound
MCQ	Santa Rosa
MCU	Mosquero
MCY	Tucumcari
MCX	Nara Visa
MDA	Fence Lake
MDC	Reserve
MDE	Grants
MDG	Quemado
MDM	Socorro
MDP	Los Lunas
MDR	Field
MDS	Bernardo
MDU	Estancia
MDX	Encino
MDZ	Carrizozo
MED	Corona
MEG	Fort Sumner
MEH	Ragland
MEJ	Mesa
MEL	Portales
MEP	Clovis
MER	Elida
MFA	Truth or Consequences
MFF	Alamogordo
MFG	Fort Stanton
MFH	Elk
MFN	Roswell
MFP	Artesia
MFT	Lovington
MFW	Milnesand
MGA	Lordsburg
MGB	Hachita
MGC	Silver City
MGF	Deming
MGH	Hillsboro
MGK	Las Cruces
MGO	Orogrande
MGS	Carlsbad
MGY	Jal
	OKLAHOMA
MHA	Boise City
MHE	Guymon
MHH	Beaver
MHN	Buffalo
MHQ	Woodward
MHT	Alva
MHW	Fairview
MHZ	Cherokee
MIE	Enid
MIJ	Medford
MIN	Perry
MIS	Newkirk
MIV	Pawnee
MIZ	Pawhuska
MJD	Bartlesville
MJG	Nowata
MJJ	Claremore
MJM	Pryor
MJP	Vinita
MJS	Miami
MJW	Jay
MKA	Arnett
MKD	Cheyenne
MKI	Taloga
MKL	Arapaho
MKR	Watonga
MKV	Kingfisher
MKZ	El Reno
MLC	Guthrie
MLG	Oklahoma City
MLO	Stillwater
MLR	Chandler
MLV	Okemah
MLY	Sapulpa
MMA	Tulsa
MMG	Okmulgee
MMJ	Wagoner
MML	Muskogee
MMO	Tahlequah
MMS	Sallisaw
MMV	Stilwell
MNA	Hollis
MNC	Sayre
MNG	Mangum
MNJ	Hobart
MNM	Cordell
MNQ	Anadarka
MNT	Chickasha
MNW	Norman
MOA	Purcell
MOD	Pauls Valley
MOH	Shawnee
MOL	Ada
MOO	Wewoka
MOQ	Holdenville
MOU	McAlister
MOY	Eufaula
MPB	Wilburton
MPD	Stigler
MPI	Poteau
MPK	Altus
MPN	Frederick
MPP	Walters
MPR	Lawton
MPY	Duncan
MQB	Waurika
MQF	Ardmore
MQI	Marietta
MQL	Sulphur
MQO	Madhill
MQQ	Tishomingo
MQT	Durant
MQY	Coalgate
MRC	Atoka
MRG	Antlers
MRK	Hugo
MRO	Nashoba

Designator	City
OKLAHOMA—Con.	
MRS	Idabel
MRW	Hochatown
TEXAS	
MSA	Dalhart
MSD	Channing
MSG	Stratford
MSJ	Dumas
MSM	Spearman
MSP	Stinnett
MSS	Perryton
MSU	Miami
MSX	Lipscomb
MTA	Canadian
MTG	Vega
MTJ	Hereford
MTO	Canyon
MTR	Amarillo
MTX	Panhandle
MTZ	Claude
MUE	Pampa
MUH	Clarendon
MUK	Wheeler
MUN	Wellington
MUQ	Farwell
MUU	Muleshoe
MUY	Dimmitt
MVB	Littlefield
MVF	Tulia
MVI	Plainview
MVL	Silverton
MVO	Floydada
MVR	Matador
MVU	Memphis
MVX	Peducah
MWD	Quanah
MWG	Crowell
MWJ	Vernon
MWM	Wichita Falls
MWR	Henrietta
MWU	Morton
MWX	Plains
MXA	Levelland
MXD	Brownfield
MXG	Lubbock
MXL	Tahoka
MXO	Crosbyton
MXQ	Post
MXU	Dickens
MXW	Clairemont
MXZ	Guthrie
MYC	Aspermont
MYF	Benjamin
MYH	Haskell
MYK	Seymour
MYN	Throckmorton

Designator	City
MYQ	Archer City
MYT	Graham
MYW	Jacksboro
MZD	Montague
MZF	Decatur
MZI	Gainesville
MZL	Denton
MZO	Sherman
MZR	McKinney
MZV	Bonham
MZY	Commerce
NAB	Cooper
NAE	Paris
NAH	Sulphur Springs
NAK	Mt. Vernon
NAM	Clarksville
NAP	Mt. Pleasant
NAS	Pittsburg
NAV	Daingerfield
NAX	Boston
NAZ	Linden
NBE	Seminole
NBH	Andrews
NBK	Lamesa
NBM	Stanton
NBP	Gail
NBR	Big Spring
NBU	Snyder
NBX	Colorado City
NCA	Roby
NCC	Sweetwater
NCF	Anson
NCI	Abilene
NCN	Albany
NCP	Baird
NCS	Breckenridge
NCV	Eastland
NCZ	Palo Pinto
NDD	Stephenville
NDG	Weatherford
NDI	Granbury
NDK	Glen Rose
NDM	Cleburne
NDP	Ft. Worth
NDZ	Dallas
NEE	Waxahachie
NEI	Rockwall
NEL	Corsicana
NEO	Kaufman
NES	Canton
NEU	Emory
NEW	Athens
NFB	Quitman
NFD	Tyler
NFG	Gilmer
NFJ	Henderson

Designator	City
NFM	Longview
NFP	Jefferson
NFR	Marshall
NFT	Carthage
NFX	El Paso
NGI	Mentone
NGK	Pecos
NGP	Kermit
NGR	Monahans
NGU	Odessa
NGW	Crane
NGZ	Midland
NHD	Rankin
NHG	Garden City
NHI	Big Lake
NHL	Sterling City
NHN	Mertzon
NHQ	Robert Lee
NHT	San Angelo
NHX	Ballinger
NHZ	Paint Rock
NIB	Coleman
NIE	Brady
NIH	Brownwood
NIK	San Saba
NIM	Comanche
NIP	Goldthwaite
NIS	Hamilton
NIU	Lampasas
NIX	Gatesville
NJB	Meridian
NJE	Temple
NJI	Hillsboro
NJM	Waco
NJS	Marlin
NJV	Groesbeck
NJX	Franklin
NKA	Fairfield
NKD	Centerville
NKG	Palestine
NKJ	Crockett
NKM	Rusk
NKP	Groveton
NKS	Lufkin
NKV	Nacogdoches
NKY	Center
NLB	San Augustine
NLF	Hemphill
NLG	Sierra Blanca
NLI	Van Horn
NLL	Marfa
NLO	Fort Davis
NLQ	Alpine
NLU	Ft. Stockton
NLX	Ozona
NOA	Eldorado

Designator	*City*
NOD	Sonora
NOF	Menard
NOI	Junction
NOL	Mason
NOO	Fredericksburg
NOR	Llano
NOT	Johnson City
NOV	Burnet
NPA	Austin
NPG	Georgetown
NPI	Cameron
NPL	Caldwell
NPO	Bryan
NPR	Anderson
NPT	Madisonville
NPW	Huntsville
NPZ	Conroe
NQC	Coldspring
NQG	Livingston
NQJ	Woodville
NQM	Kountze
NQP	Beaumont
NQS	Jasper
NQU	Newton
NQW	Orange
NRA	Sanderson
NRD	Del Rio
NRI	Brackettville
NRK	Rocksprings
NRM	Leakey
NRO	Uvalde
NRR	Kerrville
NRU	Hondo
NRX	Bandera
NRZ	Boerne
NSB	San Antonio
NSK	New Braunfels
NSN	Floresville
NSQ	San Marcos
NST	Seguin
NSW	Lockhart
NTA	Gonzales
NTD	Bastrop
NTG	Guero
NTJ	LaGrange
NTL	Hallettsville
NTN	Brenham
NTQ	Columbus
NTS	Bellville
NTV	Hempstead
NTY	Wharton
NUB	Bay City
NUG	Richmond
NUI	Houston
NUP	Angleton
NUR	Liberty
NUU	Galveston
NUZ	Anahuac
NVA	Port Arthur
NVB	Eagle Pass
NVD	Carrizo Springs
NVF	Crystal City
NVI	Cotulla
NVL	Pearsall
NVO	Jourdanton
NVQ	Tilden
NVS	George West
NVV	Karnes City
NVZ	Beeville
NWC	Goliad
NWF	Refugio
NWI	Victoria
NWL	Edna
NWN	Port Lavaca
NWS	Loredo
NWX	Hebbronville
NXD	San Diego
NXF	Alice
NXI	Kingsville
NXK	Sinton
NXN	Corpus Christi
NXW	Rockport
NXX	Zapata
NYC	Rio Grande City
NYH	Falfurrias
NYL	Edinburg
NYO	Sarita
NYR	Raymondville
NYX	Brownsville

MEXICO

Designator	*City*
NZA	Ciudad Juarez
NZB	Candelaria
NZC	Guadalupe
NZD	Banderas
NZE	El Cuervo
NZF	Coyame
NZG	Ojinaga
NZH	Trincheras
NZI	Alamo
NZJ	Boquillas
NZK	LaPalma
NZL	San Graciano
NZM	Villa Acuna
NZN	Piedras Negras
NZO	Allende
NZP	Sabinas
NZQ	Lampazos
NZR	Nuevo Laredo
NZS	LaGloria
NZT	Ciudad Guerrero
NZU	Cerralvo
NZV	C. Camargo
NZW	China
NZX	Reynosa
NZY	Matamoros

ARKANSAS

Designator	*City*
OAA	Bentonville
OAE	Fayetteville
OAI	Eureka Springs
OAL	Huntsville
OAP	Berryville
OAT	Jasper
OAY	Harrison
OBD	Yellville
OBH	Marshall
OBM	Mountain Home
OBP	Mountain View
OBV	Melborne
OCA	Salem
OCE	Batesville
OCG	Evening Shade
OCJ	Hardy
OCL	Powhatan
OCN	Pocahontas
OCQ	Walnut Ridge
OCT	Jonesboro
OCW	Corning
ODA	Paragould
ODD	Piggott
ODG	Osceola
ODI	Blytheville
ODK	Ft. Smith
ODO	Van Buren
ODQ	Greenwood
ODS	Charleston
ODU	Booneville
ODW	Ozark
ODZ	Paris
OEC	Clarksville
OEF	Danville
OEI	Russellville
OEL	Perryville
OEO	Morrilton
OER	Clinton
OET	Conway
OEW	Heber Springs
OEZ	Searcy
OFC	Des Arc
OFF	Newport
OFI	Augusta
OFL	Cotton Plant
OFN	Harrisburg
OFP	Wynne
OFR	Forrest City
OFU	Marion
OFX	Mena

Designator	City
	ARKANSAS—Con.
OGD	Waldron
OGI	Mount Ida
OGN	Hot Springs
OGR	Malvern
OGV	Benton
OHA	Sheridan
OHE	Little Rock
OHN	Pine Bluff
OHQ	Lonoke
OHT	Stuttgart
OHV	Clarendon
OHZ	DeWitt
OIE	Marianna
OIG	Helena
OIJ	DeQueen
OIN	Ashdown
OIR	Nashville
OIV	Murfreesboro
OIY	Hope
OJD	Prescott
OJI	Arkadelphia
OJN	Camden
OJS	Fordyce
OJW	Rison
OKB	Warren
OKH	Star City
OKM	Monticello
OKV	Arkansas City
OLA	Texarkana
OLF	Lewisville
OLJ	Magnolia
OLQ	El Dorado
OLV	Hampton
OMB	Hamburg
OMK	Lake Village
	LOUISIANA
ONA	Shreveport
ONI	Benton
ONL	Minden
ONP	Homer
ONS	Arcadia
ONV	Ruston
ONY	Farmerville
OOD	Monroe
OOI	Bastrop
OON	Rayville
OOS	Oak Grove
OOW	Lake Providence
OPA	Tallulah
OPE	Mansfield
OPK	Many
OPP	Coushatta
OPU	Natchitoches
OPY	Jonesboro
OQC	Winnfield
OQH	Columbia
OQL	Jena
OQP	Harrisonburg
OQT	Winnsboro
OQY	Vidalia
ORC	St. Joseph
ORH	DeRidder
ORM	Leesville
ORR	Colfax
ORZ	Alexandria
OSF	Marksville
OSK	St. Francisville
OSO	Clinton
OSR	Greensbury
OSW	Franklinton
OTA	Lake Charles
OTJ	Oberlin
OTN	Jennings
OTV	Crowley
OUA	Ville Platte
OUG	Opelousas
OUL	Lafayette
OUR	St. Martinville
OUW	New Roads
OVB	Plaquemine
OVH	Baton Rouge
OVO	Donaldsonville
OVT	Convent
OVX	Springville
OWA	Amite
OWD	Edgard
OWI	Covington
OWQ	New Orleans
OXA	Cameron
OXM	Abbeville
OXT	New Iberia
OYA	Franklin
OYN	Napoleonville
OYR	Thibodaux
OYY	Houma
OZG	Hahnville
OZO	Gretna
OZV	St. Bernard
OZZ	Pte. a la Hache

OCD REGION SIX

NORTH DAKOTA

(Saskatchewan)
(Manitoba)
(Ontario)

Designator	City
PAA	Weyburn
PAC	Estevan
PAE	Moosomin
PAF	Virden
PAG	Melita
PAJ	Killarney
PAK	Portage La Praire
PAM	Winkler
PAN	Winnipeg
PAO	Badger
PAP	Rennie
PAQ	Kenora
PAV	Fort Frances
PAX	Atikokan

NORTH DAKOTA

Designator	City
PBA	Crosby
PBG	Epping
PBO	Stanley
PBT	Bowbells
PBZ	Mohall
PCE	Minot
PCP	Bottineau
PCV	Towner
PCZ	Rugby
PDN	Cando
PDS	Edmore
PDW	Langdon
PEA	Cavalier
PEF	Grafton
PEM	Williston
PER	Watford City
PFH	Parshall
PFL	Garrison
PFO	Stanton
PFR	Bergen
PFU	McClusky
PGA	Fessenden
PGG	Minnewaukan
PGN	New Rockford
PGR	Carrington
PGV	Devils Lake
PHB	Lakota
PHG	Cooperstown
PHJ	Finley
PH[illegible]	Grand Forks
PHU	Hillsboro
PIA	Beach
PIG	Mendora
PIL	Dickinson
PIQ	Manning
PIU	Hebron
PJE	Center
PJI	Washburn
PJH	Mandan
PJR	Bismarck
PJV	Steele
PKA	Jamestown
PKE	Valley City
PKK	Fargo
PKQ	Bowman
PKU	Amidon
PKY	Hettinger
PLB	Mott
PLF	Carson
PLK	Ft. Yates
PLP	Linton
PLU	Napoleon
PLZ	Ashley
PME	Ellendale
PMJ	La Moure
PMP	Lisbon
PMS	Forman
PMX	Wahpeton

SOUTH DAKOTA

Designator	City
PND	Buffalo
PNJ	Bison
PNS	McIntosh
PNW	Timber Lake
POB	Mound City
POG	Selby
POM	Ipswitch
POQ	Leola
POV	Aberdeen
PPA	Britton
PPH	Webster
PPQ	Sisseton
PPX	Milbank
PQD	Belle Fourche
PQL	Deadwood
PQQ	Sturgis
PQU	Haydraw
PQY	Dupree
PRE	Cherry Creek
PRI	Fort Pierre
PRL	Pierre
PRP	Onida
PRU	Gettysburg
PSA	Highmore
PSG	Faulkton
PSL	Miller
PSP	Redfield
PSV	Huron
PTC	Clark
PTH	DeSmet
PTL	Hayti
PTP	Watertown
PTU	Brookings
PTY	Clear Lake
PUD	Custer
PUQ	Rapid City
PVC	Philip
PVH	Wanblee
PVL	Kadoka
PVP	Murdo
PVU	White Rivef
PWA	Kennebec
PWE	Chamberlain
PWI	Gannvalle
PWL	Wessington Sprs.
PWQ	Plankinton
PWV	Woonsocket
PXA	Mitchell
PXE	Alexandria
PXH	Howard
PXL	Salem
PXO	Madison
PXS	Sioux Falls
PXY	Flandreau
PYC	Hot Springs
PYG	Manderson
PYK	Martin
PYO	St. Francis
PYT	Winner
PYX	Burke
PZA	Lake Andes
PZD	Armour
PZH	Tyndall
PZK	Olivet
PZN	Yankton
PZQ	Parker
PZT	Vermillion
PZW	Canton
PZY	Elk Point

Designator	*City*
	WYOMING
QAA	Yellowstone Park
QAK	Cody
QAZ	Basin
QBF	Sheridan
QBN	Buffalo
QBU	Gillette
QCA	Rockypoint
QCK	Hulett
QCP	Sundance
QCY	Jackson
QDE	Du Noir
QDN	Sunshine
QDS	Thermopolis
QDX	Worland
QEI	Kaycee
QEO	Turnercrest
QET	Lawver
QEY	Newcastle
QFF	Afton
QFK	Bondurant
QFP	Pinedale
QFV	Lenore
QGA	Lander
QGH	Shoshoni
QGM	Arminto
QGQ	Midwest
QGV	Casper
QHA	Verse
QHG	Douglas
QHM	Lusk
QHS	Cokeville
QIC	Eden
QIH	Bairoil
QIM	Leo
QIR	Freeland
QIW	Wheatland
QJH	Torrington
QJN	Evanston
QJS	Kemmerer
QJY	McKinnon
QKD	Green River
QKN	Superior
QKR	Wamsutter
QKW	Dixon
QLA	Rawlins
QLE	Saratoga
QLN	Rock River
QLS	Laramie
QLW	Cheyenne
	COLORADO
QMA	Greystone
QME	Craig
QMJ	Steamboat Springs
QMO	Walden
QMY	Fort Collins
QND	Greeley
QNI	Ft. Morgan
QNM	Sterling
QNX	Julesburg
QOC	Holyoke
QOH	Atchee
QOL	Rangely
QOP	Meeker
QOV	Glenwood Springs
QPA	Eagle
QPI	Hot Sulphur Sprgs.
QPM	Breckenridge
QPP	Georgetown
QPS	Central City
QPY	Boulder
QQD	Golden
QQN	Denver
QQW	Littleton
QRA	Brighton
QRG	Castle Rock
QRK	Kiowa
QRS	Akron
QRX	Wray
QSB	Burlington
QSS	Grand Junction
QTC	Delta
QTM	Gunnison
QTT	Aspen
QUA	Leadville
QUF	Salida
QUJ	Fairplay
QUN	Cripple Creek
QUR	Colorado Springs
QUZ	Hugo
QVC	Eads
QVF	Cheyenne Wells
QVO	Montrose
QUV	Telluride
QVX	Ouray
QVZ	Silverton
QWC	Lake City
QWF	Creede
QWK	Saguache
QWO	Westcliff
QWS	Canon City
QWZ	Pueblo
QXF	Ordway
QXM	La Junta
QXR	Las Animas
QXW	Lamar
QYA	Cortez
QYH	Durango
QYM	Pagosa Springs
QYQ	Del Norte
QYW	Conejos
QZA	Alamosa
QZE	San Luis
QZK	Walsenburg
QZP	Trinidad
QZU	Springfield
	NEBRASKA
RAA	Harrison
RAH	Chadron
RAL	Alliance
RAO	Rushville
RAR	Valentine
RAV	Ainsworth
RAY	Springview
RBB	Bassett
RBD	Butte
RBF	O'Neill
RBI	Neligh
RBL	Center
RBQ	Pierce
RBT	Hartington
RBW	Wayne
RBZ	Ponca
RCC	Pender
RCG	Dakota City
RCI	Gering
RCQ	Harrisburg
RCT	Kimball
RCY	Bridgeport
RDB	Sidney
RDF	Chappell
RDI	Oshkosh
RDO	Hyannis
RDR	Arthur
RDU	Ogallala
RDY	Mullen
REB	Tryon
REF	North Platte
REL	Thedford
REN	Stapleton
RER	Brewster
REU	Broken Bow
REY	Taylor
RFA	Burwell
RFE	Loup City
RFH	Ord
RFK	Bartlett
RFM	Greeley
RFO	St. Paul
RFS	Albion
RFW	Fullerton
RFZ	Central City
RGC	Osceola

Designator	*City*
RGG	Madison
RGK	Columbus
RGN	Stanton
RGQ	David City
RGT	Schuyler
RGX	West Point
RHA	Wahoo
RHD	Fremont
RHJ	Tekamah
RHM	Blair
RHP	Papillion
RHT	Omaha
RIC	Grant
RIF	Imperial
RIJ	Benkelman
RIM	Hayes Center
RIP	Trenton
RIS	McCook
RIX	Stockville
RJB	Elwood
RJE	Beaver City
RJH	Lexington
RJK	Holdrege
RJN	Alma
RJR	Kearney
RJU	Minden
RJX	Franklin
RJZ	Red Cloud
RKC	Grand Island
RKG	Hastings
RKM	Aurora
RKP	Clay Center
RKS	Nelson
RKW	York
RLA	Geneva
RLD	Hebron
RLG	Fairbury
RLJ	Seward
RLL	Wilber
RLO	Lincoln
RLU	Beatrice
RMC	Tecumseh
RMF	Pawnee City
RML	Plattsmouth
RMO	Nebraska City
RMR	Auburn
RMU	Falls City

KANSAS

Designator	*City*
RNA	St. Francis
RNE	Goodland
RNI	Atwood
RNL	Colby
RNP	Oberlin
RNS	Hoxie
RN[illegible]	Norton
RNY	Hill City
ROB	Phillipsburg
ROE	Stockton
ROK	Smith Center
RON	Osborne
ROR	Mankato
ROU	Beloit
RPB	Belleville
RPE	Concordia
RPI	Minneapolis
RPL	Clay Center
RPO	Washington
RPR	Marysville
RPU	Manhattan
RPX	Westmoreland
RQA	Seneca
RQD	Holton
RQG	Hiawatha
RQM	Oskaloosa
RQP	Atchison
RQR	Troy
RQU	Leavenworth
RQX	Kansas City
RRC	Sharon Springs
RRE	Tribune
RRH	Leoti
RRK	Russell Springs
RRO	Scott City
RRS	Gove
RRV	Dighton
RRY	Wakeeney
RSA	Ness City
RSF	Hays
RSH	La Crosse
RSL	Russell
RSO	Ellsworth
RSQ	Lincoln
RST	Salina
RSY	Abilene
RTA	Junction City
RTE	Council Grove
RTH	Alma
RTM	Topeka
RTR	Lyndon
RTU	Lawrence
RTX	Ottawa
RUA	Olathe
RUD	Paola
RUG	Syracuse
RUJ	Lakin
RUL	Garden City
RUO	Cimarron
RUR	Dodge City
RUV	Jetmore
RUY	Kinsley
RVC	Larned
RVF	Great Bend
RVI	St. John
RVN	Lyons
RVQ	Hutchinson
RVT	McPherson
RVW	Newton
RVZ	Marion
RWC	El Dorado
RWE	Cottonwood Falls
RWG	Eureka
RWI	Emporia
RWL	Burlington
RWO	Yates Center
RWT	Iola
RWW	Garnett
RWZ	Mound City
RXB	Fort Scott
RXE	Johnson
RXH	Richfield
RXJ	Ulysses
RXM	Hugoton
RXP	Sublette
RXS	Liberal
RXV	Meade
RXY	Ashland
RYB	Greensburg
RYD	Coldwater
RYG	Pratt
RYJ	Medicine Lodge
RYM	Kingman
RYP	Anthony
RYT	Wichita
RYZ	Wellington
RZC	Winfield
RZG	Howard
RZI	Sedan
RZL	Fredonia
RZN	Independence
RZP	Erie
RZT	Oswego
RZV	Girard
RZZ	Columbus

IOWA

Designator	*City*
SAA	Rock Rapids
SAD	Orange City
SAH	Sibley
SAK	Primghar
SAN	Spencer
SAQ	Spirit Lake
SAS	Estherville
SAV	Emmetsburg
SAY	Algona
SBE	Forest City
SBG	Garner
SBJ	Northwood

IOWA—Con.

Designator	City
SBN	Mason City
SBR	Osage
SBU	Charles City
SBX	New Hampton
SCA	Cresco
SCD	Decorah
SCG	West Union
SCJ	Waukon
SCO	Sioux City
SCV	Le Mars
SCY	Cherokee
SDB	Ida Grove
SDE	Storm Lake
SDH	Sac City
SDK	Pocahontas
SDN	Rockwell City
SDS	Dakota City
SDU	Fort Dodge
SDZ	Webster City
SEB	Clarion
SEE	Hampton
SEH	Eldora
SEK	Allison
SEN	Grundy Center
SEQ	Waverly
SET	Waterloo
SEY	Independence
SFB	Elkader
SFD	Manchester
SFI	Dubuque
SFO	Onawa
SFT	Logan
SFX	Denison
SGB	Harlan
SGE	Carroll
SGH	Audubon
SGL	Guthrie Center
SGO	Jefferson
SGS	Adel
SGW	Boone
SHC	Des Moines
SHI	Nevada
SHL	Newton
SHO	Marshalltown
SHS	Toledo
SHW	Montezuma
SIA	Vinton
SIE	Marengo
SIH	Cedar Rapids
SIM	Iowa City
SIP	Anamosa
SIS	Tipton
SIV	Maquoketa
SIY	Davenport
SJB	Clinton
SJE	Council Bluffs
SJH	Glenwood
SJJ	Red Oak
SJM	Atlantic
SJP	Corning
SJR	Greenfield
SJU	Creston
SJX	Winterset
SKA	Osceola
SKE	Indianola
SKI	Chariton
SKL	Knoxville
SKO	Albia
SKR	Oskaloosa
SKU	Ottumwa
SKZ	Sigourney
SLD	Fairfield
SLG	Washington
SLK	Mt. Pleasant
SLN	Wapello
SLQ	Muscatine
SLV	Sidney
SMB	Clarinda
SME	Bedford
SMI	Mount Ayr
SMP	Leon
SMS	Corydon
SMW	Centerville
SNA	Bloomfield
SNF	Keosauqua
SNK	Ft. Madison
SNP	Burlington

MISSOURI

Designator	City
SOA	Rockport
SOE	Oregon
SOH	Maryville
SOK	Savannah
SOM	Grant City
SOP	Albany
SOS	Maysville
SOV	Bethany
SOY	Gallatin
SPB	Princeton
SPD	Trenton
SPG	Chillicothe
SPI	Linneus
SPL	Milan
SPN	Unionville
SPP	Lancaster
SPS	Kirksville
SPV	Memphis
SPY	Edina
SQA	Shelbyville
SQD	Kahoka
SQG	Monticello
SQI	Palmyra
SQL	St. Joseph
SQQ	Platte City
SQZ	Plattsburg
SRB	Liberty
SRD	Independence
SRF	Kingston
SRI	Richmond
SRN	Carrollton
SRS	Marshall
SRU	Keytesville
SRW	Boonville
SRZ	Fayette
SSB	Huntsville
SSD	Macon
SSG	Columbia
SSK	Paris
SSM	Mexico
SSO	Montgomery City
SSR	New London
SSU	Bowling Green
SSX	Troy
STC	Harrisonville
STF	Butler
STI	Clinton
STK	Warrensburg
STN	Sedalia
STQ	Warsaw
STS	Versailles
STU	California
STW	Tuscumbia
STY	Jefferson City
SUB	Fulton
SUE	Linn
SUH	Hermann
SUJ	Warrenton
SUL	Union
SUN	Hillsboro
SUP	St. Charles
SUS	Clayton
SUU	St. Louis
SVC	Nevada
SVE	Stockton
SVG	Osceola
SVJ	Bolivar
SVL	Hermitage
SVN	Buffalo
SVQ	Camdenton
SVS	Lebanon
SVU	Waynesville
SVX	Vienna
SWB	Rolla
SWF	Salem
SWI	Steelville
SWK	Patosi
SWN	Ironton

OCD REGION SIX—Continued

Designator	*City*
SWQ	Farmington
SWT	Fredericktown
SWV	Ste. Genevieve
SWX	Perryville
SXE	Carthage
SXG	Neosho
SXI	Pineville
SXN	Greenfield
SXP	Mt. Vernon
SXR	Cassville
SXV	Galena
SXY	Springfield
SYD	Ozark
SYF	Forsyth
SYH	Marshfield
SYJ	Ava
SYM	Hartville
SYO	Gainesville
SYQ	Houston
SYS	West Plains
SYU	Eminence
SYW	Alton
SYY	Van Buren
SZB	Centerville
SZE	Doniphan
SZH	Greenville
SZJ	Poplar Bluff
SZL	Marble Hills
SZN	Bloomfield
SZP	Jackson
SZS	Benton
SZU	New Madrid
SZV	Charleston
SZX	Kennett
SZY	Caruthersville

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OCD REGION SEVEN

CALIFORNIA

Designator	City
TAA	Crescent City
TAI	Etna
TAP	Tulelake
TAQ	Weed
TAR	Yreka
TAZ	Alturas
TBD	Eureka
TBO	Weaverville
TBU	Redding
TBZ	Susanville
TCB	Ft. Bragg
TCC	Point Arena
TCD	Ukiah
TCI	Lakeport
TCP	Santa Rosa
TCY	Napa
TDD	Red Bluff
TDJ	Willows
TDR	Oroville
TDW	Quincy
TEA	Colusa
TEG	Yuba City
TEM	Woodland
TEU	Sacramento
TFA	Marysville
TFE	Downieville
TFI	Nevada City
TFK	Auburn
TFT	Placerville
TFX	Jackson
TGH	San Rafael
TGV	San Francisco
THC	Fairfield
THU	Martinez
TID	Stockton
TIH	Modesto
TIQ	San Andreas
TIT	Sonora
TIV	Markleeville
TIY	Bridgeport
TJI	Redwood City
TJY	Santa Cruz
TKF	Hayward
TKI	Oakland
TLL	San Jose
TMF	Merced
TMR	Mariposa
TMZ	Madera
TNH	Salinas
TNJ	Soledad
TNX	Hollister
TOB	Coalings
TOE	Fresno
TPB	Hanford
TPP	Visalia
TPX	Independence
TPY	Bishop
TQD	San Luis Obispo
TQL	Santa Barbara
TQY	Ventura
TRA	Bakersfield
TRI	Tehachapi
TSG	Barstow
TSL	Needles
TSP	San Bernardino
TUE	Glendale
TUN	Long Beach
TUO	Los Angeles
TVC	Santa Monica
TWP	Santa Ana
TXC	Blythe
TXI	Indio
TXL	Riverside
TYE	Escondido
TYJ	San Diego
TZC	Calipatria
TZD	El Centro

MEXICO

Designator	City
TZU	Tijuana
TZV	Ensenada
TZW	Tecate
TZX	Hechicera
TZY	Mexicali
TZZ	Mayor

NEVADA

Designator	City
UAA	Vya
UAE	Summit Lake
UAJ	McDermitt
UAN	Paradise Valley
UAS	Mountain City
UAX	Contact
UBC	Gerlach
UBG	Sulphur
UBK	Winnemucca
UBQ	Midas
UBT	Battle Mountain
UCA	Elko
UCI	Metropolis
UCM	Shafter
UCP	Montello
UCU	Flanigan
UCY	Lovelock
UDG	Watts
UDK	Buckhorn
UDO	Huntington
UDS	Cherry Creek
UDW	Goshute
UEB	Reno
UEL	Carson City
UER	Virginia City
UEV	Fallon
UFA	Dixie Valley
UFE	Austin
UFJ	Eureka
UFN	Ely
UFU	Minden
UFZ	Yerington
UGD	Hawthorne
UGJ	Gabbs
UGP	Round Mountain
UGU	Currant
UGX	Silver Spring
UHC	Baker
UHK	Basalt
UHO	Goldfield
UHS	Tonopah
UIA	Red Bluff Spgs.
UIF	Nyala
UIL	Sand Springs
UIS	Pioche
UIV	Beatty
UJA	Alamo
UJK	Mercury
UJQ	Indian Springs
UJT	Las Vegas
UKM	Overton
UKR	Bunkerville
ULA	Boulder City
ULG	Searchlight

UTAH

Designator	City
UMA	Lucin
UMJ	Rosette
UMP	Snowville
UMU	Promontory
UNB	Tremonton
UNI	Brigham City
UNQ	Ogden
UNZ	Logan

Designator	*City*
UOD	Morgan
UOH	Randolph
UOL	Wendover
UOV	Tooele
UOZ	Farmington
UPC	Salt Lake City
UPO	Pleasant Grove
UPV	Coalville
UPZ	Heber
UQQ	Manila
UQT	Vernal
URA	Gandy
URD	Gold Hill
URJ	Trout Creek
URQ	Vernon
URU	Santaquin
URW	Nephi
USC	Provo
USJ	Soldier Summit
USM	Price
USS	Duchesne
USZ	Leota
UTH	Garrison
UTL	Delta
UTQ	Filmore
UTU	Richfield
UTZ	Monroe
UUC	Salina
UUG	Manti
UUK	Emery
UUN	Castle Dale
UUQ	Green River
UUW	Neslen
UVA	Moab
UVH	Milford
UVL	Lund
UVO	Parowan
UVR	Beaver
UVW	Pangvitch
UWB	Junction
UWK	Loa
UWQ	Grover
UWU	Hanksville
UXC	Monticello
UXN	St. George
UXV	New Harmony
UYE	Springdale
UYM	Alton
UYR	Kanab
UZH	Escalante
UZP	Blanding
UZU	Bluff

ARIZONA

Designator	*City*
VAA	Littlefield
VAK	Mt. Trumbull
VAP	Fredonia
VBA	Marble Canyon
VBI	Ruins
VBO	Kayenta
VBV	Tes Nos Pes
VCD	Mt. Wilson
VCL	Peach Springs
VCS	Fraziers Well
VCZ	Grand Canyon
VCW	Supai
VDH	Tuba City
VDQ	Shongopovi
VDX	Chinle
VED	Ganado
VEN	Kingman
VEY	Seligman
VFE	Camp Wood
VFK	Williams
VFX	Flagstaff
VGJ	Winslow
VGS	Holbrook
VGZ	Houck
VHF	Parker
VHL	Wikieup
VHR	Congress Junction
VHX	Prescott
VIK	Crown King
VIM	Camp Verde
VIV	Young
VJL	Shumway
VJQ	St. Johns
VKC	Quartzsite
VKK	Cibola
VKR	Wenden
VKY	Wickenburg
VLD	Buckeye
VLT	Phoenix
VME	Cavecreek
VNA	Globe
VNJ	Fort Apache
VNS	Nutrioso
VNZ	Blue
VOF	Yuma
VOT	Mohawk
VPA	Gila
VPN	Casa Grande
VQB	Florence
VQL	Oracle
VQS	Bylas
VRA	Safford
VRN	Clifton
VRV	Duncan
VSH	Tule Well
VSP	Ajo
VSZ	Lukeville
VTH	Sells
VUA	Tucson
VVF	Nogales
VVT	Greaterville
VWA	Benson
VWR	Bisbee
VXA	Bowie
VXK	Douglas
VXS	Paradise

MEXICO

Designator	*City*
VYA	San Luis
VYC	El Golfo
VYE	Zumbador
VYG	Puerto Penasco
VYI	Tajitos
VYK	Sasabe
VYO	Nogales
VYQ	Cananea
VYU	Casa Janos
VYW	Casa Grandes
VYY	Ascension
VYZ	Las Palomas

HAWAII

Designator	*City*
WAA	Kii Landing, Niihau
WAM	Haena, Kauai
WAT	Lihue, Kauai
WBC	Haleiwa, Oahu
WBN	Kahuku, Oahu
WBT	Wahiawa, Oahu
WCK	Honolulu, Oahu
WDE	Kualapuu, Molokai
WDY	Lanai City, Lanai
WFA	Keoneoio, Maui
WGG	Hawi, Hawaii
WGM	Holualoa, Hawaii
WHD	Humuula, Hawaii
WHL	Kaalualu, Hawaii
WHR	Hilo, Hawaii

OCD REGION EIGHT

WASHINGTON
(British Columbia)

Designator	City
XAA	Nanaimo
XAB	Ladysmith
XAC	Duncan
XAD	Victoria
XAF	Vancouver
XAG	Langlie Prairie
XAH	Mission City
XAI	Chilliwack
XAJ	Hope
XAK	North Bend
XAL	Princeton
XAM	Hedley
XAN	Penticton
XAO	Osoyoos
XAP	Rock Creek
XAR	Grand Forks
XAS	Edgewood
XAT	Trail
XAU	Nelson
XAV	Salmo

WASHINGTON

Designator	City
XBD	Bellingham
XBH	Mt. Vernon
XBM	Marblemount
XBT	Okanogan
XBX	Oroville
XCA	Republic
XCH	Colville
XCL	Ione
XCT	Port Angeles
XCZ	Port Townsend
XDG	Port Orchard
XDJ	Seattle
XDU	Everett
XEA	Skykomish
XEE	Holden
XEI	Wenatchee
XEP	Waterville
XET	Coulee Dam
XEW	Davenport
XFA	Spokane
XFJ	Newport
XFW	Montesano
XGA	Shelton
XGE	Olympia
XGI	Tacoma
XGN	Eatonville
XGS	Ellensburg
XGX	Ephrata
XHD	Ritzville
XHI	Colfax
XHQ	South Bend
XHU	Cathlamet
XHX	Chehalis
XIE	Kelso
XII	Vancouver
XIN	Randle
XIR	Stevenson
XJB	Goldendale
XJF	Yakima
XJM	Prosser
XJR	Pasco
XJZ	Walla Walla
XKG	Dayton
XKN	Pomeroy
XKW	Asotin

OREGON

Designator	City
XLA	Astoria
XLF	Tillamook
XLM	McMinnville
XLQ	Hillsboro
XLV	St. Helens
XMA	Portland
XMJ	Oregon City
XMN	Hood River
XMU	The Dalles
XND	Maupin
XNI	Moro
XNM	Condon
XNR	Heppner
XNW	Umatilla
XOA	Pendleton
XOL	La Grande
XOR	Troy
XOV	Enterprise
XOZ	Homestead
XPJ	Toledo
XPN	Dallas
XPR	Corvallis
XPX	Albany
XQB	Salem
XQN	Idantra
XQW	Madras
XRE	Prineville
XRK	Fossil
XRN	Mitchell
XRR	Monument
XRV	Canyon City
XSH	Baker
XSS	Reedsport
XTA	Eugene
XTJ	Culp Creek
XTT	Bend
XTZ	Brothers
XUG	Paulina
XUM	Seneca
XUR	Burns
XVA	Juntura
XVH	Vale
XVT	Port Orford
XWF	Coquille
XWL	Glendale
XWP	Roseburg
XWU	Prospect
XXA	Chemult
XXN	Summer Lake
XXT	Princeton
XXZ	Frenchglen
XYE	Arock
XYI	Rockville
XYO	Gold Beach
XYT	Brookings
XZA	Grants Pass
XZE	Medford
XZJ	Fort Klamath
XZM	Klamath Falls
XZR	Malin
XZW	Lakeview
XZZ	Andrews

IDAHO

Designator	City
YAB	Coeur d'Alene
YAG	Sandpoint
YAL	St. Maries
YAR	Bonner's Ferry
YAX	Wallace
YBG	Moscow
YBK	Lewiston
YBT	Nez Perce
YBY	Orofino
YCE	Grangeville
YCL	Riggins
YCQ	Council

Designator	City
YCZ	Cascade
YDF	Challis
YDM	Salmon
YDT	Weiser
YEA	Payette
YEE	Caldwell
YEK	Emmett
YEQ	Boise
YEX	Idaho City
YFC	Stanley
YFH	Chilly
YFM	Arco
YFW	Dubois
YGC	Rigby
YGG	Rexburg
YGL	St. Anthony
YGV	Driggs
YHG	Silver City
YHN	Mountain Home
YHT	Fairfield
YHW	Gooding
YIA	Shoshone
YIE	Hailey
YIK	American Falls
YIP	Pocatello
YIT	Blackfoot
YIW	Idaho Falls
YJD	Three Creek
YJG	Twin Falls
YJK	Jerome
YJO	Burley
YJS	Rupert
YJV	Malad City
YKA	Preston
YKG	Soda Springs
YKM	Paris

MONTANA

(British Columbia)
(Alberta)
(Saskatchewan)

Designator	City
YLA	Creston
YLB	Yank
YLC	Moyle
YLD	Cranbrook
YLF	Elko
YLG	Blairmore
YLH	Pincher Creek
YLJ	Cardston
YLL	Raymond
YLM	Warner
YLN	Foremost
YLO	Medicine Hat
YLQ	Walsh
YLR	Maple Creek
YLS	Shawnavon
YLT	Aneroid
YLU	Assiniboia
YLV	Rockglen
YLW	Minton
YLX	Regina

MONTANA

Designator	City
YMC	Libby
YMK	Cut Bank
YMO	Shelby
YMT	Chester
YMX	Havre
YNC	Chinook
YNL	Malta
YNQ	Baylor
YNV	Scobey
YOB	Plentywood
YOG	Thompson Falls
YOL	Kalispell
YOP	Polson
YOS	Choteau
YOW	Conrad
YOZ	Fort Benton
YPE	Zortman
YPI	Glasgow
YPN	Wolf Point
YPU	Sidney
YQA	Superior
YQJ	Missoula
YQQ	Ovando
YQU	Craig
YQX	Great Falls
YRG	Stanford
YRL	Lewistown
YRP	Winnett
YRS	Jordan
YRW	Circle
YSA	Terry
YSE	Glendive
YSI	Wibaux
YSM	Hamilton
YSQ	Philipsburg
YSX	Deer Lodge
YTB	Boulder
YTF	Helena
YTK	Townsend
YTP	White Sulphur Springs
YTT	Harlowton
YTZ	Ryegate
YUC	Roundup
YUG	Hysham
YUJ	Forsyth
YUN	Miles City
YUR	Baker
YUY	Anaconda
YVC	Butte
YVK	Bozeman
YVP	Livingston
YVV	Bigtimber
YVZ	Columbus
YWE	Billings
YWM	Hardin
YWX	Broadus
YXC	Ekalaka
YXK	Dillon
YXU	Virginia City
YYJ	Red Lodge
YYT	Wyola
YYW	Bay Horse

ALASKA

Designator	City
ZAA	Point Lay
ZAG	Barrow
ZAM	Kaktovik
ZAU	Wales
ZBA	Noatak
ZBL	Candle
ZBQ	Kobuk
ZBW	Allakaket
ZCB	Anaktuvuk Pass
ZCM	Arctic Village
ZCS	Fort Yukon
ZDA	Savoonga
ZDH	Pitkas Point
ZDN	Nome
ZEI	Holikachuk
ZEP	Koyukuk
ZFC	Ophir
ZFQ	Nikolai
ZGK	Curry
ZHH	Fairbanks
ZHX	Tanacross
ZID	Eagle
ZIN	Nash Harbor
ZIT	Kwinhagak (Quinhagak)
ZJB	Bethel
ZJS	Napamute
ZJZ	Dillingham
ZKH	Newhalen
ZLK	Port Graham
ZLT	Anchorage
ZMK	Seward
ZNG	Copper Center
ZNL	Cordova
ZOD	Atka
ZOM	Nikolski

Designator	*City*
	ALASKA—Con.
ZOR	Akutan
ZPE	King Cove
ZPJ	Squaw Harbor
ZPP	Chignik
ZPU	Egegik
ZQH	Kodiak
ZQS	Yakutat
ZQZ	Pelican City
ZRS	Skagway
ZSB	Sitka
ZSL	Juneau
SSW	Angoon
ZTC	Port Alexander
ZTK	Kake
ZTR	Point Baker
ZTW	Edna Bay
ZUE	Petersburg
ZUL	Craig
ZUS	Wrangell
ZVA	Ketchikan
ZVP	Hyder

CHAPTER VI

APPLICATION OF METEOROLOGICAL DATA TO RADEF

This chapter provides guidance to assist State and local governments in the use of meteorological data to:

1. prepare area fallout forecasts and estimates of fallout arrival time for operational use,
2. prepare hypothetical dose rate contours for use in conjunction with tests and exercises, and
3. determine the most probable direction and extent of fallout distribution in areas of interest as a basis for preattack planning.

PREPARING FALLOUT FORECASTS

In the preparation of area fallout forecasts and estimates of fallout arrival time, the following information is needed:

1. fallout area forecast plot constructed from UF message,
2. the approximate ground zero location and time of detonation,
3. the approximate yield of the weapon or the dimensions of the nuclear cloud at time of stabilization.

Determining Ground Zero Location. Ground zero location may be determined in some areas by electronic devices such as atmospheric overpressure or incident thermal radiation detectors. At more distant locations it may be determined by weather or reconnaissance radar. Also, the ground zero location may be approximated by visual observation of the direction of the flash or the stem of the subsequent nuclear (mushroom) cloud. The time interval between the observation of the flash and the detection of the subsequent bang will indicate the approximate distance of the ground zero location from the observer. At temperatures generally encountered, the speed of sound at the earth's surface is about 1 mile in 5 seconds or 12 miles per minute. Thus, if a lapse of 5 minutes occurred between the time the flash was observed and the time the bang was heard, the detonation would be about 60 miles away. Knowing the direction and approximate distance of the detonation from the point of observation, the ground zero location may be determined with sufficient accuracy for preparing an area fallout forecast. Further knowledge of the location of likely targets in the general area will be helpful in deducing ground zero locations.

Determining Weapon Yield or Dimensions of Nuclear Cloud. The nuclear cloud from a surface burst will reach stabilization within 10 minutes after detonation. At this time, when vertical development of the cloud ceases, the dimensions of the nuclear cloud (height and diameter) will vary with the size of the weapon and the atmospheric conditions. Figure 1 indicates the approximate dimensions of nuclear clouds as a function of total weapon yield.

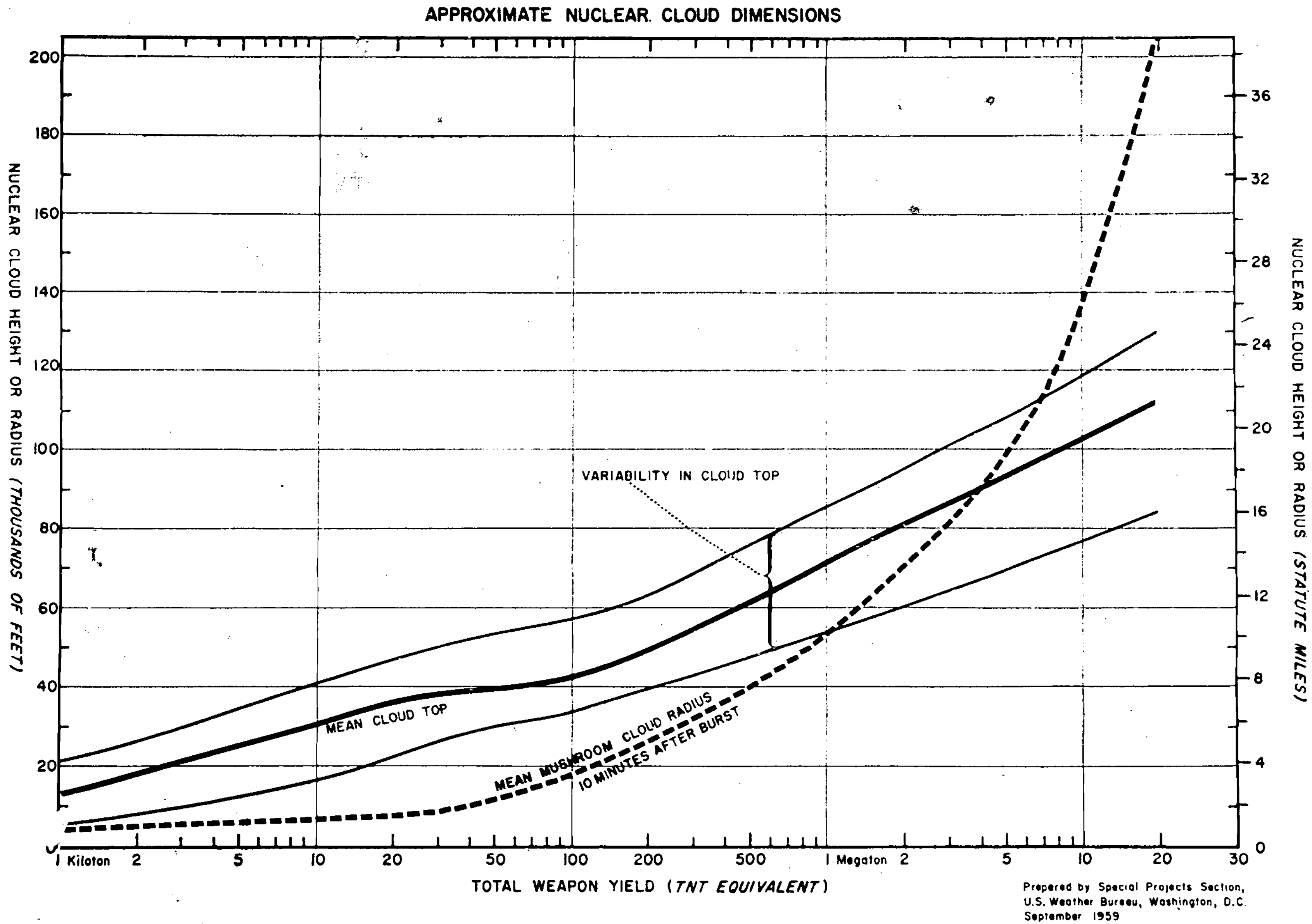

Figure 1.—Approximate nuclear cloud dimensions.

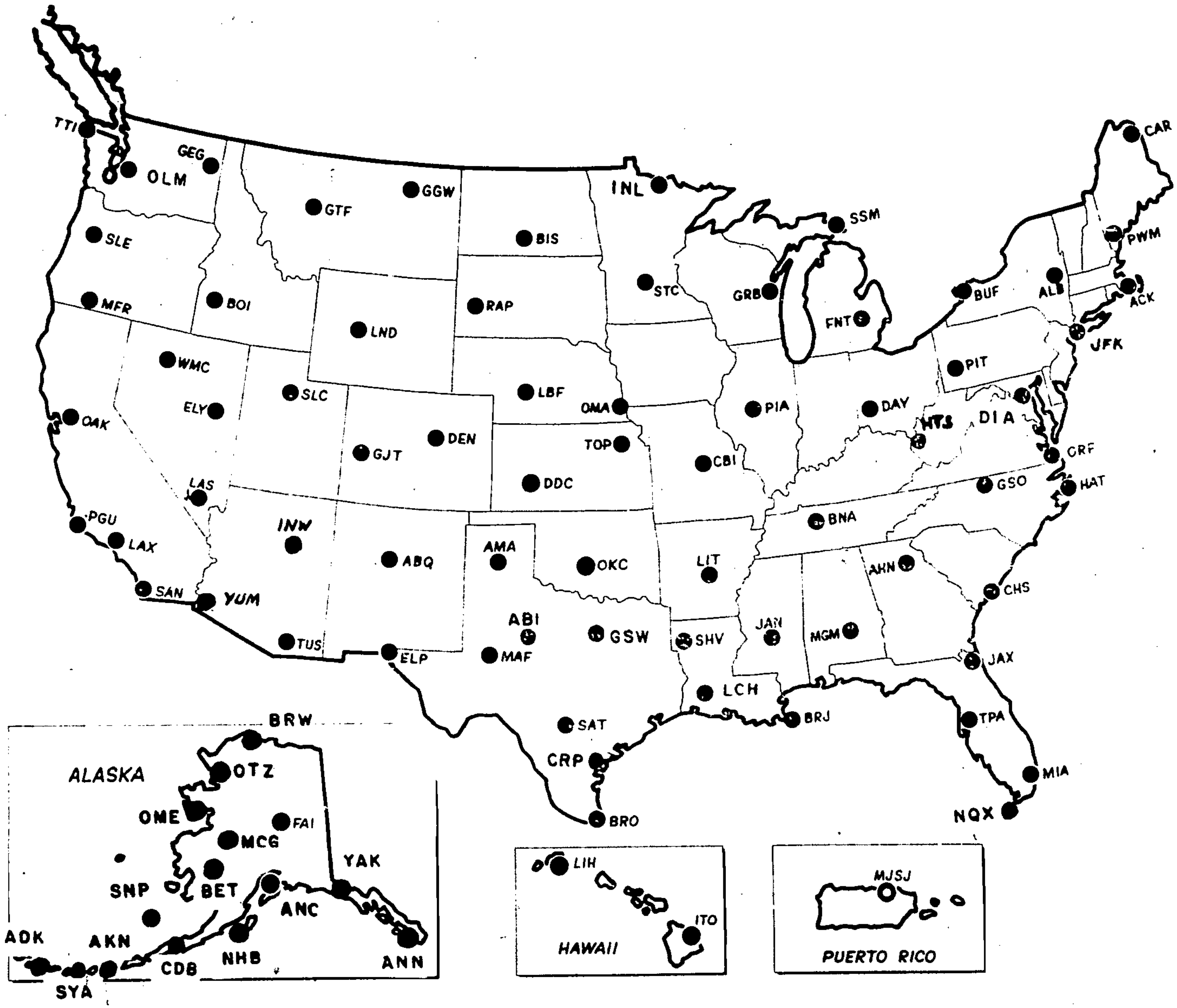

FIGURE 2.—Rawin observatories (UF input data locations).

RAWIN OBSERVATORIES

(UF INPUT DATA LOCATIONS)

Data Transmitted Under FAA Service "C"

Ident. Code	Location
	Circuit 30 Sequence
JFK	New York, N.Y. (John F. Kennedy)
PWM	Portland, Maine
CAR	Caribou, Maine
BUF	Buffalo, N.Y.
ALB	Albany, N.Y.
PIT	Pittsburgh, Pa.
ACK	Nantucket, Mass.
HTS	Huntington, W. Va.
DIA	Washington, D.C. (Dulles)
	Circuit 31 Sequence
NQX	Key West, Fla.
HAT	Hatteras, N.C.
AHN	Athens, Ga.
ORF	Norfolk, Va.
GSO	Greensboro, N.C.
BNA	Nashville, Tenn.
CHS	Charleston, S.C.
JAX	Jacksonville, Fla.
TPA	Tampa, Fla.
JAN	Jackson, Miss.
MGM	Montgomery, Ala.
MIA	Miami, Fla.
BRJ	Burrwood, La.
	Circuit 32 Sequence
CRP	Corpus Christi, Tex.
TOP	Topeka, Kans.
DDC	Dodge City, Kans.
CBI	Columbia, Mo.
DEN	Denver, Colo.
OKC	Oklahoma City, Okla.
PIA	Peoria, Ill.
GSW	Ft. Worth, Tex.
LIT	Little Rock, Ark.
SHV	Shreveport, La.
LCH	Lake Charles, La.
SAT	San Antonio, Tex.
AMA	Amarillo, Tex.
MAF	Midland, Tex.
ABI	Abilene, Tex.
BRO	Brownsville, Tex.
	Circuit 33 Sequence
FNT	Flint, Mich.
DAY	Dayton, Ohio
GRB	Green Bay, Wis.
INL	Internat'l Falls, Minn.
SSM	Sault Ste. Marie, Mich.
RAP	Rapid City, S. Dak.
STC	St. Cloud, Minn.
OMA	Omaha, Nebr.
LBF	North Platte, Nebr.
	Circuit 34 Sequence
OLM	Olympia, Wash.
GEG	Spokane, Wash.
GTF	Great Falls, Mont.
GGW	Glasgow, Mont.
BIS	Bismark, N. Dak.
SLE	Salem, Oreg.
LND	Lander, Wyo.
MFR	Medford, Oreg.
BOI	Boise, Idaho
TTI	Tatoosh Island, Wash.
	Circuit 35 Sequence
YUM	Yuma, Ariz.
LAX	Los Angeles, Calif.
SLC	Salt Lake City, Utah
OAK	Oakland, Calif.
WMC	Winnemucca, Nev.
INW	Winslow, Ariz.
ELY	Ely, Nev.
GJT	Grand Junction, Colo.
PGU	Point Arguello, Calif.
LAS	Las Vegas, Nev.
ABQ	Albuquerque, N. Mex.
SAN	San Diego, Calif.
TUS	Tucson, Ariz.
ELP	El Paso, Tex.

Data Transmitted by Military Communications (Service "O")

Ident. Code	Location
ANC	Anchorage, Alaska
YAK	Yakutat, Alaska
ANN	Annette Island, Alaska
SYA	Shemya, Alaska
ADK	Adak Island, Alaska
CDB	Cold Bay, Alaska
NHB	Kodiak, Alaska
AKN	King Salmon, Alaska
SNP	St. Paul Island, Alaska
BET	Bethel, Alaska
MCG	McGrath, Alaska
FAI	Fairbanks, Alaska
BRW	Barrow, Alaska
OME	Nome, Alaska
OTZ	Kotzebue, Alaska
ITO	Hilo, Hawaii
LIH	Lihue, Kauai, Hawaii
MJSJ [1]	San Juan, Puerto Rico

[1] Will include UF collectives reported over Circuit #31, Service "O".

Current Upper Air Wind Information. Executive Order No. 10999 assigns to the Department of Commerce (Weather Bureau) the responsibility for preparing and issuing currently, as well as in an emergency, forecast and estimates of areas likely to be covered by fallout in event of attack and for making this information available to Federal, State and local authorities.

The United States Weather Bureau maintains a network of RAWIN observatories which measure, by electronic methods, the direction and speed of the wind from the surface to high altitudes above the surface of the earth for use primarily as a basis for routinely analyzing and forecasting the motions of the atmosphere. Periodically, these data are transmitted to a central location at Suitland, Maryland, where they are processed by a computer system into fallout vector data for use in preparation of fallout area forecasts. At 10:41 a.m. and 10:41 p.m. (EST) daily the fallout vector data for each of approximately 70 selected RAWIN locations within the contiguous United States are transmitted over the Federal Aviation Agency Service "C" Teletypewriter Facility to most Weather Bureau offices, Federal Aviation Agency offices and military installations. Fallout vector data for Alaska, Hawaii, and Puerto Rico are transmitted over military communication nets (Service "O"). These special messages are transmitted two times daily under the identifying designator "UF" for the RAWIN observatories indicated on the map in Figure 2. Identification code letters and the corresponding locations are listed on page 4 in order of their reporting sequence.

State and local civil defense offices should arrange for the receipt of UF messages that would pertain to their area of jurisdiction. The nearest Federal Aviation Agency or Weather Bureau office should be contacted to arrange for appropriate relay of UF messages.

UF Message Format. The basic transmission is headed by the designator, UF, and a date time group showing when the upper wind observation was actually taken. A sample heading is:

> UF 301200 indicating that the wind observation was taken on the 30th day of the month at 1200 GMT.

This message heading is followed by a list of the fallout vector reports from each RAWIN station in coded form. Each fallout vector report is prefaced by the assigned three-letter designator that identifies the RAWIN station from which the observation is taken. These designators are shown on the map in Figure 2, and listed in the tabulation following Figure 2. A sample coded message follows:

> PIT 10205 20406 40610 60714 80912

PIT identifies the RAWIN station from which the observation was taken, as Pittsburgh, Pennsylvania. The first group of five numbers 10205, means that fallout particles falling from 10,000 feet above the surface of the earth (indicated by the number 1), will spread in the direction 020 degrees from true north (indicated by the numbers 02). The final two numbers, 05, indicate that these particles will extend a distance of 50 miles in three hours time. Thus, the fallout particles carried only to 10,000 feet in the nuclear cloud or stem would be expected to cause a pattern of radioactive contamination along the surface of the earth extending from the ground zero point toward the north-northeast (020 degrees from true north); and in three hours time this contamination would extend for 50 miles outward from ground zero in this direction of 020 degrees.

The second group of five numbers, 20406, indicates that particles from the 20,000 foot level would be expected to cause a pattern of fallout along the surface of the earth extending from ground zero toward the northeast (040 degrees from true north); and in three hours time, this contamination would extend for 60 miles outward from ground zero in this direction of 040 degrees. The third group, 40610, pertains to fallout particles descending from the 40,000 foot level; the fourth group, 60714, pertains to particles from the 60,000 foot level, and the last group, 80912, pertains to particles from the 80,000 foot level.

Thus, the first number of each group pertains to the elevation of the particles in tens of thousands of feet at time of stabilization of the nuclear cloud. The second two numbers of each group indicate the direction in tens of degrees from the true north of the expected deposit of contamination along the surface of the earth. The last two numbers of each group indicate the extent in tens of miles that the fallout will spread in three hours. If the distance, indicated by the last two numbers of the group, is divided by three, this will indicate the expected speed, in miles per hour, of spread of fallout along the surface of the earth. Any quantity which has both direction and magnitude is called a vector. Therefore, these UF messages are often referred to as fallout vector reports. A plot of the five vectors in a UF message, when adjusted to allow for nuclear cloud radius and when applied to an assumed ground zero (surface burst), delineates the area which would be expected to be affected by fallout from a megaton sized surface detonation during the first three hours after burst.

Plotting the Fallout Vectors. Figure 3 shows the basic steps in plotting fallout vectors. The sample UF message presented above is used as reference.

1. Draw a north-south line on a map of the area, through the assumed or reported ground zero location as in Figure 3. This line must be parallel to the meridian of longitude nearest to the ground zero point. Use the UF message from the RAWIN station nearest to the ground zero location.

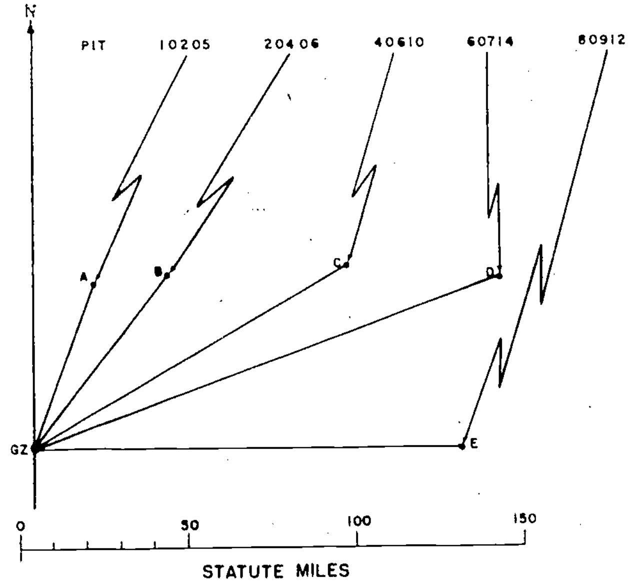

FIGURE 3.—Fallout vector plot for a 3-hour period.

2. Using a protractor, compass card, or template, draw a line from ground zero in the direction and for the distance indicated by the 10,000-foot group in the UF message. In the example, this line is in the direction of 020 degrees (approximately north-northeast) and extends 50 miles from GZ to A in Figure 3. Thus, fallout particles originating at the 10,000-foot level above assumed ground zero, and reaching the earth's surface in 3 hours or less after detonation, are forecast to be distributed along this line. Those particles which require more than a 3-hour fall time will reach the earth's surface in the direction of 020 degrees, but beyond the 3-hour, or 50-mile, distance limit.
3. Similarly, draw a line from ground zero in the direction and for the distance indicated by the 20,000-foot group in the UF message. In the example, this line is in the direction of 040 degrees (approximately northeast) and extends 60 miles from GZ to B. Thus, fallout particles originating at the 20,000-foot level above ground zero, and reaching the earth's surface in 3 hours or less after detonation, are forecast to be distributed along this line. Those particles which require more than a 3-hour fall time will reach the earth's surface in the direction of 040 degrees, but beyond the 3-hour, or 60-mile, distance limit.
4. Draw a line from ground zero in the direction and for the distance indicated by the 40,000-foot group in the UF message. In the example, this line is in the direction of 050 degrees (approximately east-northeast) and extends 100 miles from GZ to C. Thus, fallout particles originating at the 40,000-foot level above assumed ground zero, and reaching the earth's surface in 3 hours or less after detonation, are forecast to be distributed along this line. Those particles which require more than a 3-hour fall time will reach the earth's surface in the direction of 060 degrees, but beyond the 3-hour, or 100-mile, distance limit.
5. Draw a line from ground zero in the direction and for the distance indicated by the 60,000-foot group in the UF message. In the example, this line is in the direction of 070 degrees (approximately east-northeast) and extends 140 miles from GZ to D. Thus, fallout particles originating at the 60,000-foot level above assumed ground zero, and reaching the earth's surface in 3 hours or less after detonation, are forecast to be distributed along this line. Those particles which require more than a 3-hour fall time will reach the earth's surface in the direction of 070 degrees, but beyond the 3-hour, or 140-mile, distance limit.
6. Draw a line from ground zero in the direction and for the distance indicated by the 80,000-foot group in the UF message. In the example, this line is in the direction of 090 degrees (due east) and extends 120 miles from GZ to E. Thus, fallout particles originating at the 80,000-foot level above assumed ground zero, and reaching the earth's surface in 3 hours or less after detonation, are forecast to be distributed along this line. Those particles which require more than a 3-hour fall time will reach the earth's surface in the direction of 090 degrees, but beyond the 3-hour, or 120-mile, distance limit.

7. Connect, with a broken line, points A, B, C, D, and E as in Fig. 4. The enclosed area GZ-A-B-C-D-E-GZ is forecast to be affected by fallout during the first 3 hours after detonation of a nuclear weapon at the assumed ground zero.

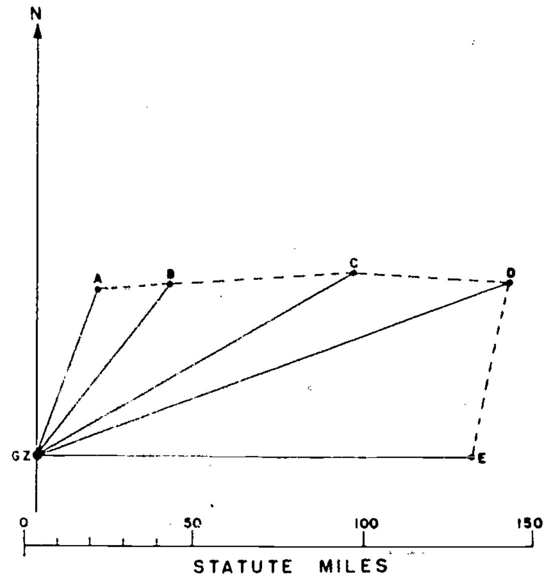

FIGURE 4.—Preliminary fallout area forecast plot for a 3-hour period.

Assumptions Concerning Dimensions of Nuclear Cloud. As indicated in Figure 1, the nuclear cloud of a multimegaton sized weapon will assume rather large dimensions at time of stabilization. The enclosed area in Figure 4 is based upon a line source of contamination extending from the surface of the earth at ground zero, vertically to 80,000 feet above the surface. To account for the geometry of the cloud, the enclosed area of Figure 4 must be modified accordingly. Under generally prevailing wind conditions and with megaton sized weapons it is assumed that:

1. the heavier area of fallout will extend 15 miles or less upwind and crosswind of ground zero,
2. the ten and twenty thousand foot vectors, representing fallout from the stem portion of the mushroom cloud, should be expanded by about 10 miles, and
3. the forty, sixty, and eighty thousand foot vectors, representing fallout from the head portion of the mushroom cloud, should be expanded by about 20 miles.

Modifying the Forecast Area to Account for Assumed Dimensions of the Nuclear Cloud. With reference to Figure 5, the following simplified routine is suggested to account approximately for the dimensional effects:

1. Swing an arc of 15 mile radius around GZ.
2. Swing arcs of 10 mile radius around points A and B.
3. Swing arcs of 20 mile radius around points C, D, and E.
4. Connect the outer periphery of these arcs with a solid line.
5. The area enclosed by the heavy solid line in Figure 5 is the area expected to be affected by fallout during the first three hours with an approximate modification for the nuclear cloud geometry.

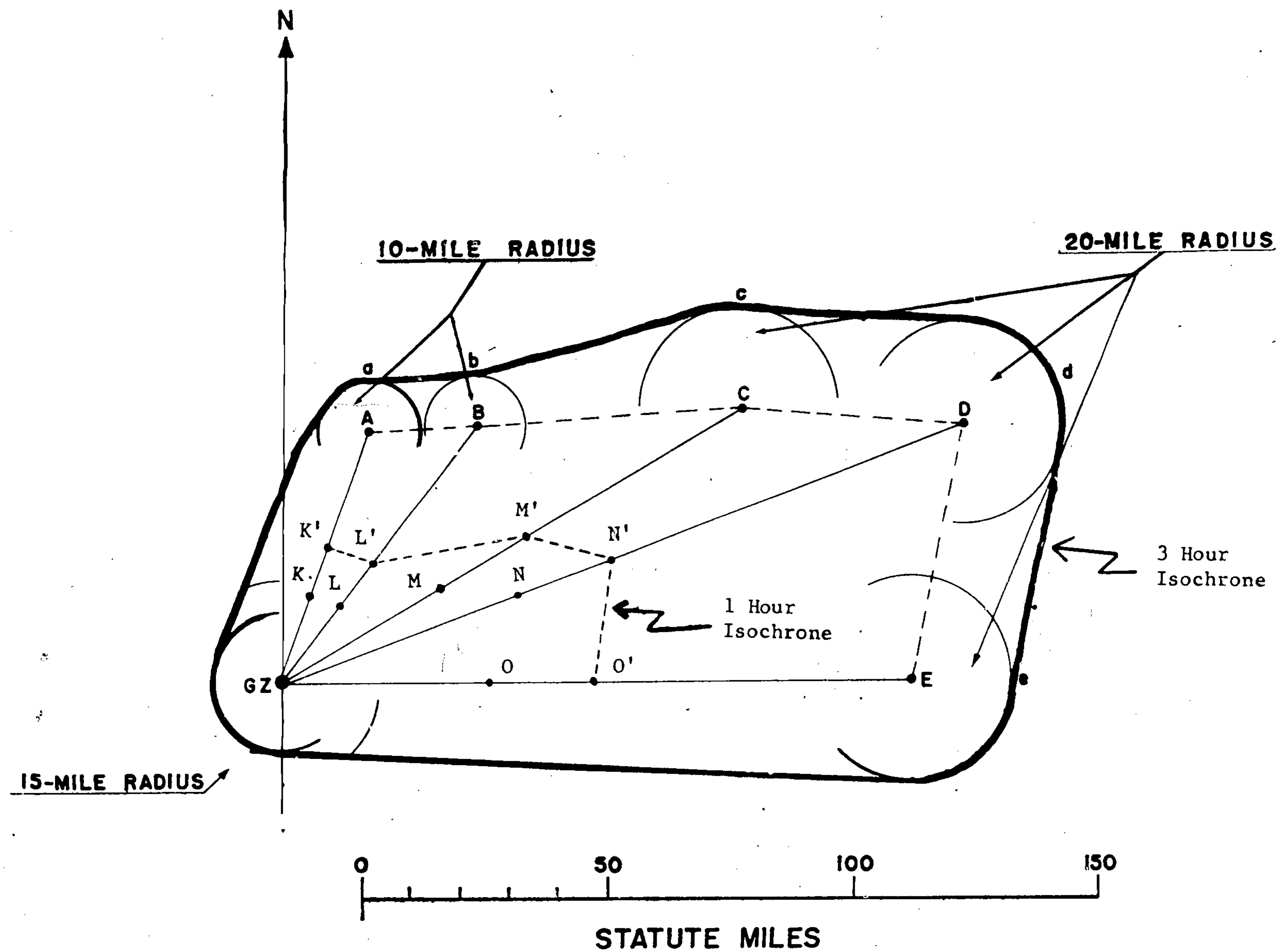

FIGURE 5.—Adjusted fallout area forecast plot for a 3-hour period (adjustments made for nuclear cloud dimensions—megaton range).

Modifying the Forecast Area for Kiloton Sized Weapons. For weapons of 100 kilotons or less, only the first 3 vectors of the UF message should be used. In Figure 5, this would be represented by the area enclosed by the lines GZ-A-B-C-GZ. To approximate the effects of cloud dimensions, an arc of 5 mile radius should be drawn about points A, B, and C and an arc of 2 miles radius about GZ. A line connecting the periphery of the four arcs would enclose the approximate area expected to be affected by fallout from a small to medium kiloton sized weapon. For weapons of 200 to 900 kiloton yield, the first 4 vectors of the UF message should be used. In Figure 5, this would be represented by the area enclosed by the line GZ-A-B-C-D-GZ. To approximate the effects of cloud dimensions, an arc of 10 mile radius should be drawn about points A, B, C, and D, and an arc of 5 mile radius about GZ. A line connecting the periphery of the five arcs would enclose the approximate area expected to be affected by fallout from a large kiloton sized weapon. For megaton sized weapons, all five wind vectors are used as described in the three preceding paragraphs.

Forecasting Arrival Time of Fallout. In Figure 5, the heavy line a, b, c, d, e, represents the predicted location of the leading edge of the spreading fallout 3 hours after detonation. This line, representing the 3-hour arrival time is called the 3-hour isochrone. For the 1-hour isochrone, a point should be plotted on each vector--one-third the distance from GZ to the terminal point of that vector, i.e., one-third the distance of GZ-A, GZ-B, GZ-C, GZ-D, and GZ-E respectively. On Figure 5, these points are represented by K, L, M, N, and O. However, to account for nuclear cloud geometry, K and L must be extended 10 miles further to K' and L' respectively; and M, N, and O must be extended 20 miles further to M', N', and O' respectively. Therefore, the dashed line K'L'-M'N'O' represents the 1-hour arrival line of fallout or the 1-hour isochrone for a megaton sized weapon.

Extending Fallout Forecast Beyond the 3-Hour Isochrone. With surface detonations in the megaton yield range, there is sufficient radioactivity contained in the mushroom head of the nuclear cloud to pose a serious hazard to distances well beyond the 3-hour isochrone. Therefore, when megaton detonations are involved, the forty, sixty, and eighty thousand foot vectors should be extended to the 6-hour isochrone. This is accomplished by doubling the distance of each of the 3 vectors and then adding a twenty mile arc to

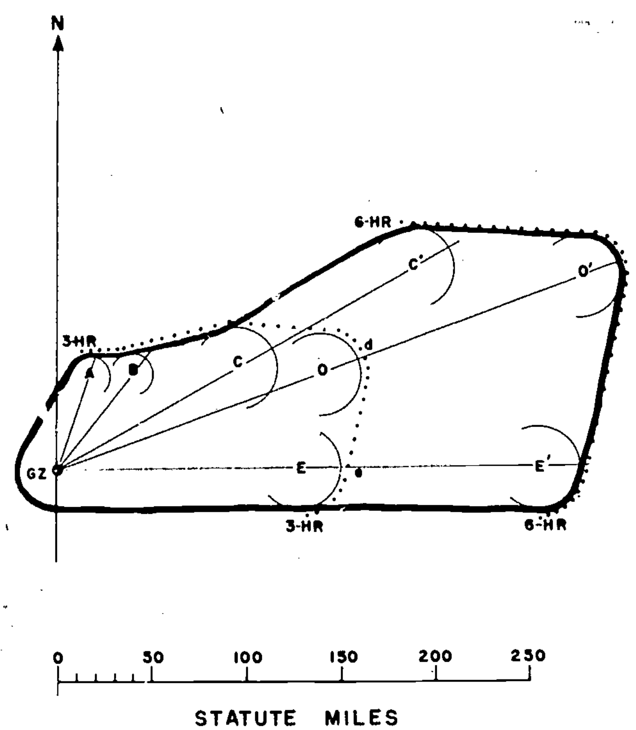

FIGURE 6.—Fallout area forecast plot extended to the 6-hour isochrone (Megaton Range).

each point to account for cloud geometry. Figure 6 illustrates the construction of the 6-hour isochrone. As an example, GZ-C is extended to C' where the distance C-C' equals GZ-C. Similarly, GZ-D is extended to D' and GZ-E to E'. However, less confidence should be placed in area fallout forecast extended beyond the 3-hour isochrone. Where available, a meteorologist should assist in modifying the forecast to account for changes of UF winds, with time and distance from GZ. By using the current 300 millibar analysis and prognosis (or 500 millibar if the 300 is not available), the meteorologist can attempt to correct for expected changes as the fallout proceeds downwind. Downwind curvature of fallout areas might also be estimated by plotting the 60,000-foot UF vectors for all RAWIN stations within a radius of 500 miles and preparing a streamline analysis from these vectors.

Figure 7 is an example of a simplified streamline analysis. The enclosed areas represent the 60,000-foot vectors only with a 20 mile envelope around each vector to account for geometry. The length indicates the distance that the fallout particles at 60,000 feet would spread along the earth's surface in 3 hours. The heavy black line with arrows is a streamline and shows the variation of direction in space, or the spatial variation. An example of the use of the chart is illustrated in the case of Washington, D.C. The individual plot for Washington indicates that fallout from an attack on Washington would spread toward the east across Chesapeake Bay, the Delmarvian Peninsula and into the Atlantic Ocean. However, the streamline shows that because of spatial variation, the fallout from an attack on Washington would initially spread toward the east, but after crossing Chesapeake Bay, it would curve to the northeast across Delaware and New Jersey toward New York City. Where feasible, civil defense offices planning to use fallout forecasts should arrange to have the services of a meteorologist made available in time of emergency.

Operational Application. State and local civil defense offices should arrange for the emergency receipt of all UF messages applicable to their areas. Actually, all State and the larger local CD offices should obtain UF data for locations well beyond the limits of their areas so that streamline analyses, similar to Figure 7, can be prepared. State and local civil defense offices should maintain proficiency in the rapid decoding and plotting of the UF report so that the reports may be efficiently and accurately applied in the event of emergency.

As indicated in Chapter 3, surviving elements of an attacked city should issue advisories indicating the direction toward which fallout is expected to spread and its forecast speed. Cities that have not suffered direct attack should apply the proper UF data to known or suspected ground zero locations within a 500 mile radius of their area to determine whether fallout is likely to occur in their area and, if so, its approximate arrival time.

247-884 O - 67 - 14

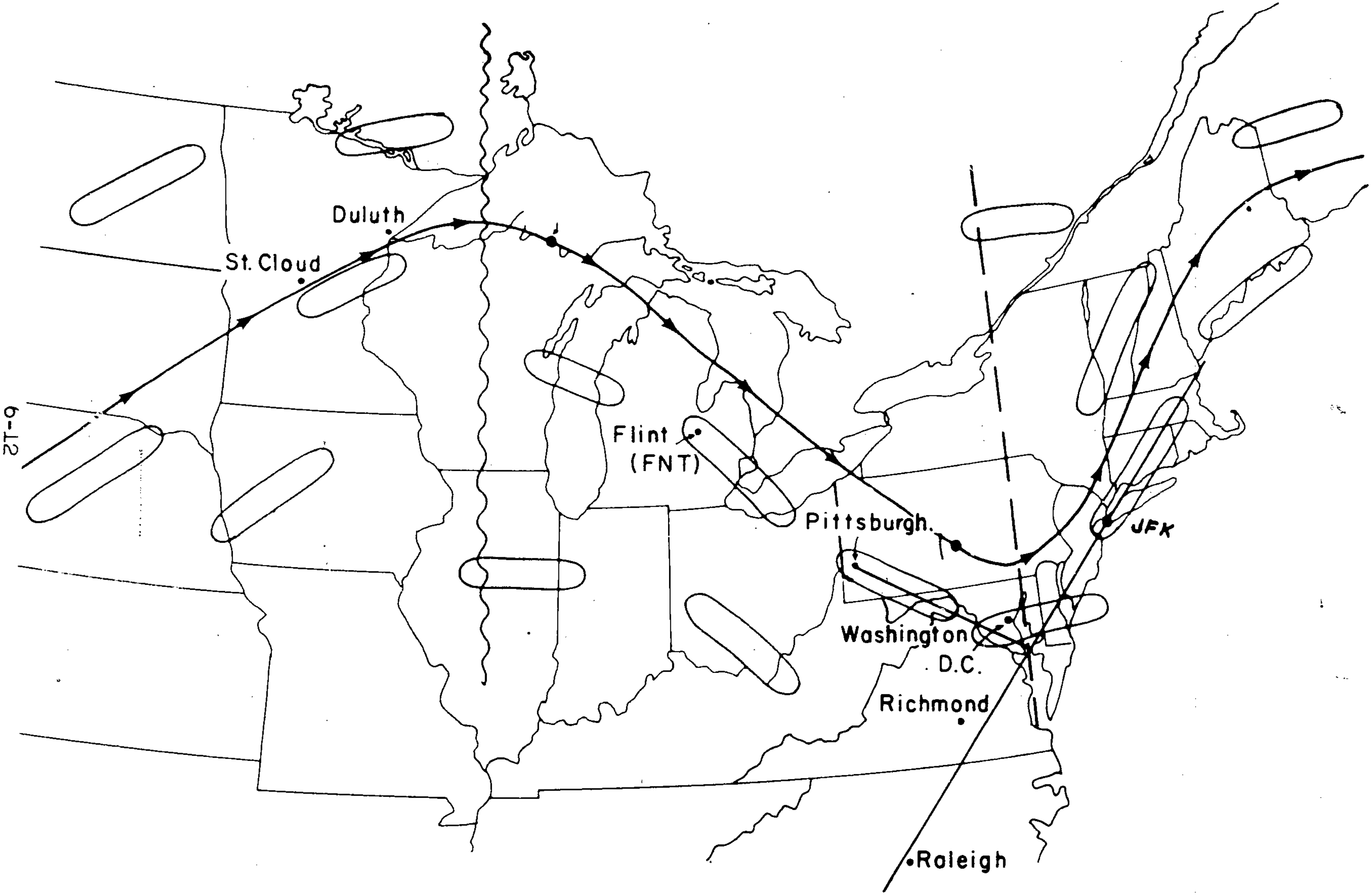

FIGURE 7.—Windflow variations at 60,000-ft. level from observations at 16 stations.

Uses and Limitations. Fallout forecasts may be subject to error, especially with the passage of time. Further, the area forecasts, prepared from the UF wind vectors, do not indicate the relative degree of hazard. Therefore, they should be used primarily to determine the likelihood of fallout occurrence and its approximate arrival time. This information can be of value to industry in more effectively planning and scheduling its shutdown procedures. Further, it may be of value to a community in planning its movement to group fallout shelter, to individuals in the improvisation of final countermeasures, and to farmers in getting livestock under cover. However, after fallout has arrived at a location, survival and recovery operations will be based upon dose rate reports from the monitors and not upon fallout forecasts.

PREPARING HYPOTHETICAL FALLOUT CONTOURS FOR TESTS AND EXERCISES

As indicated in Chapter 3, periodically radiological defense exercises should be planned and scheduled as a basis for the practice and training of radef personnel and as a basis for measuring capability and testing procedures. Hypothetical dose rate contours should be prepared as indicated in subsequent paragraphs to simulate the exercise fallout situation. Dimensions of the theoretical patterns assume typical (1) air density, (2) particle density and shape, (3) range of particle sizes, and (4) distribution of radioactivity with respect to particle size. All of these would vary from day to day, or with weapon yield, height of burst, and nature of soil at the point of detonation. However, the dose rate contours would have sufficient validity for test and exercise purposes, but would not have operational application. Operationally, the fallout situation would be determined by monitoring as indicated in Chapter 9.

Particle Sizes Associated Radioactivity and Fall Rates. In a surface burst weapon, large quantities of earth enter the fireball at an early stage and are fused or vaporized. When sufficient cooling has occurred the vaporized soil and rock, fission products and other radioactive residues condense forming particles, or become incorporated with the earth particles as a result of condensation onto their surfaces. The majority of the contamination of earth particles is found mainly in a shell near the surface. The amount of radioactivity associated with particles of different sizes may vary considerably with the design of weapon and the type soil over which the weapon is detonated. As the violent disturbance due to the explosion subsides, the contaminated particles gradually fall back to earth. This effect is referred to as "fallout." The fallout particles resemble cinders, sand or ashes and will vary considerably in size and shape. Some particles that are extremely small, less than 1 micron in diameter, will remain suspended in the stratosphere for many months to possibly a year or longer. Larger particles, with diameters exceeding 500 microns, may fall back to earth within 25 to 30 minutes after detonation.

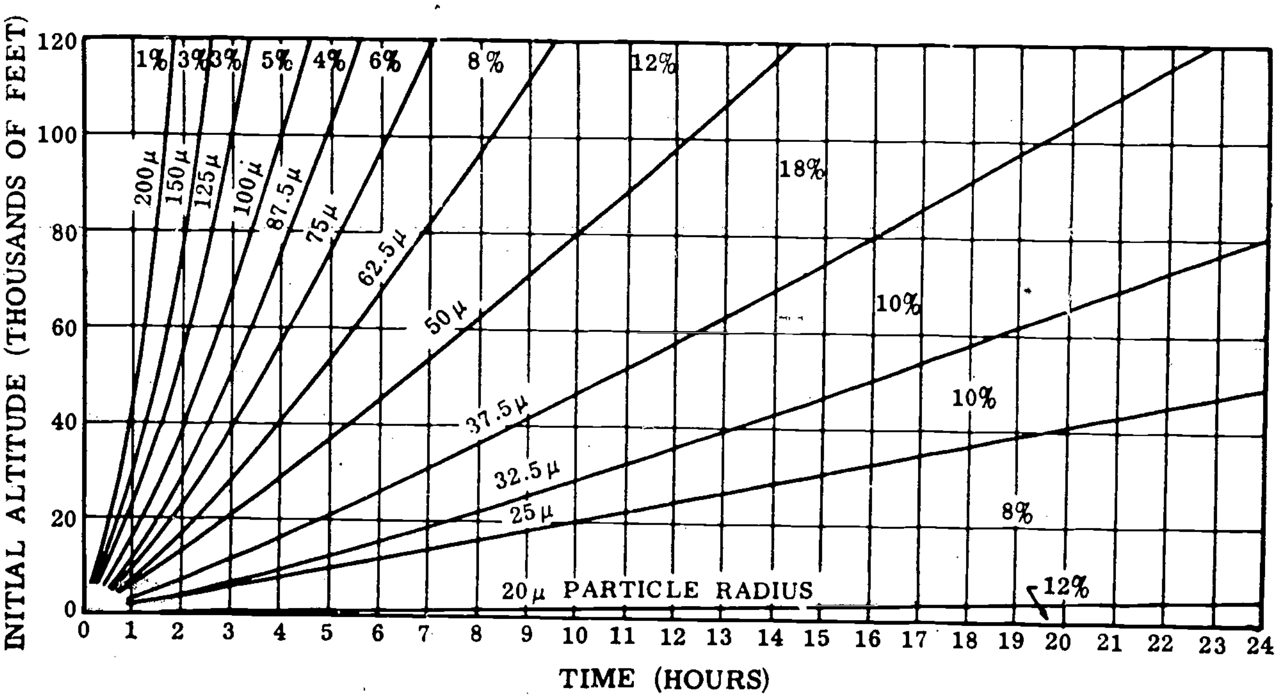

FIGURE 8.—Times of fall of particles of different sizes from various altitudes and percentages of total activity carried (Reproduced from "The Effects of Nuclear Weapons," DA Pamphlet No. 39-3 dated April 1962.)

Figure 8 indicates typical distribution of radioactivity with particle size and approximate fall times for spherical particles of different sizes. Particles of irregular shape would fall more slowly. It is emphasized that the data summarized in the figure may not be strictly valid in any given case and have no direct operational application. However, study of the figure can lead to a better understanding of radioactive fallout deposition.

Dimensions of Hypothetical Dose Rate Contours. Annex 1 to this chapter provides theoretical dimensional data for specific dose rate contours in statute miles as of H + 1 hour for different weapon sizes detonated at the earth's surface and under different wind speed situations. Data are provided for 8 weapon sizes--10KT, 30KT, 100KT, 300KT, 1MT, 3MT, 10MT, and 30MT. For each weapon size the dimensions are indicated for the contours indicating the degrees of contamination equivalent to dose rates of 10, 30, 100, 300, 1,000 and 3,000 r/hr as of H + 1 hour. For each contour, the data indicates the maximum upwind and downwind distances, the halfwidth at point of origin, and the maximum halfwidth of each contour, with the maximum halfwidth occurring at one-half the distance between ground zero and the maximum downwind extent of the contour. Data are shown for four wind speeds--10, 20, 40 and 60 knots.

The dimensions of the contours are based upon an assumption of 100% fission yield. Although this assumption may be valid for some low kiloton yield weapon, it would not be valid for the megaton yield weapons. For exercise purposes, it is generally assumed that the design of megaton yield weapons is half fission—half fusion. To account for the above assumed fission-fusion ratio, the dose rate values in Annex 1 for megaton sized weapons should be halved to 5, 15, 50, 150, 500 and 1,500 r/hr. For different fission-fusion ratio assumptions, the values of the dose rate contours would be modified accordingly.

The axis of the hypothetical dose rate contours should be oriented in the direction of the 20,000-foot UF fallout vector or streamline for weapon yields of 20KT or less; the 40,000-foot streamline for yields from 30KT to 900KT; the 60,000-foot streamline for the 1-5MT range; and the 80,000-foot streamline for yields above 5MT. However, it should be emphasized that these hypothetical contours should be used for test and exercise purposes only. They have no validity for operational use. Furthermore, fallout from a weapon detonation may be extremely irregular, not in smooth elongated ellipses as indicated by these hypothetical contours.

CLIMATOLOGICAL FACTORS TO BE CONSIDERED IN DETERMINING FALLOUT PROBABILITY

Because of the prevailing westerly winds in temperate latitudes, fallout from surface burst nuclear weapons in the North Temperate Zone would spread from a westerly toward an easterly direction a high percentage of the time. Because of the prevailing easterly winds in tropical latitudes, fallout from surface burst nuclear weapons in tropical latitudes would spread from an easterly direction toward a westerly direction a high percentage of the time. Therefore, in the temperate and tropical latitudes, upper wind climatological data may be of value in planning countermeasures for defense against fallout. The following sections pertain to the annual and seasonal variation of the mean wind field from the earth's surface to 80,000-foot altitude as it would affect the spread of fallout across the United States.

Basis of the Data. The data in this section are based upon daily upper air wind observations taken during the period March 1, 1951, through February 29, 1956, at rawinsonde observatories located across the fifty States, the Panama Canal Zone, southern Canada, and Puerto Rico. For the Winter season (December, January, February), there were 452 sets of observations; for the Spring and Summer seasons, 460 sets of observations; and for the Fall, 455 sets of observations. The annual data were derived by vectorial addition and averaging of the seasonal data.

Seasonal and Annual Tabulation. Table I indicates the seasonal and annual climatological, mean wind direction and average speed in the atmospheric layer from 80,000 feet altitude to the surface of the earth for each of 52 RAWIN locations. For radiological defense planning purposes it represents by seasons, the mean direction and speed of spread of fallout along the surface of the earth for multimegaton surface detonations. The first column of Table I lists the locations alphabetically where the upper air wind observations were taken. Under each column labeled Spring, Summer, Fall and Winter, there are three subcolumns, labeled D, S and V. D is the

TABLE I.—*Climatological mean wind direction (D) and average speed (S) in knots in the layer from 80,000 ft. altitude to surface of the earth and vector standard deviation (V)*

Location	Spring			Summer			Fall			Winter			Annual	
	D	*S*	*V*	*D*	*S*	*V*	*D*	*S*	*V*	*D*	*S*	*V*	*D*	*S*
Albrook	276	02. 5	08. 3	277	14. 7	07. 3	275	08. 8	07. 6	044	02. 2	09. 3	279	6
Albuquerque	082	24. 9	19. 4	035	03. 6	13. 2	095	17. 1	19. 5	092	28. 9	22. 3	087	18
Anchorage	056	05. 8	19. 4	049	03. 7	17. 0	053	14. 3	20. 4	080	17. 7	28. 0	064	10
Annette	077	12. 9	22. 4	098	05. 0	18. 9	076	22. 0	21. 7	090	24. 0	23. 5	084	16
Big Spring	078	30. 7	18. 7	284	05. 3	13. 8	093	15. 5	20. 0	084	35. 6	21. 2	084	19
Bismark	097	17. 1	20. 0	085	16. 8	15. 1	087	23. 9	20. 5	109	27. 8	20. 5	095	21
Boise	096	16. 6	20. 0	062	15. 7	14. 8	097	19. 4	20. 7	102	25. 9	22. 9	092	19
Brownsville	078	24. 4	15. 4	275	12. 8	10. 7	088	08. 2	17. 7	077	29. 5	16. 5	075	13
Buffalo	096	26. 3	23. 1	107	16. 6	16. 5	083	28. 8	22. 6	089	37. 4	23. 7	092	27
Burrwood	087	28. 1	18. 7	261	09. 5	11. 8	088	14. 0	19. 4	083	37. 0	17. 8	086	18
Caribou	089	19. 0	22. 7	093	16. 4	18. 7	080	29. 9	23. 3	081	29. 7	24. 1	084	23
Charleston	092	29. 8	22. 3	229	03. 6	13. 6	079	19. 0	21. 6	088	42. 4	19. 4	089	22
Columbia	087	28. 2	22. 6	099	08. 4	13. 4	096	23. 8	21. 3	091	38. 5	25. 3	092	24
Dayton	092	28. 7	23. 5	115	11. 5	14. 9	089	24. 9	20. 9	090	41. 5	26. 0	092	26
Denver	090	20. 7	20. 2	073	10. 0	13. 5	103	18. 6	19. 7	104	26. 0	22. 0	097	18
Dodge City	083	25. 7	20. 4	072	06. 7	13. 1	096	20. 8	20. 7	093	32. 2	23. 2	090	20
Edmonton	099	12. 8	17. 8	076	09. 5	15. 3	102	23. 0	18. 5	109	27. 1	18. 2	100	17
Ely	095	17. 7	20. 0	052	12. 9	13. 0	092	16. 9	19. 0	102	24. 0	23. 0	089	17
Fairbanks	067	06. 8	18. 2	060	04. 6	14. 8	061	15. 3	18. 4	085	18. 7	25. 5	072	11
Fort Worth	082	31. 5	20. 4	282	03. 7	13. 2	095	16. 5	20. 7	085	37. 8	22. 3	087	20
Great Falls	095	18. 8	19. 4	069	16. 8	15. 3	102	24. 1	20. 3	106	30. 0	21. 8	098	22
Green Bay	096	21. 7	21. 5	105	17. 3	16. 1	097	26. 2	22. 1	098	32. 4	23. 0	099	24
Greensboro	092	30. 2	22. 8	137	05. 0	14. 5	081	22. 3	21. 5	087	43. 4	21. 2	090	25
Hempstead	094	29. 0	24. 4	104	13. 6	16. 7	081	29. 0	24. 2	089	42. 7	25. 3	090	29
Internat'l Falls	099	16. 3	20. 2	098	17. 8	16. 5	106	24. 0	21. 4	107	27. 9	21. 2	104	21
Jacksonville	094	27. 7	20. 8	253	06. 5	12. 0	083	16. 5	20. 7	088	39. 0	18. 2	090	20
Lake Charles	083	29. 6	19. 0	263	08. 2	12. 1	094	15. 3	19. 8	082	38. 8	19. 3	085	19
Lihue	093	15. 8	15. 0	289	04. 5	09. 8	123	01. 0	12. 0	106	15. 1	16. 8	100	07
Little Rock	085	31. 1	21. 8	212	01. 9	13. 2	096	19. 7	20. 8	085	40. 5	23. 2	089	22
Long Beach	093	20. 7	20. 4	029	07. 6	13. 2	082	12. 7	17. 1	101	22. 2	23. 3	098	14
Maniwaki	097	20. 5	22. 7	108	16. 2	17. 0	085	27. 3	23. 0	089	30. 8	22. 2	092	23
Medford	100	18. 8	21. 2	064	12. 0	16. 0	092	17. 0	22. 2	099	26. 3	24. 3	092	18
Miami	097	21. 8	17. 2	267	12. 4	10. 7	080	06. 5	18. 4	088	29. 5	17. 2	092	11
Montgomery	092	30. 7	22. 5	246	05. 4	13. 4	087	18. 5	21. 5	086	42. 2	21. 4	091	21
Mt. Clemens	089	26. 2	24. 0	109	16. 2	16. 4	088	26. 9	22. 3	090	37. 0	24. 7	093	26
Nantucket	090	29. 3	24. 3	091	14. 6	17. 7	077	30. 3	23. 6	085	42. 6	26. 2	085	29
Nashville	088	31. 2	22. 7	146	03. 7	13. 3	089	22. 0	21. 2	086	42. 7	22. 8	089	24
Nome	042	05. 7	18. 8	040	03. 2	17. 0	066	11. 1	19. 5	081	17. 4	25. 7	066	09
Norfolk	095	31. 0	23. 0	124	06. 8	15. 7	079	23. 9	22. 9	089	44. 9	22. 3	089	26
Oakland	104	19. 5	21. 5	060	11. 2	15. 1	093	14. 0	20. 7	105	25. 1	25. 6	096	17
Omaha	089	24. 2	22. 0	089	11. 8	13. 9	100	24. 2	21. 2	098	32. 3	22. 9	097	23
Pittsburgh	093	29. 5	23. 7	110	13. 1	15. 8	083	27. 3	22. 2	089	43. 0	23. 6	092	29
Rantoul	092	28. 2	23. 5	110	11. 9	14. 8	095	25. 3	21. 4	091	39. 0	24. 9	096	27
Rome	094	26. 8	24. 2	104	17. 0	18. 1	081	29. 2	23. 7	088	37. 5	24. 4	090	27
San Juan	105	10. 5	12. 7	276	13. 4	09. 0	250	05. 7	13. 1	114	11. 8	13. 6	172	02
Seattle	093	16. 8	21. 8	076	11. 0	18. 0	091	21. 4	21. 8	097	25. 7	24. 0	092	18
Sault Ste. Marie	098	19. 9	22. 0	110	17. 7	17. 0	095	25. 3	22. 9	098	30. 4	23. 5	100	21
St. Cloud	095	18. 9	21. 0	095	17. 7	16. 8	103	25. 2	21. 3	103	29. 1	22. 0	101	23
Tucson	081	26. 7	20. 3	349	05. 1	14. 4	085	14. 4	18. 6	088	27. 4	22. 7	078	16
Washington	094	30. 5	24. 1	112	10. 5	16. 5	080	26. 7	22. 9	089	44. 7	24. 2	089	27
Whitehorse	060	08. 7	19. 7	071	02. 9	15. 1	066	17. 8	19. 5	087	21. 3	23. 9	073	12

climatological mean wind direction in full degrees from true north. S is the average speed in knots and V is the vector standard deviation. The D values on Table I represent the mean direction toward which the wind is blowing and thus, the mean direction toward which fallout would spread. For example, at Buffalo in Springtime, the mean direction is 096 degrees (slightly south of east) and the average speed is 26.3 knots. The vector standard deviation, 23.1 miles, indicates the degree of scatter or distribution of the observations about the mean. As a further example, at Washington, D.C., in Winter the mean direction is 089 degrees (almost straight east), and the average speed is 44.7 knots.

Streamline and Isotach Analysis. Figures 9 through 13 portray the data from Table I in map form. The solid black lines (streamlines with arrows) indicate the mean direction of spread, and the dashed lines (isotachs) indicate the average wind speed in knots. Figures 9 through 12 are for the Fall, Winter, Spring and Summer seasons respectively, and Figure 13 portrays the annual data. During the Fall, Winter and Spring seasons the mean direction of flow is generally west to east. Average speeds are greatest in Winter and least in Summer. However, as indicated on Figure 12, during the Summer season there is a pronounced directional shift across the Gulf of Mexico and the southern States, with the mean flow generally from the east toward the west.

Daily Variability. It should be noted that the data in Table I and Figures 9 through 13 represent mean or averaged data, based upon five years of upper air observations. On any one day, the actual direction and speed may vary considerably from the seasonal or annual mean. Table II shows the ratios of the speeds for Winter and Summer and the range of the mean seasonal direction in degrees for each of the 52 RAWIN locations. The former tabulations indicate the ratio of the scatter to the scaler magnitude of the vector and thus, are a measure of the reliability of the mean as a prediction. The mean data in Table I are more representative of the winds on any particular day where the ratio of V/S has a low value. For example, the mean data for Washington, in Winter, (089 degrees, 45 knots) has a V/S value of .55, whereas the Summer mean data (112 degrees, 10 knots) has a V/S value of 1.57. Therefore, the mean Winter data for Washington are more representative of the winds on any one day during the Winter than the mean Summer data are representative of the winds on any one Summer day. Further, at Ft. Worth, in Summer, when V/S equals 3.56 the mean Summer data (282 degrees, 4 knots) would not be a very reliable prediction for the winds on any one Summer day.

The latter tabulations, D_1-D_2, indicate the seasonal variation of the mean wind directions. As such, they give a measure of the reliability of the annual data in Table I when this is used as a planning guide for selecting stockpiling sites or strategic locations. The lower the value of D_1-D_2, the more reliable are the annual mean data. For example, Green Bay shows a mean directional range of only 009 degrees during the four seasons. Therefore, the annual data in this region should be very valuable as a criterion for civil defense planning purposes in locating areas of low fallout probability. On the other hand, Ft. Worth and

Big Spring have mean directional ranges of 200 degrees and 206 degrees respectively during the four seasons. The annual data would be of limited value in these regions, and for civil defense planning the seasonal data should be used.

The values for D_1-D_2 have been plotted and analyzed in Figure 14. The analysis shows that the seasonal variation of the mean wind direction is very low across New England and the Upper Mississippi Valley. Actually, it is less than 50 degrees for most sections north of the 36th parallel of latitude. Civil defense organizations north of the 36th parallel should be able to apply the annual fallout probabilities quite successfully in their survival planning. However, in the southern States where the range of the seasonal mean direction exceeds 80 degrees, it becomes increasingly difficult to apply the fallout probabilities to survival planning.

Probabilities in Windrows Form. The climatological data referred to above have also been processed in windrows format indicating the percentage of time that fallout would spread in the direction of each ten degree sector of the compass, and the probabilities of the speed of spread within each of the categories 1-25, 26-50, 51-75, 76-100 miles per hour. This degree of detail is not generally required by civil defense offices in their survival planning. However, in instances where this degree of detail is required for an engineering survey, copies of the windrows may be obtained upon request to the Office of Civil Defense.

TABLE II.—*Ratio of vector standard deviations to average wind speeds (V/S) and the range of the annual mean wind direction in degrees (D_1-D_2)*

	V/S Summer	V/S Winter	D_1-D_2
Albrook	0.5	4.22	129
Albuquerque	3.7	0.77	060
Anchorage	4.6	1.58	031
Annette	3.8	0.98	022
Big Spring	2.52	0.60	206
Bismark	.90	0.74	024
Boise	.94	0.89	040
Brownsville	.84	0.56	198
Buffalo	.99	0.63	024
Burrwood	1.24	0.48	178
Caribou	1.14	0.81	013
Charleston	3.78	0.46	150
Columbia	1.60	0.66	012
Dayton	1.30	0.63	026
Denver	1.35	0.85	030
Dodge City	1.96	0.72	024
Edmonton	1.61	0.70	033
Ely	1.00	0.96	050
Fairbanks	3.22	1.36	025
Fort Worth	3.56	0.59	200
Great Falls	.91	0.78	037
Green Bay	.93	0.71	009
Greensboro	2.9	0.49	056
Hempstead	1.23	0.59	023
Internat'l Falls	.93	0.76	009
Jacksonville	1.85	0.47	170
Lake Charles	1.48	0.50	181
Lihue	2.18	1.11	196
Little Rock	7.94	0.57	127
Long Beach	1.74	1.05	047
Maniwaki	.95	0.72	023
Medford	1.33	0.92	036
Miami	.86	0.58	187
Montgomery	2.48	0.51	160
Mt. Clemens	1.01	0.67	021
Nantucket	1.21	0.61	014
Nashville	3.59	0.53	060
Nome	5.31	1.48	041
Norfolk	2.31	0.50	045
Oakland	1.35	1.02	045
Omaha	1.18	0.71	011
Pittsburgh	1.21	0.55	027
Rantoul	1.24	0.64	019
Rome	1.06	0.65	023
San Juan	.67	1.15	171
Seattle	1.64	0.93	021
Sault Ste. Marie	.96	0.77	015
St. Cloud	.95	0.76	008
Tucson	2.82	0.83	090
Washington	1.57	0.55	032
Whitehorse	5.2	1.12	027

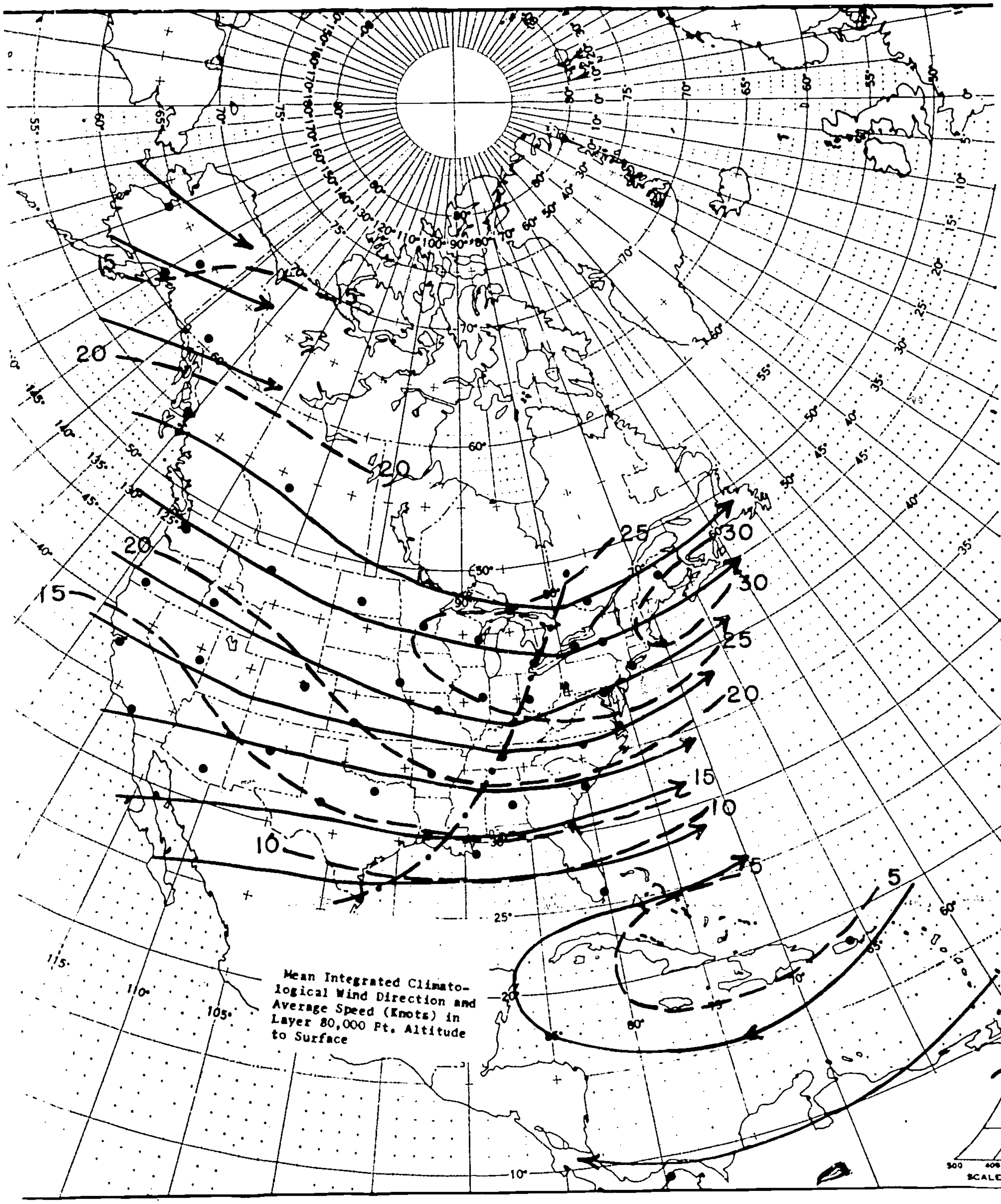

FIGURE 9.—Fall.

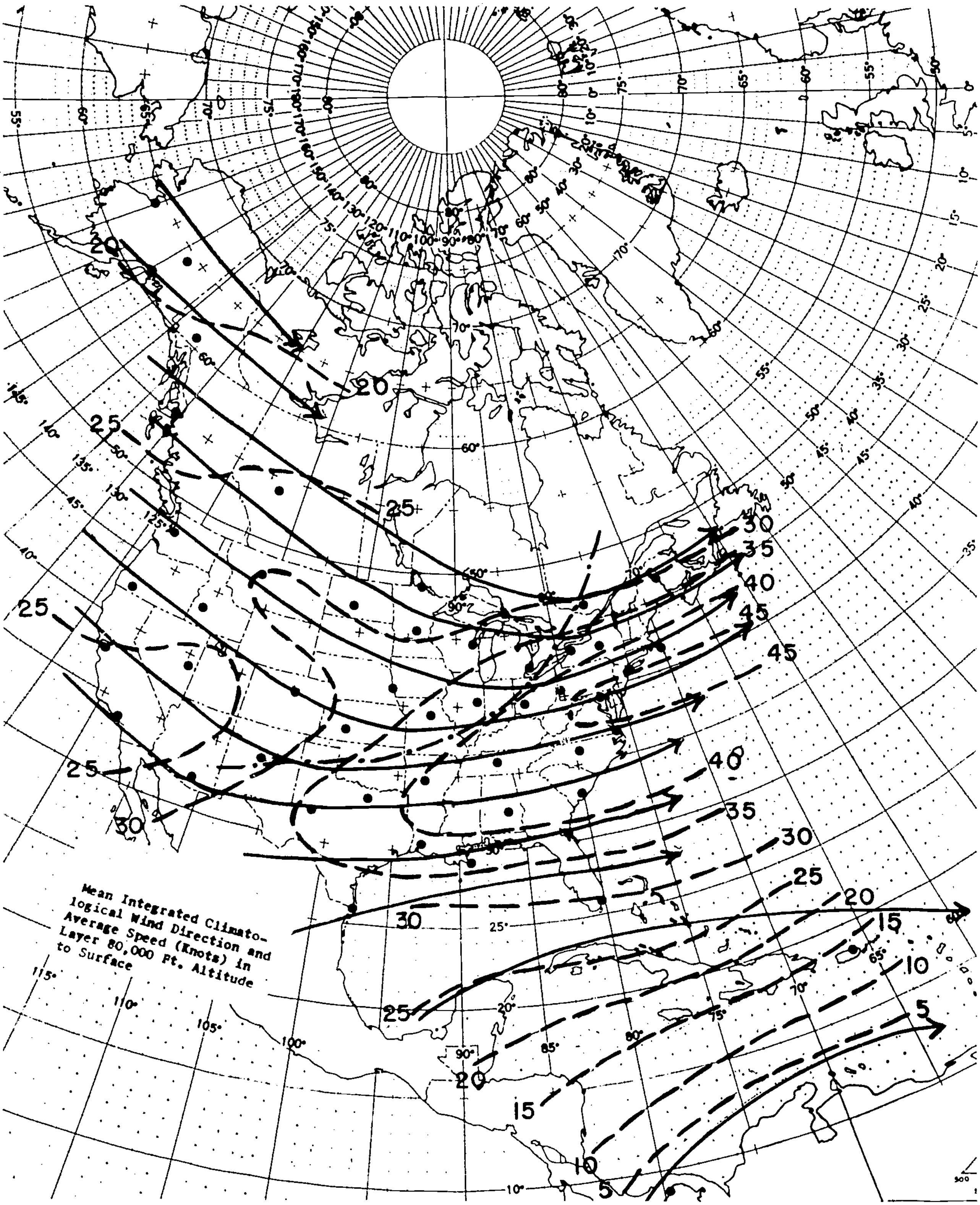

FIGURE 10.—Winter.

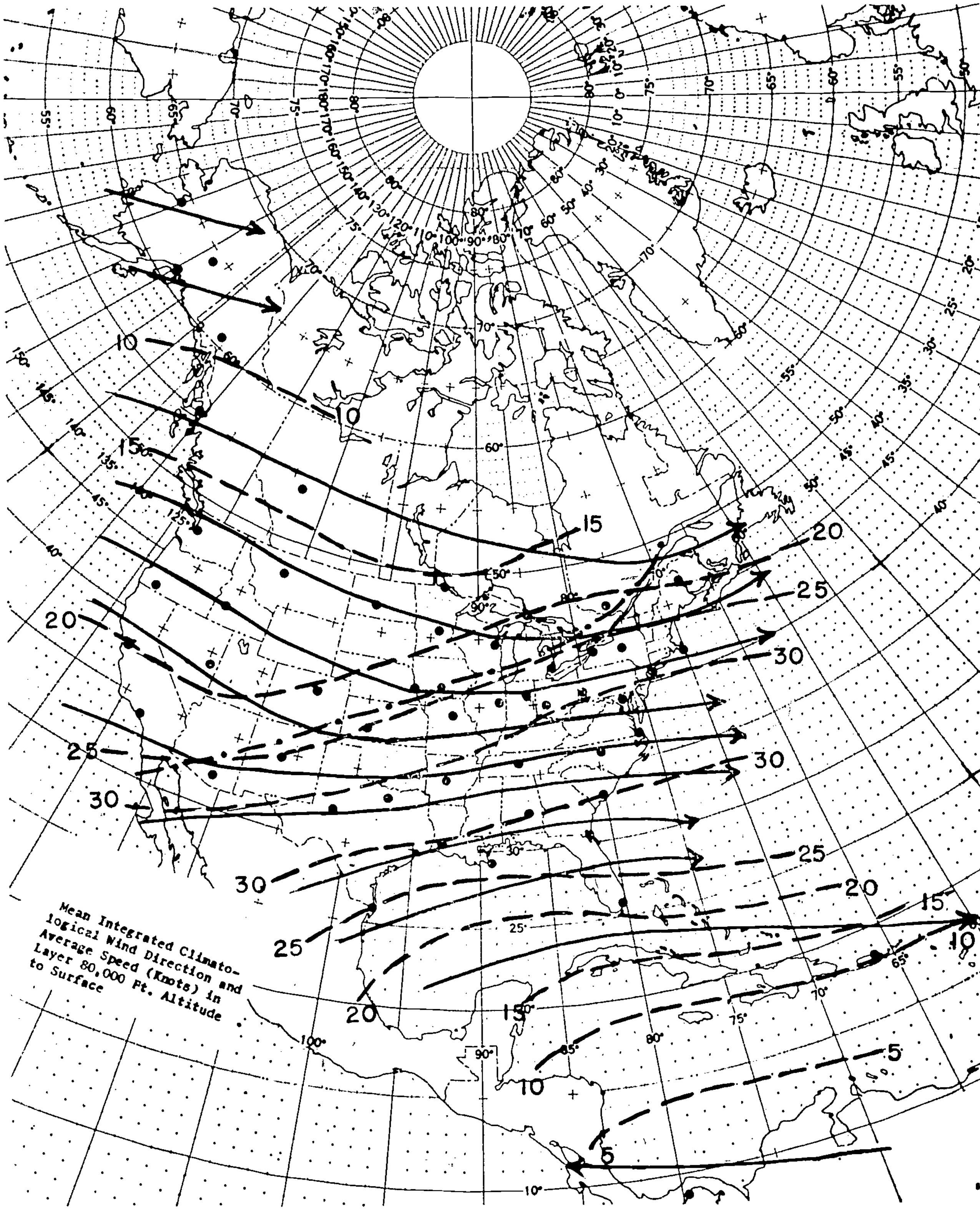

FIGURE 11.—Spring.

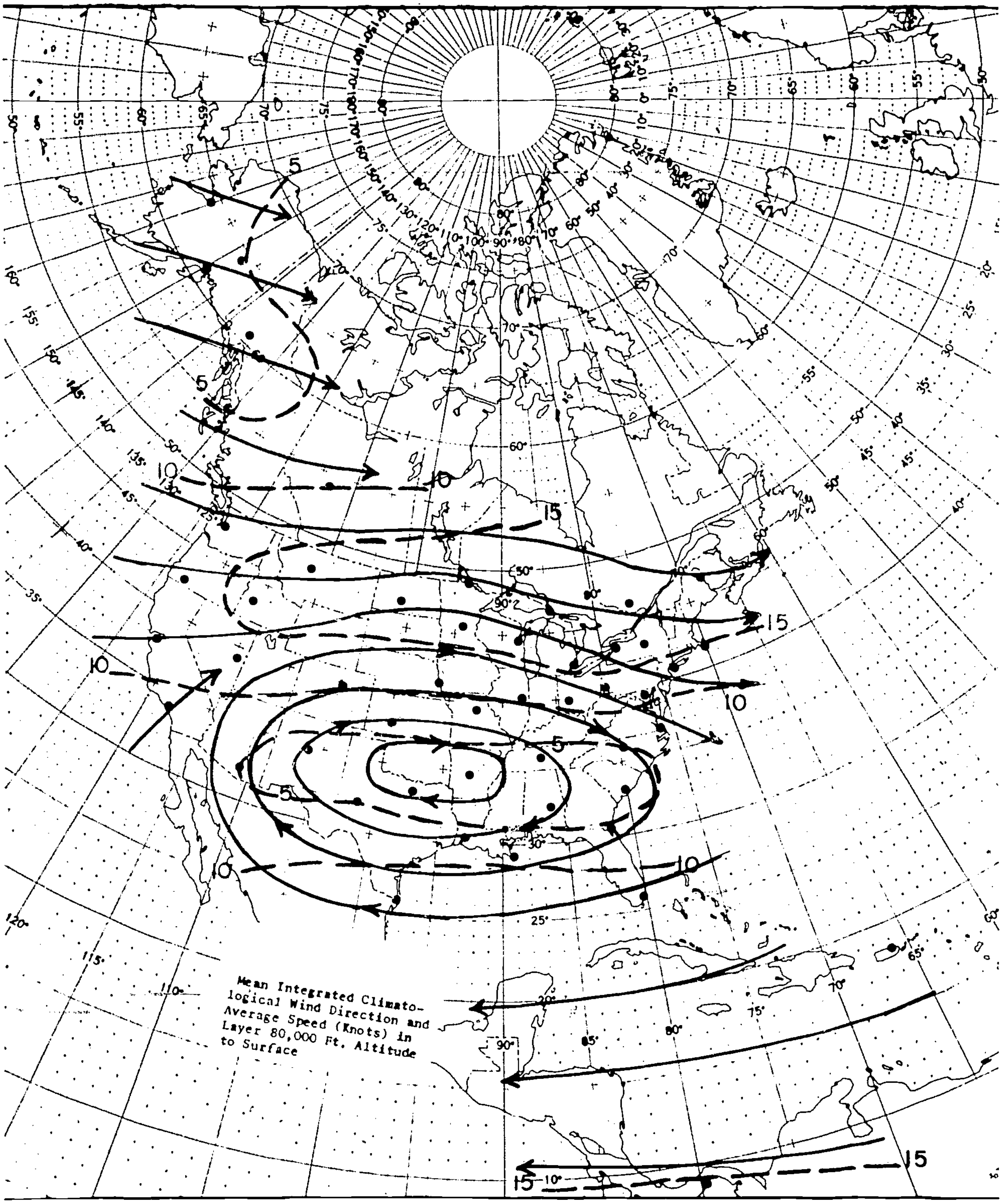

FIGURE 12.—Summer.

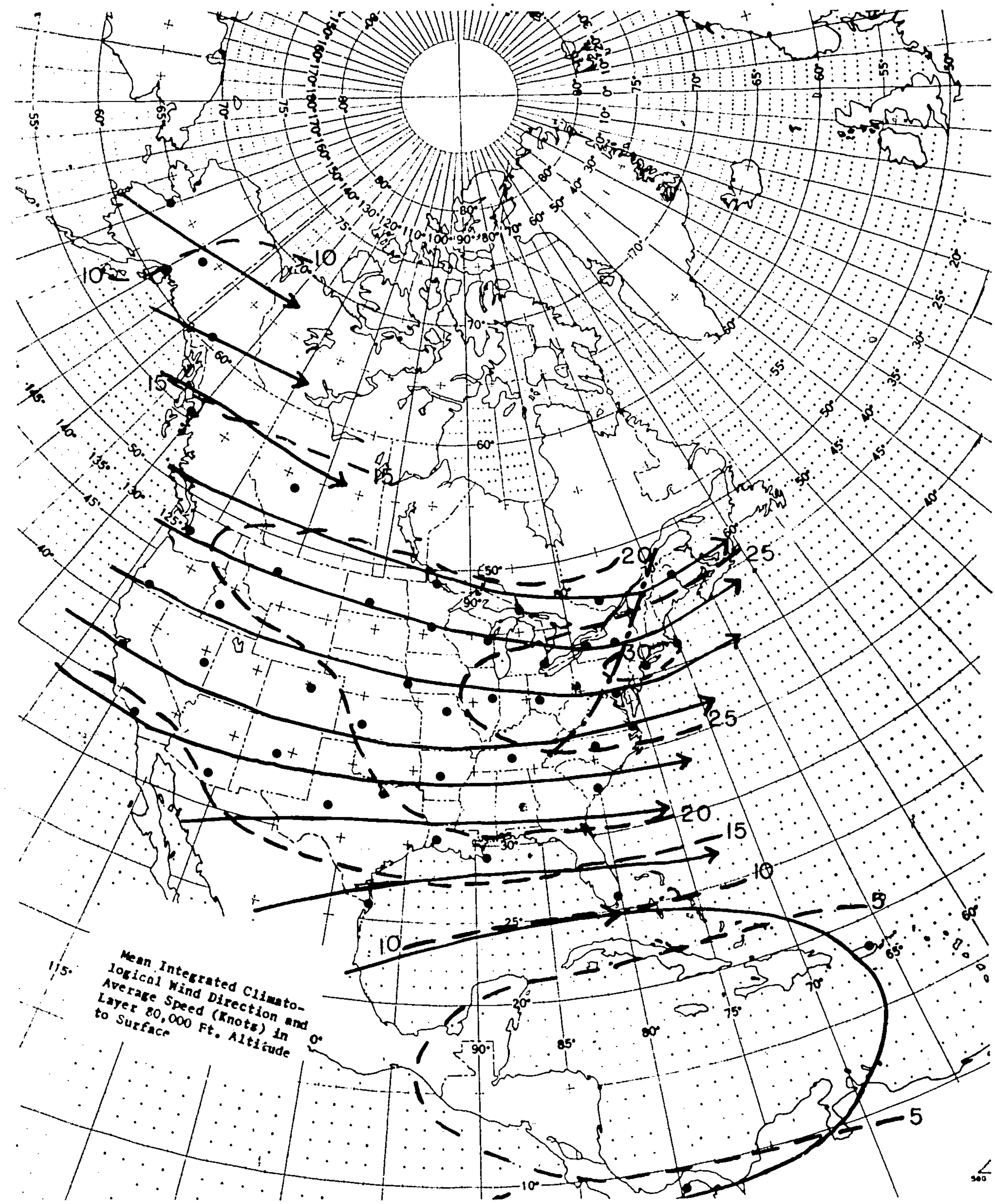

FIGURE 13

6-23

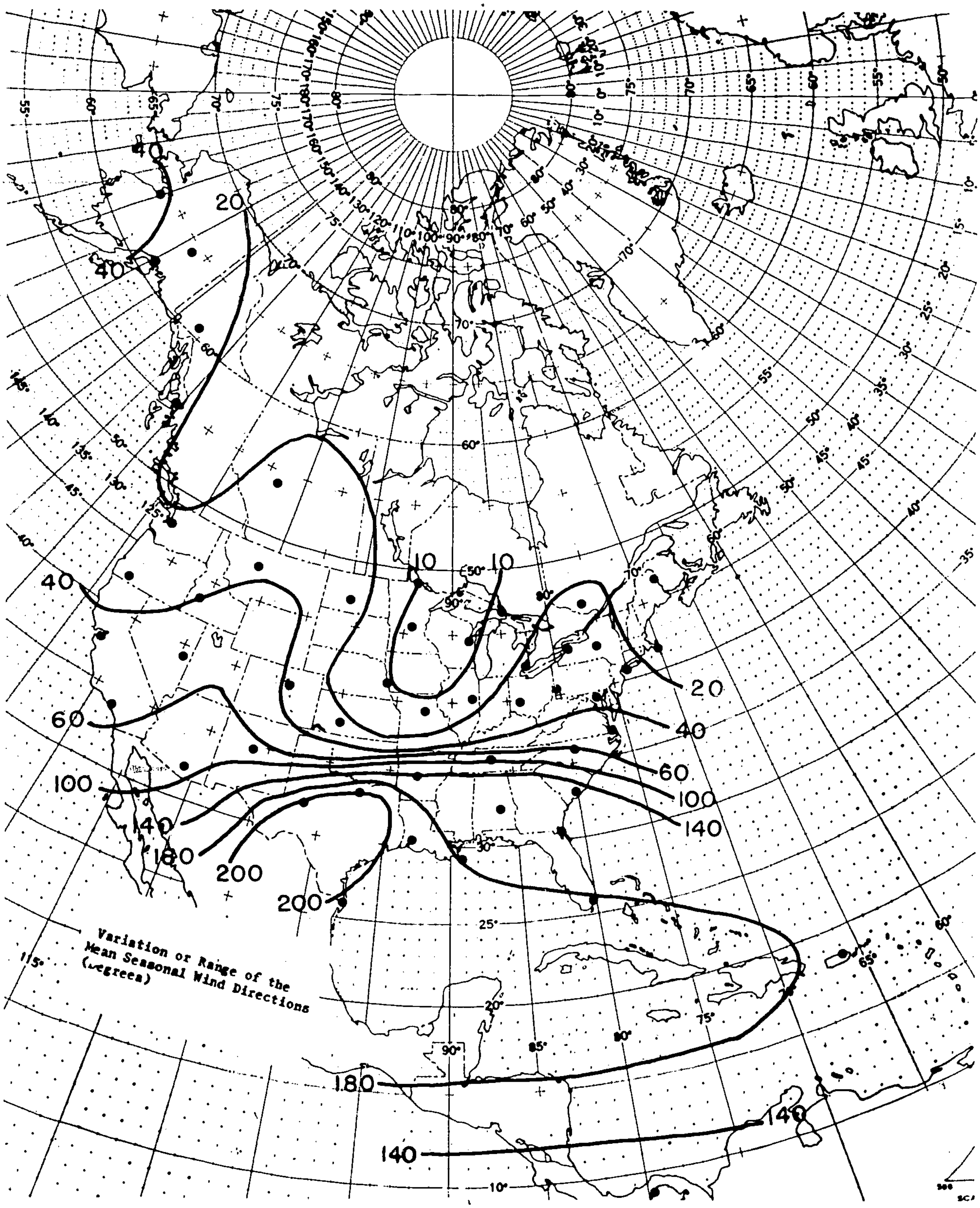

FIGURE 14

6-24

DIMENSIONS OF HYPOTHETICAL DOSE RATE CONTOURS

DIMENSIONS IN STATUTE MILES FOR HYPOTHETICAL DOSE RATE CONTOURS NORMALIZED TO H+1 HOURS

Yield 10 kiloton

(Average Wind Speed to 20,000 ft. altitude—10 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.5	35	0.7	8
30 r/hr	0.4	24	0.6	5
100 r/hr	0.3	12	0.5	2
300 r/hr	0.2	5	0.4	0.4
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 20,000 ft. altitude—20 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.4	55	0.6	6
30 r/hr	0.3	34	0.5	3
100 r/hr	0.2	15	0.4	1
300 r/hr	0.1	5	0.2	0.2
1000 r/hr	------	------	--------	--------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 20,000 ft. altitude—40 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.3	85	0.4	4
30 r/hr	0.2	45	0.3	2
100 r/hr	0.1	15	0.2	0.5
300 r/hr	------	------	--------	---------
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 20,000 ft. altitude—60 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.2	104	0.3	3
30 r/hr	0.1	50	0.2	1.5
100 r/hr	0.05	16	0.1	0.4
300 r/hr	------	------	--------	---------
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

Yield 30 Kiloton

(Average Wind Speed to 40,000 ft. altitude—10 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	1.0	50	1.6	17
30 r/hr	0.8	35	1.4	10
100 r/hr	0.6	18	1.1	4
300 r/hr	0.4	8	0.8	2
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

See footnote at end of table.

(Average Wind Speed to 40,000 ft. altitude—20 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.6	80	1.0	12
30 r/hr	0.5	50	0.8	6
100 r/hr	0.3	20	0.6	3
300 r/hr	0.2	7	0.4	1
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—40 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.4	125	0.8	8
30 r/hr	0.3	65	0.6	4
100 r/hr	0.2	25	0.4	1
300 r/hr	[1] −3.0	8	--------	0.3
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—60 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.3	150	0.6	7
30 r/hr	0.2	70	0.4	3
100 r/hr	0.1	28	0.2	0.9
300 r/hr	------	------	--------	---------
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

Yield 100 Kiloton

(Average Wind Speed to 40,000 ft. altitude—10 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	2.0	80	3.4	35
30 r/hr	1.6	55	3.0	20
100 r/hr	1.2	30	2.0	10
300 r/hr	0.7	12	1.7	4
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—20 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	1.2	130	2.0	25
30 r/hr	1.0	80	1.5	15
100 r/hr	0.8	35	1.0	6
300 r/hr	0.4	14	0.7	2
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—40 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	0.8	200	1.2	18
30 r/hr	0.6	110	0.8	8
100 r/hr	0.4	40	0.6	3
300 r/hr	0.1	15	0.2	1
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

Yield 100 Kiloton—Continued.

(Average Wind Speed to 40,000 ft. altitude—60 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	0.6	240	0.8	14
30 r/hr	0.4	120	0.7	6
100 r/hr	0.3	40	0.4	2
300 r/hr	[1] −3.0	10	--------	0.6
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

Yield 300 Kiloton

(Average Wind Speed to 40,000 ft. altitude—10 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	3.0	115	6	65
30 r/hr	2.6	80	5	40
100 r/hr	2.0	50	4	20
300 r/hr	1.4	20	3	9
1000 r/hr	0.3	6	1.3	2
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—20 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	2.0	190	3.0	50
30 r/hr	1.6	120	2.4	30
100 r/hr	1.2	65	2.0	12
300 r/hr	0.8	25	1.4	5
1000 r/hr	[1] −4.0	7	--------	0.5
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—40 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	1.3	300	2.0	35
30 r/hr	1.0	180	1.5	18
100 r/hr	0.7	75	1.1	7
300 r/hr	0.3	25	0.6	3
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 40,000 ft. altitude—60 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	0.8	380	1.1	28
30 r/hr	0.6	210	0.8	13
100 r/hr	0.4	85	0.6	5
300 r/hr	[1] −1.0	27	--------	2
1000 r/hr	------	------	--------	---------
3000 r/hr	------	------	--------	---------

Yield 1 Megaton

(Average Wind Speed to 60,000 ft. altitude—10 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	5	160	11	115
30 r/hr	4	120	9	75
100 r/hr	3	80	8	45
300 r/hr	2	45	6	20
1000 r/hr	1	15	3	7
3000 r/hr	------	------	--------	---------

See footnote at end of table.

(Average Wind Speed to 60,000 ft. altitude—20 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	4	325	6	60
30 r/hr	3	250	4	40
100 r/hr	2	150	3	20
300 r/hr	1.5	90	2.5	10
1000 r/hr	0.7	30	1.5	3
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 60,000 ft. altitude—40 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	3	550	4	45
30 r/hr	2	400	3	30
100 r/hr	1.5	225	2	15
300 r/hr	1.0	110	1.5	6
1000 r/hr	[1] −3.0	30	--------	2
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 60,000 ft. altitude—60 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	2	800	3	25
30 r/hr	1.5	650	2	15
100 r/hr	1.0	350	1.5	10
300 r/hr	0.5	175	1.0	4
1000 r/hr	[1] −8	25	--------	1
3000 r/hr	------	------	--------	---------

See footnote at end of table.

Yield 3 Megaton

(Average Wind Speed to 60,000 ft. altitude—10 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	6	250	12	120
30 r/hr	5	200	10	85
100 r/hr	4	150	8	55
300 r/hr	3	100	7	35
1000 r/hr	2	55	5	15
3000 r/hr	1	20	3	7

(Average Wind Speed to 60,000 ft. altitude—20 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	5	500	10	60
30 r/hr	4	400	8	45
100 r/hr	3.5	300	7	30
300 r/hr	3.0	200	6	15
1000 r/hr	2.0	100	4	10
3000 r/hr	[1] −0.5	35	--------	4

(Average Wind Speed to 60,000 ft. altitude—40 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	4	850	8	50
30 r/hr	3	675	6	35
100 r/hr	2.5	475	5	20
300 r/hr	2.0	300	4	12
1000 r/hr	1.0	115	2	5
3000 r/hr	------	------	--------	---------

(Average Wind Speed to 60,000 ft. altitude—60 knots)

Contour value	Up-wind	Down-wind	Halfwidth at origin	Maximum halfwidth
10 r/hr	2.5	1300	4	30
30 r/hr	2.0	1000	3	20
100 r/hr	1.5	700	2	15
300 r/hr	1.0	400	1.5	8
1000 r/hr	0.1	150	0.5	3
3000 r/hr	------	------	--------	---------

Yield 10 Megaton

(Average Wind Speed to 80,000 ft. altitude—10 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	10	300	20	175
30 r/hr	8	250	16	130
100 r/hr	6	200	12	100
300 r/hr	5	150	10	65
1000 r/hr	4	100	8	35
3000 r/hr	2	50	4	20

(Average Wind Speed to 80,000 ft. altitude—20 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	8	600	15	90
30 r/hr	6	500	12	75
100 r/hr	5	400	10	50
300 r/hr	4	300	8	35
1000 r/hr	3	200	6	20
3000 r/hr	1.5	100	4	10

(Average Wind Speed to 80,000 ft. altitude—40 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	6	1100	12	80
30 r/hr	5	900	10	60
100 r/hr	4	700	8	40
300 r/hr	3	500	6	25
1000 r/hr	2	250	4	10
3000 r/hr	0.1	80	0.5	5

(Average Wind Speed to 80,000 ft. altitude—60 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	4	1700	7	50
30 r/hr	3	1400	5	35
100 r/hr	2.5	1000	4	25
300 r/hr	2	700	3	20
1000 r/hr	1	300	2	9
3000 r/hr	[1] −5	65	--------	3

DIST.: 2c, 2d, 3, 4a, 6c, and 7d.

Yield 30 Megaton

(Average Wind Speed to 80,000 ft. altitude—10 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	16	400	30	250
30 r/hr	14	300	27	200
100 r/hr	12	250	24	150
300 r/hr	10	200	22	100
1000 r/hr	8	150	18	70
3000 r/hr	6	100	14	40

(Average Wind Speed to 80,000 ft. altitude—20 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	14	800	18	130
30 r/hr	12	650	16	110
100 r/hr	10	500	14	80
300 r/hr	8	400	12	60
1000 r/hr	6	300	10	35
3000 r/hr	4	150	8	20

(Average Wind Speed to 80,000 ft. altitude—40 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	10	1400	12	120
30 r/hr	8	1200	10	90
100 r/hr	6	900	8	65
300 r/hr	4	700	6	45
1000 r/hr	3	400	5	25
3000 r/hr	2	200	4	13

(Average Wind Speed to 80,000 ft. altitude—60 knots)

Contour value	*Up-wind*	*Down-wind*	*Halfwidth at origin*	*Maximum halfwidth*
10 r/hr	6	2000	8	75
30 r/hr	5	1800	7	60
100 r/hr	4	1400	6	45
300 r/hr	3	1000	5	30
1000 r/hr	2	600	4	20
3000 r/hr	1	250	2	10

[1] Minus sign in front of upwind distance indicates that contour originate downwind of ground zero.

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INSTRUMENTATION, MAINTENANCE AND CALIBRATION

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

The purpose of this Chapter is to present comprehensive information on civil defense instruments and the policies, requirements, and procedures relating to the maintenance and calibration of these instruments. More detailed information is presented in the annexes to this Chapter.

INSTRUMENT REQUIREMENTS

Radiological instruments have been developed by OCD to meet the requirements evidenced as a result of the extensive testing of nuclear weapons. These instruments provide radiation exposure (dose) and exposure (dose) rate information in a form which is usable to estimate probable biological effects. In addition, these instruments are designed for use in both the preattack and postattack civil defense environments as regards temperature, humidity, radiation damage, etc.

The instruments that have been developed are of two major categories; namely, rate meters and dosimeters. They measure exposure rate and exposure, respectively. The units of measurement used for dose rate and total dose of gamma radiation are the roentgen per hour (R/hr) and the roentgen (R).

SURVEY METERS

Survey meters are portable rate meters and are basically reconnaissance instruments. They are used to provide the information required for direction of radiological defense (RADEF) and other civil defense operations. Some survey meters measure gamma radiation only, while others through the use of a removable shield permit a comparative measurement of gamma radiation only and combined beta and gamma radiation. The presence of beta radiation may be detected by only two OCD instruments; the CD V-700 and CD V-720. The ability to detect beta radiation is useful under special conditions for decontamination of personnel and areas.

Survey meters required for civil defense use have direct reading scales that indicate the gamma dose rate in roentgens per hour or milliroentgens per hour. Instruments designed to give merely "go-no-go" indications, such as those with blinking lights or audible warnings, do not meet the criteria established by OCD and the Federal Trade Commission. Annex 3 to this Chapter is the OCD "Criteria for Radiation Instruments for Use by the General Public," and Annex 4 is a reprint of the Federal Trade Commission publication, "Guides for Advertising Radiation Monitoring Instruments."

The sensitivity requirements of radiation instruments depend upon the tasks the instruments must perform. To provide adequate operational monitoring, civil defense portable radiological instruments should be capable of measuring gamma dose rates as high as 500 r/hr, and indicate when dose rates exceed this. Measurement above this amount is not necessary for portable survey instruments because a higher level of radiation would preclude unsheltered monitoring operations. On the other hand, when exposure rates are low but no longer decreasing rapidly, a fraction of a roentgen per hour, over an extended period, can be hazardous. There is a requirement for instruments giving definitive indication of dose rates in the milliroentgen per hour range. Also, they are used in training monitors and may be of value following some peacetime nuclear incidents.

DOSIMETERS

Dosimeters are for use by civil defense personnel to provide continuous information as to radiation exposures during the course of emergency operations. The dosimeters are of the self-reading type, commonly referred to as quartz-fiber dosimeters. The sensitive element is an ionization chamber in which the electrical discharge is proportional to the total quantity of ionizing radiation passing through it. The electrical charge is measured by an electroscope which is an integral part of the instrument. These dosimeters respond to the gamma component of residual radiation. They are to be charged with the Radiological Dosimeter Charger, CD V-750.

INSPECTION, MAINTENANCE AND CALIBRATION

The periodic and routine inspection and proper maintenance and calibration of radiological instruments is essential. All operational instruments should be inspected at least once every two months and checked for operability. Instruments which fail the operability check should be repaired and calibrated. In addition, all instruments distributed for operational purposes should be calibrated on a scheduled basis.

AVAILABILITY OF RADIOLOGICAL EQUIPMENT

Radiological defense equipment may be obtained by States or political subdivisions in the following manner: (1) grant or loan from OCD; (2) purchase through OCD, or (3) direct purchase.

Radiological equipment for all licensed public shelters, civil defense training, and civil defense operational purposes is available from the Office of Civil Defense to States, and through the States to their political subdivisions. Detailed information on policies, requirements, and procedures relating to shelter radiation monitoring kits and radiological equipment for training and operations is described in Part D, Chapter 2, Appendix 3 of the Federal Civil Defense Guide, and Chapter VIII of this Guide, respectively.

Federal financial assistance is available to States and their political subdivisions for purchase of non-standard radiological instruments and other special radiological defense equipment that may be required. The Federal Government will assume up to a maximum of one-half of the unit cost, as indicated in Part F, Chapter 5 of the Federal Civil Defense Guide, subject to availability of funds and provided that prescribed criteria are met. In some instances, States will match expenditure of their political subdivisions.

CHAPTER VII
ANNEX 1

OCD RADIOLOGICAL INSTRUMENTS FOR OPERATIONAL USE

The OCD standard item instruments described below are made available for civil defense operations.

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

Operationally this instrument consists of a radiation detector, a regulated high voltage supply, electronic circuitry for pulse shaping and metering, and an indicating meter and headphone for audible detection of radiation. Ranges of this instrument are 0-0.5, 0-5, and 0-50 mr/hr. When properly calibrated, the response of this instrument is within the range of plus or minus 15 percent of the true gamma radiation dose rate from cobalt 60, or cesium 137.

The detecting element of the CD V-700 is a Geiger tube with an adjustable shield so that only gamma dose rate is measured or beta and gamma can be indicated together with the shield open. This instrument is designed for sensitive measurements and has very limited usefulness in areas of high contamination. In radiological defense operations during periods of high radiation intensity, the instruments would have to be used in locations well shielded from fallout radiation where food, water, and personnel could be checked for contamination. During the later recovery period, it will be used to locate remaining sources of contamination that might need to be removed for long-term occupancy. A special Geiger tube can be used to shift the range of this instrument upwards by a factor of 10; that is to 0-5, 0-50, and 0-500 mr/hr.

CD V-711, a remote sensor radiation ratemeter, is especially designed for permanent installation at blast resistant-type Emergency Operating Centers (EOC's). It provides intermittent or continuous surveillance of the outside radiation exposure rate during early postattack periods when exterior radiation levels are too high to permit leaving the sheltered area for direct manual monitoring. The meter consists of a detector unit built for mounting on either a 3-1/2 inch or 4 inch International Plumbers Standard pipe outside the facility so as to withstand a blast overpressure of at least 50 pounds per square inch (psi); a connecting cable of 300 feet maximum length, which is provided in sections of 50, 100, and 150 feet; and a unit indicating the dose rate in r/hr, to be located within the EOC. Ranges of this instrument are 0-1, 0-10, 0-100 and 0-1,000 r/hr. When properly calibrated, the response of this instrument is within the range of plus or minus 20 percent of the true gamma dose rate from cobalt 60 or cesium 137.

CD V-715 is a high range gamma survey meter for general postattack operational use. The ranges of this instrument are 0-0.5, 0-5, 0-50, and 0-500 r/hr.

When properly calibrated, the response of this instrument is within the range of plus or minus 20 percent of the true gamma dose rate from cobalt 60 or cesium 137.

The instrument was designed for use by radiological monitors for the major part of their operation in the period following the attack. The instrument is primarily for surface monitoring survey but it can serve as supplemental equipment for aerial measurements.

This instrument consists of a detecting element, a power supply, electronic circuitry to amplify the minute current from the detector, and an indicating meter. The detecting element of the CD V-715 is an ionization chamber.

The CD V-710 medium range 0-50 r/hr gamma survey meter, which is similar to the CD V-715 except for its range, and the CD V-720 high range beta-gamma survey meter have been replaced by the CD V-715. The CD V-710 will be phased out and replaced with CD V-715's as States develop their own maintenance and calibration programs. The detecting element of the CD V-720 is an ionization chamber with a movable shield so that gamma radiation only can be measured, or beta and gamma radiation can be monitored together when the shield is open. The CD V-720 can be used in high level contamination areas where civil defense operations are necessary and for making high level beta radiation determinations.

<u>CD V-717</u>, remote sensor survey meter, is essentially a CD V-715 gamma survey meter with a removable detector unit for making remote measurements to distances of 25 feet. The ranges of this instrument are 0-0.5, 0-5, 0-50 and 0-500 r/hr. When properly calibrated, the response is within the range of plus or minus 20 percent of the true gamma dose rate from cobalt 60 or cesium 137. When the cable is connected for remote sensor use, the instrument response is within plus or minus 5 percent of the meter indication when the cable is not in the circuit. This instrument is for use by radiological monitors in monitoring stations during the early period following a nuclear attack. The instrument was designed to decrease the radiation exposure to the monitor by enabling him to obtain outside dose rate readings while utilizing the protection of some portion of the structure.

<u>CD V-742</u> is a high range dosimeter for general postattack operational use to measure radiation exposures to workers in fallout areas. It is a self-indicating, quartz-fiber electrostatic type and resembles a fountain pen in size and shape. The measurement range is 0-200 roentgens. Before the availability of the CD V-742, the CD V-730 with a range of 0-20 roentgens and the CD V-740 with a range of 0-100 roentgens had been procured and distributed in relatively small numbers. Where provided, they are to be used for operational purposes. The CD V-742 is more appropriate for use by most emergency workers where the requirement may be to measure a single large exposure or have a measurement of cumulative exposure resulting from a series of missions. The CD V-730 can be used to provide a more precise measurement of a single mission dose. This is desirable for some special functions such as measuring the aerial monitoring "in-flight" dose over a transportation route for calculation of the exposures to be expected in surface travel of the route.

The CD V-742 can be distinguished readily from OCD dosimeters of different range by the color of the pocket clip, which is bronze.

Quartz-fiber electrostatic dosimeters contain two electrically conducting components; a coated quartz fiber and a metal mounting ring. To prepare the instrument for operation, these two electrodes are charged by using a battery operated charger, CD V-750. This is also known as setting-to-zero or zeroing a dosimeter.

Radiation passing through the dosimeter loses energy by ionization. As the ions are drawn to the electrodes, there is a reduction in the charge and the quartz fiber moves. Through a built-in optical system the user of the dosimeter can read the position of the fiber image on the graduated scale. The accumulated dose can be read directly at any time. By recharging, these dosimeters can be used repeatedly.

The accuracy of response to radiation cannot be adjusted after manufacture. OCD specifications require that the response of the CD V-742 be within the range of plus or minus 10 percent of the true gamma dose from cobalt 60 or cesium 137. These instruments can give an erroneous reading if roughly handled or because of electrical leakage over a long period. Therefore, all dosimeters should be leak tested periodically.

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

<u>CD V-781</u>, aerial survey meter, is for general postattack surveying from light aircraft after fallout has been deposited. The instrument consists of an indicating unit adaptable to quick mounting in the aircraft and interconnecting cable to the detector unit which uses three Geiger tubes, associated electronic circuits, and three indicating meters; one for each of the three ranges 0-0.1, 0-1 and 0-10 r/hr. When properly calibrated, the response of this instrument is within the range of plus or minus 10 percent of the true gamma dose rate from cobalt 60 or cesium 137. Because the dose rate over a fallout area decreases when height is increased, the instrument readings must be corrected for the effect of height above the ground to approximate the ground dose rate. The power source may be either the self-contained power pack (D-cells) or the aircraft electrical system, through a special connector. A tape recorder, with associated throat microphone and a remote control switch, permits inflight recording of necessary data. The unit also includes a means for simulating radiation environment for training and test flight purposes.

OCD RADIOLOGICAL INSTRUMENTS AND EQUIPMENT FOR TRAINING

Operational instruments discussed in Annex 1 are used in training monitors. The additional instruments and equipment listed below are provided to meet special training requirements.

CD V-138 is a low range direct reading, quartz fiber dosimeter similar to the CD V-742. The range of the CD V-138 is 0-200 milliroentgens. It is mainly used to measure the exposure dose to ionizing radiation during training or other activities involving the use of civil defense sealed radioactive sources.

CD V-457 is a Geiger counter which has been especially designed for classroom demonstration use. It operates on a normal 110 volt AC power supply and produces both visible and audible responses to nuclear radiation. The instrument is used in teaching basic nuclear radiation physics and for decontamination demonstrations.

CD V-784 consists of six sealed capsules each containing radioactive cobalt 60. When procured, each capsule contains five millicuries of cobalt 60. Cobalt 60 has a half life of 5.3 years. These capsules are used in training exercises and are not accurately calibrated. The CD V-784 has replaced an earlier radioactive source set which was the CD V-786 and consisted of 12 sealed capsules. The total amount of radioactivity in the source set was the same, 30 millicuries, but the amount of activity in each source varied from .1 to 5 millicuries. Each capsule has a 1 inch square warning label attached with a ring. A radioactive byproduct material license is required to possess and use this item.

CD V-788 is a pair of long-handled tongs for handling individual radioactive source capsules. The length is 18 inches and the points are especially made for picking up a capsule or its attached tag and ring.

CD V-791 is a small lead container used for temporary storage and transport by hand of the CD V-784 radioactive sources. It is designed to fit inside the more massive CD V-792 lead container. When so assembled and locked, these containers are used to ship and store a CD V-784 source set.

CRITERIA FOR RADIATION INSTRUMENTS FOR USE BY THE GENERAL PUBLIC

As a supplement to organized Federal, State, and local monitoring systems, instruments for measuring gamma radiation exposure rates (dose rates) and total exposure (dose) can provide valuable on-the-spot information for the citizen following a nuclear explosion. Where, through choice or necessity, one provides a private shelter for the protection of himself and family, knowledge of the radiation situation within the shelter, the home, and, under some circumstances, in surrounding areas, can be used as a basis for determining appropriate courses of action. Instruments designed for measurement of gamma radiation dose rate (rate meters) and instruments for measurement of accumulated gamma radiation dose (dosimeters) can be of value for home use.

To meet the needs of an individual or household for measurement of gamma radiation following a nuclear attack, instruments manufactured for sale to the general public must meet minimum criteria, and it will be the responsibility of the manufacturer to assure that his instruments do meet these criteria in all material respects, if they are to be advertised as being adequate for this purpose. The following criteria are essential:

1. Criteria common to both rate meters and dosimeters:

   a. The instrument must be of such design and construction that reliable performance can be expected following a storage period of at least five years (batteries excluded, if used). Use of components subject to significant change in characteristics affecting the performance of the instrument is not acceptable.

   b. The instrument must be easy to operate and interpret.

   c. The energy dependence of the instrument should be less than plus or minus 25 percent for energies between 80 kev and 1.2 mev.

   d. The temperature dependence of the instrument should be less than plus or minus 30 percent between 0°F and 110°F.

   e. The instrument, without batteries, should withstand 72-hour storage at a temperature of minus 30°F and 72 hours at plus 150°F. At the conclusion of these exposures and return to room temperature, the instrument must meet the over-all accuracy requirements.

   f. The effect of humidity on the over-all accuracy should be less than plus or minus 20 percent. Some of the instruments will be positioned in underground shelters where humidity may be high and, with change of temperature, there could be condensation. Instruments should be designed for operation after prolonged storage under such conditions.

g. The instrument should satisfactorily withstand atmospheric pressure changes likely to result from shipment by air.

h. The instrument should meet the accuracy specifications from sea level to the equivalent pressure of an altitude of 6,000 feet.

i. The batteries, if used in the instrument or auxiliary equipment, should be standard "D" type flashlight cells.

j. The instrument should be constructed for moderately rugged use, and for outdoor use during inclement weather.

k. The instrument, and any auxiliary equipment, should be designed for simple maintenance by commercial radio and television service organizations.

l. Representations, pictures, seals, insignia, trade or brand names, c., any other term or symbol which would imply any government connection, approval, or any other form of government endorsement, shall not be used on instruments for the general public. Further, although instruments for the general public may be any color, it is recommended that use of civil defense yellow be restricted to official civil defense monitoring instruments.

2. Rate meter criteria (in addition to the above):

a. The instrument must indicate gamma radiation dose rates from 1 to 100 r/hr with an over-all accuracy better than plus or minus 35 percent, referenced to cobalt 60, at all dose rates within the prescribed range of the instrument.

b. The detector must be shielded against beta radiation with a minimum of 1,000 mg/cm^2.

c. The indicator must be calibrated in r/hr and may not be dependent upon the subjective interpretation of varying tones, varying brightness, varying loudness, etc.

d. The instrument must read off-scale or give some other positive indication when dose rates exceed an indicated 100 r/hr. This must apply for all dose rates between that radiation rate and 1,000 r/hr.

e. A means must be provided for checking positive operation of any electronic circuit used.

f. The batteries, if used, must operate the instrument for a reasonable period of time. (When the instrument is indicating 50 r/hr, or more, the battery must operate the instrument continuously for at least 50 hours.)

g. The instrument response shall be such that the difference in the indication for radiation incident normal to the front and that for radiation incident normal to the bottom does not exceed 15 percent over the photon energy range of 80 kev to 1.2 mev.

h. A dosimeter type instrument, to be exposed for a timed interval for determining dose rate and reading in roentgens per hour, is permissible provided that the timed interval is greater than five seconds and does not exceed one minute for an indication of 100 r/hr.

i. An instrument using an electronic circuit should respond so that after warm up 95 percent of the final indication of all dose rates measured is reached in no more than ten seconds.

j. Any circuit instability and meter fluctuation should be less than five percent of full-scale.

3. Dosimeter criteria (in addition to general specifications in 1, "Criteria common to both rate meters and dosimeters"):

a. The indicator must be calibrated in roentgens and may not be dependent upon subjective interpretation of varying color or varying transmission or reflection of light, etc.

b. It must be feasible to read the instrument in the field without destruction of its capability to indicate additional increments of radiation exposure or loss of past exposure indication.

c. The instrument must indicate the gamma radiation dose, within the prescribed limits of true gamma radiation dose, in the presence of beta radiation fields likely to be present in a fallout radiation field.

d. The range preferably should be 0-600 r, but not be less than 0-200 r with an over-all accuracy better than plus or minus 25 percent, reference to cobalt 60, at all doses within the prescribed range of the instrument.

e. If the instrument is an electrostatic, self-reading type it must conform to the following criteria:

(1) Be capable of being recharged (reset to 0) with either a built-in or an auxiliary charger.

(2) After standing charged for 48 hours electrical leakage shall not exceed two percent of full-scale in four days.

f. An instrument or device which is not designed to be reset to zero must meet the following criteria:

(1) Have a range of 0-600 r.

(2) After a storage period of five years, the accuracy of radiation dose indication must still be within the limits of the criteria prescribed in 3d, above.

g. The instrument must read off-scale or give other positive indication when the total dose exceeds the range of the instrument.

h. The physical size, shape, and weight shall be such as to allow field use without serious interference with performance of necessary tasks.

GUIDES FOR ADVERTISING RADIATION MONITORING INSTRUMENTS

This is a reprint of the Federal Trade Commission publication of the same title, dated May 9, 1963.

These guides have been adopted by the Federal Trade Commission in the interest of protecting the public from the harm that might result from the deceptive advertising of devices offered to the public for detecting and measuring fallout radiation. In addition, the guides are intended to assist manufacturers and other sellers of such products in complying with the requirements of the Federal Trade Commission Act in their advertising and labeling of these products.

Mandatory proceedings to prevent deceptive advertising of radiation monitoring equipment may be brought under the Federal Trade Commission Act (15 U.S.C., Secs. 41-58) against those whose practices are subject to the jurisdiction of the Commission. Briefly stated, that Act makes it illegal for one to engage in "unfair methods of competition" or "unfair or deceptive acts or practices" in interstate commerce.

These guides were prepared on the basis of technical information furnished by the Office of Civil Defense, Department of Defense, and in cooperation with that Office. They were published in the Federal Register on May 28, 1963, and became effective immediately.

Inquiries and requests for copies of the Guides should be directed to the Bureau of Industry Guidance, Federal Trade Commission, Washington 25, D.C.

THE GUIDES

Application. These guides are applicable to the advertising of instruments, devices or other products which are represented in any manner to be of use to the general public for detecting or measuring fallout radiation. All forms of advertising, labeling and other promotional material, however disseminated, are within the scope of these guides.

Explanation of Terms. As used in these guides:

1. "Gamma Radiation" refers to the high energy radiation which would be given off by radioactive fallout particles and would present the major radiation hazard for the first few weeks after a nuclear attack;

2. "Roentgen" refers to the standard unit of measure for the amount (dose) of gamma radiation exposure;

3. "Dosimeter" refers to an instrument or device designed to measure the accumulated amount (total dose) of gamma radiation to which

an individual or area has been exposed during the period of measurement;

4. "Rate Meter" refers to an instrument or device designed to measure the intensity (dose rate) of gamma radiation existing at the time and place of measurement;

5. "Official OCD Criteria" refers to the CRITERIA FOR RADIATION INSTRUMENTS FOR USE BY THE GENERAL PUBLIC as published by the Office of Civil Defense, Department of Defense, Washington 25, D.C. (See Annex 3 to this Chapter).

I. PRODUCTS ADEQUATE FOR HOME CIVIL DEFENSE USE

A product should not be represented, directly or by implication, as providing an adequate means whereby families or individual users may detect or measure radiation resulting from a nuclear attack, unless the product meets the Official OCD Criteria in all material respects.

The following are some examples of products which would fail, in material respects, to meet the Official OCD Criteria:

Example 1. A rate meter which will not measure (indicate quantitatively) gamma radiation dose rates from 1 to at least 100 roentgens per hour and give positive indication when the dose rate is between 100 roentgens per hour and 1000 roentgens per hour;

Example 2. A dosimeter which will not measure (indicate quantitatively) accumulated doses of gamma radiation:

a. From zero to at least 600 roentgens, or
b. From zero to at least 200 roentgens (when provision is made for resetting the instrument's indicator back to zero to permit further use);

Example 3. A rate meter which will not provide a measure of gamma radiation within an over-all accuracy of plus or minus 35% of the true gamma radiation intensity (dose rate);

Example 4. A dosimeter which will not measure gamma radiation within an over-all accuracy of plus or minus 25% of the true accumulated amount (total dose) of gamma radiation;

Example 5. An instrument, the operation of which would be materially affected by temperature changes, habitable altitudes, high humidity and other climatic and weather conditions, or by prolonged periods of storage;

Example 6. An instrument or device which would require the user to evaluate the radiation dose or dose rate by nothing more than his interpretation of variations in tone, brightness, loudness, color or photographic densities.

II. PRODUCTS OF LIMITED HOME CIVIL DEFENSE USE - AFFIRMATIVE DISCLOSURES OF LIMITATIONS

A product which does not meet the Official OCD Criteria in all material respects, but which would be of some significant use in detecting and measuring fallout radiation, should not be represented, directly or by implication, as providing any means whereby members of the general public could detect or measure radiation resulting from a nuclear attack, unless all advertising, labeling and promotional material used therefor clearly and conspicuously disclose all material respects in which the product fails to meet the Official OCD Criteria.

III. REPRESENTATIONS FOR TOYS, NOVELTIES, ETC.

Products which cannot be relied on to serve a significant purpose in detecting and measuring radiation after a nuclear attack, should not be advertised or labeled in any manner which would convey the impression that the product would fulfill any such home civil defense need.

IV. REPRESENTATIONS FOR PROFESSIONAL MONITORING INSTRUMENTS

Professional, industrial, laboratory and other types of products designed for specialized radiation monitoring, but which would not be of practical use for some significant home civil defense need, should not be represented in any manner that would convey the impression that the product would be useful for home civil defense purposes.

V. REPRESENTATIONS REQUIRING QUALIFICATIONS

A. Representations which are susceptible of more than one interpretation, one or more of which would be misleading, should be qualified to remove the deceptive implications.

   Example 1. Claims implying that radiation monitoring instruments provide "protection" from fallout radiation are misleading because such instruments only detect and measure radiation. Shelter is required for protection against radiation hazards. Therefore, any statement implying that monitoring instruments afford protection, such as "Help Protect the Family," should be properly qualified.

   Example 2. Such representations as "Detect and Measure Radiation" should be qualified so as to make it clear that the advertised product would be adequate for measuring only dose rates or only total doses of gamma radiation, as the case may be, unless the product adequately provides for making both types of measurements.

B. Representations which cannot be qualified without the qualification amounting to a contradiction should not be used.

Example 1. Representations such as "100% Accurate" and "Fully Accurate," or any other expressions implying that an instrument would be completely accurate under all possible conditions of use, should not be used unless true in fact, because any qualification would amount to a contradiction.

Example 2. If a product does not include an adequate dosimeter and an adequate rate meter it should not be represented as a "Complete Family Kit," because any qualification of that claim, or one of similar meaning, would necessarily contradict the implication that a family would need nothing more than the kit to satisfy its basic radiation monitoring needs.

C. Qualifications or disclosures should be made clearly and conspicuously in close conjunction with any representation which makes the qualification or disclosure necessary, and should have sufficient prominence to be observed by casual readers. Qualifications and disclosures should not be deceptively de-emphasized through use of small print, asterisks, footnotes or by any other means.

VI. GOVERNMENT APPROVAL OR ENDORSEMENT

If a product meets the Official OCD Criteria, the advertiser may reveal this fact in advertising. However, even though the product meets such Criteria, an advertiser should not represent in any manner that the product is being offered by, or has been approved, accepted, recommended or otherwise endorsed by the Government or any agency thereof. Thus, representations, pictures, seals, insignia, trade or brand names, or any other term or symbol which would imply any Government connection, approval or any other form of Governmental endorsement, should not be used.

VII. PERFORMANCE CLAIMS AND OTHER REPRESENTATIONS

No representation should be made, in any manner, which would mislead prospective purchasers concerning:

1. A product's manner of performance, capabilities, reliability, utility, durability, or shock-resistant or moisture-resistant properties; or

2. The ease or simplicity with which a product may be operated, interpreted, calibrated, tested, repaired or maintained.

(NOTE: The Federal Trade Commission's Guides Against Deceptive Pricing and Guides Against Deceptive Advertising of Guarantees furnish guidance respecting price and guarantee representations.)

s/ Joseph W. Shea

Joseph W. Shea,
Secretary.

247-884 O - 67 - 16

CHAPTER VIII

RADIOLOGICAL EQUIPMENT AVAILABLE TO STATES FOR CIVIL DEFENSE PURPOSES

The user of this Guide should remember that this Chapter and its Annexes, with the exception of Annexes 1, 3 and 4, are reprints of clearance draft materials for FG-E-5.8. This means that the contents of the Chapter are subject to change. Annexes 1, 3 and 4 are reprints of previously issued OCD Instructions and should be considered as OCD policy.

The purpose of this Chapter is to present comprehensive information on policies, requirements, and procedures relating to the availability of the several sets, kits, separate instruments, and pieces of equipment that are available to the States for training monitors, for shelter monitoring, monitoring stations (fixed and mobile), emergency workers, maintenance and calibration, and special functions such as aerial monitoring and measurement of unshielded dose rates at blast resistant Emergency Operating Centers (EOC's).

This Chapter outlines the broad policies and procedures relative to radiological instruments and associated equipment. The annexes provide details concerning the specific policies, requirements, and procedures applicable to the various complements, or separate items, of instruments or equipment.

The Office of Civil Defense is authorized, pursuant to provisions contained in the Federal Civil Defense Act of 1950 as amended, to procure and maintain radiological instruments and detection devices and distribute the same by loan or grant to the States for civil defense purposes under terms and conditions prescribed by the Director.

PROGRAMS

The programs supported by the grant or loan of radiological instruments and associated equipment include:

Shelter Monitoring. As a portion of the shelter stocking program, OCD makes available for each licensed public shelter, which is not an operational monitoring station, at least one shelter radiation kit, CD V-777-1. Additional kits are made available to very large shelter facilities or to facilities comprising several nonadjoining shelter areas. (See FG-E-2.3)

Operational Monitoring Stations. The goal is to have a minimum of 150,000 operational monitoring locations and associated mobile monitoring capability established by agencies of Federal, State, and local government in accordance with the guidance outlined under "Nationwide Requirements," in Chapter I.

As State and local governments meet established OCD requirements for monitoring stations, a set of instruments (CD V-777) is made available on a grant basis for each station. (See Annex 1 to this Chapter) A second set (CD V-777A) will be made available for those stations as they satisfy limited additional requirements. (See Annex 2) For selected operational monitoring stations not meeting all the requirements for a second set (CD V-777A), a CD V-717 remote sensor survey meter is made available. (See Annex 7 to this Chapter).

Monitor Training. Training equipment is made available to certain Federal agencies and the State for use by qualified instructors in training monitors for shelters and monitoring stations. The Radiological Defense Training Set (CD V-776) is made available on a grant basis to the States for use by qualified instructors at the State and local levels of government. The Radiation Training Source Set (CD V-778) is made available on an indefinite loan basis only to those qualified instructors or organizations having applicable AEC licenses (or equivalent State licenses) to possess and use these radioactive sources for the training of monitors. (See Annex 3)

Instruments for Civil Defense Workers. The goal is the distribution of 5 million dosimeters (CD V-742), and appropriate numbers of chargers to agencies of Federal, State, and local government for dispersed storage at points accessible to emergency work groups, postattack. (See Annex 4)

Remote Sensor Instruments for Selected Facilities. Instruments for this purpose are designed to satisfy varying requirements for blast protection, cable length, etc., and will be made available to EOC's and other important facilities satisfying the OCD criteria presented in Annex 5.

Aerial Monitoring. The goal is the establishment of a minimum of 3,000 trained and equipped aerial monitoring teams capable of operating from the airports and landing fields of the nation. The aerial monitoring instrument (CD V-781) issued to each team is especially designed for training as well as postattack operational monitoring. Details concerning availability are contained in Annex 6.

Future Programs and Special Requirements. Changes of the threat, development of new types of instruments, or revision of civil defense operational systems could result in changes in the above programs or the establishment of new programs which will be reflected in revision, replacement, or addition of annexes to this Chapter.

In some instances, individual standard instruments may be needed to meet special or unusual requirements. Appropriately justified requests for separate standard items will be considered on their merits.

ALLOCATIONS

Generally, OCD will make annual allocations based upon availability of instruments and equipment, and the estimated requirements at Federal, State, and local levels. Special allocations may be made when appropriate.

Form OCD 342 (see page 8-5) is to be used in applying for loan or grant of all equipment except shelter radiation kits. Special forms required in addition to the OCD Form 342 for requesting specific types of equipment are reproduced in the appropriate annexes. Copies of these forms may be obtained from the State Civil Defense Director or the U.S. Army AG Publications Center, Civil Defense Branch, 2800 Eastern Boulevard (Middle River), Baltimore, Maryland 21220.

States will submit three copies of their requests, unless otherwise specified in the appropriate annex, for radiological equipment to the appropriate OCD region, using OCD Form 342 accompanied by additional requirements as set forth in the annexes. If a State certifies compliance with the conditions stated on the form and has not exceeded its allocation of equipment, the OCD region may approve the State's request for the radiological defense equipment. The OCD region will forward the original of the approved request directly to the Defense General Supply Center, Civil Defense Supply Division, Richmond, Virginia 21220. The OCD region will return one copy of the approved request to the State and retain one copy for its files. DGSC will issue shipping instructions to the OCD depot. The depot will furnish to the appropriate regional office a copy of the shipping document (DD Form 1149), which will be annotated with the date and method of shipment and government bill of lading number, if applicable.

OFFICE OF CIVIL DEFENSE
Department of Defense
Washington 25, D. C.

Form Approved
Budget Bureau No. 120-R026

APPLICATION FOR GRANT OR LOAN OF RADIOLOGICAL EQUIPMENT BY THE OFFICE OF CIVIL DEFENSE*

Date ____________________

TO: OCD REGION __________

It is requested that the following OCD radiological equipment be issued to the State of ____________________ for radiological defense purposes under the conditions indicated:

AMOUNT	TYPE OF EQUIPMENT	CONDITION *(Loan or Grant)*
________	______________________________	________________________
________	______________________________	________________________

Upon receipt of the property, the undersigned as the duly authorized agent, certifies that it will be used subject to the applicable conditions in this Application, and requests that the property listed herein be shipped to: ____

Street City County State

____
(Name of State Custodian)

____
(AEC License Number, if required)

____
(Address)

____
(No. of CD V-778 Radiation Source sets presently in possession.)

for acceptance, subject to the applicable conditions in the name of ______________________________
(State)

BY ______________________________
(Signature)

TITLE ______________________________

DATE ______________________________

TO: DEFENSE GENERAL SUPPLY CENTER, CIVIL DEFENSE SUPPLY DIVISION, RICHMOND 12, VIRGINIA

By virtue of the authority of the Federal Civil Defense Act of 1950, as amended, to grant or loan to the several States, the District of Columbia, and the Territories and Possessions, equipment for radiological defense purposes, and pursuant to the warranties and representations made in this Application, the above-described property is hereby (granted) (loaned) to the State of ______________________________, as requested.

OFFICE OF CIVIL DEFENSE

BY ______________________________
(Signature)

TITLE ______________________________

DATE ______________________________

* State prepares in quadruplicate and submits all copies to OCD Regions.

Form OCD-342
January 1965

(Supersedes Forms OCD 342-1, 342-2, and 273 which MAY NOT be used.)

TERMS AND CONDITIONS

To obtain a grant or loan of OCD radiological equipment, the State agrees that it will comply with Title VI of the Civil Rights Act of 1964, (PL 88-352) and the requirements imposed by or pursuant to the Regulation of the Department of Defense (32 CFR Part 300), and that it will immediately take measures necessary to effectuate this agreement. This assurance obligates the undersigned for the period which it retains ownership or possession of the property described in the application. It is given in consideration of obtaining the assistance described. It is understood the Federal financial assistance is extended in reliance on this assurance, and that the United States shall have the right to seek judicial enforcement thereof.

I. To obtain a grant of OCD radiological defense training equipment, the State agrees:

a. To use this equipment only for OCD-approved radiological defense training courses.
b. To maintain this equipment in an operable condition.
c. To assume the costs, custody, and reshipment within the State after receipt from OCD.
d. To meet the minimum standards of training.

II. To obtain the loan of a Radiation Source Set, the State agrees:

a. To maintain the equipment in proper operating condition and to pay costs of maintenance and reshipment within the State, while in possession of the State.
b. To indemnify the Federal Government against any loss or damage, or claim of loss or damage against the Federal Government arising from, or in any way connected with, the use, storage, or transportation of the source material.
c. To maintain current records of the location of the sources and custodians. Approval must be obtained from the appropriate Regional Office prior to the transfer of the custody of a source set. The Regional Office will be furnished a copy of the new custodian's AEC license and a letter of receipt from the new custodian stating he has received the complete source set and has accepted responsibility for it.
d. To return the source set to OCD when no longer needed or for disposal.

III. To obtain a grant of OCD operational monitoring equipment, the State agrees:

a. To train replacements for those monitors who leave monitoring stations and, whenever possible, to train four monitors per fallout monitoring station.
b. To assign the Radiological Defense Monitoring Set (CD V-777) to the fallout monitoring station(s) listed on OCD Form 342A.
c. To use this equipment for radiological defense operational purposes only.
d. To perform a monthly operability check of this equipment and to maintain it in a proper operating condition.
e. To insure that each locality maintains a current roster of trained monitors with their assignments, which is to be available for review upon request by OCD or the State.
f. To place the equipment in a monitoring station with a protection factor of at least 100, or in a station whose location is justified in accordance with the requirement appearing on OCD Form 342A.
g. To maintain the communication(s) capabilities for each monitoring station to report to the seat of government indicated in OCD Form 342A.

IV. To obtain a grant of OCD replacement batteries, the State agrees:

a. To use all batteries issued under this program exclusively for the operation of civil defense radiological instruments.
b. To assume responsibility for distribution of the batteries within the State and provide for getting the batteries from secondary distribution points into the sets for storage along with the operational instruments.

V. To obtain a grant of OCD spare parts or other expendable items under the maintenance and calibration programs, the State agrees:

a. To maintain a statewide maintenance service.
b. To use all spare parts issued under this program exclusively for the maintenance of civil defense equipment.

The Office of Civil Defense will pay shipping costs of the equipment granted to the State between OCD shipping points and the State's receiving station. The Office of Civil Defense will pay shipping costs of equipment obtained on a loan basis between OCD shipping points and the State's receiving station and return.

RADIOLOGICAL EQUIPMENT AVAILABLE TO STATES FOR OPERATIONAL MONITORING STATIONS

To provide the necessary radiological defense information required to conduct civil defense operations following nuclear attack, a national minimum of 150,000 operational fallout monitoring stations must be established. To provide 24-hour coverage of these stations in an emergency, four monitors per station should be trained.

Local and State civil defense directors should be encouraged to select some of the large community shelters as fallout monitoring stations and may, when desired, reassign the monitoring personnel and instruments from a previously established monitoring station to a community shelter. The community shelter should be located in an area providing good geographic coverage and have a communications capability. During the early period after nuclear attack, monitors will measure radiation at the monitoring stations. When radiation levels permit, the instruments assigned to the monitoring stations can be used in a mobile or aerial monitoring mission. Radiation measurements will be reported, or relayed, to assigned seats of government for plotting and analysis in accordance with established operational plans.

This annex contains information on requirements and procedures relating to availability of radiological defense equipment for operational monitoring stations.

RADIOLOGICAL DEFENSE EQUIPMENT FOR OPERATIONAL MONITORING STATIONS

The Radiological Defense Operational Set (CD V-777) consists of the following items in the quantity indicated:

Item	Quantity
CD V-700 Geiger counter (0-50 mr/hr)	1
CD V-715 Survey meter (0-500 r/hr) 1/	2
CD V-742 Dosimeter (0-200 r) 2/	2
CD V-750 Dosimeter charger	1

1/ In early distribution of CD V-777 sets, the CD V-710 and CD V-720 were supplied in place of CD V-715. The CD V-710 and CD V-720 should be used where previously supplied.

2/ In early distribution of CD V-777 sets, the CD V-730 and CD V-740 were supplied in place of CD V-742. The CD V-730 and CD V-740 should be used where previously supplied.

Requirements for obtaining operational radiological defense equipment for a monitoring station are:

1. A minimum of two monitors, trained through OCD approved courses, is required for each monitoring station. Four trained monitors are preferred so that during the emergency period 24-hour coverage can be maintained.
2. A method of communication (telephone or radio) must be available for the monitoring station to report data to the designated data collection station.
3. A facility location which satisfies the requirements of the planned dispersal of monitoring stations.
4. A facility with a protection factor of 100 or greater must be utilized, if available, in the area needed for geographical coverage. A monitoring station may be established at a location having a lower PF. However, it must be established in a facility providing the best protection available in the geographical area. A plan should be developed to improve the fallout protection as soon as practicable. Matching funds may be utilized by the State for providing a protection factor of 100.

The applicant must also agree to train replacement monitors; maintain the equipment in operating condition; perform monthly operability checks; maintain rosters of monitoring stations and trained monitors with their assignments.

State and local political subdivisions should attempt to establish monitoring stations in facilities that have the desired protection factor, or in facilities where the desired protection factor can be achieved. This annex will assist in the evaluation of the protection factor of a facility in those cases where the building has not been surveyed previously under the National Shelter Survey Program.

If requirements are met, monitoring stations should be located preferably at fire, police, welfare, highway patrol, highway maintenance, forestry, agricultural, health, or other State and local government facilities because of superior operational control. They may also be situated at radio transmitter sites, industrial or commercial facilities, at local and county airports where monitoring is not being accomplished by a field facility of the Federal Aviation Agency or the U.S. Weather Bureau as part of the Federal Agencies' participation in the monitoring network or in other private facilities if the above qualifications are met.

PROCEDURES FOR OBTAINING RADIOLOGICAL OPERATIONAL SET CD V-777

As required in the basic chapter, States will submit three copies of their requests for Operational Sets (CD V-777) to the appropriate OCD region, using OCD Form 342 accompanied by one copy of OCD Form 342A, (See page 8-11).

GUIDANCE FOR EVALUATING FALLOUT PROTECTION FACTOR OF MONITORING STATION LOCATION

If the building in which the monitoring station is to be located has not been surveyed under the National Shelter Survey Program, the following guidance will assist in determining whether existing or proposed radef monitoring stations have a PF of at least 100 as required:

1. General:

   a. The term "PF" may be applied to any building or portion thereof, and defines the amount of protection that is provided from fallout radiation. For example, a PF of 100 means a person inside the protected area would receive 1/100th the radiation he would receive if he were outside and unprotected.

   b. Calculation of the PF for a particular building or portion thereof is complex. However, most buildings will fall into certain definite categories described below, and by using these categories it is possible to determine whether a particular area in a building has a PF of 100.

2. The following structural areas can be expected to have a PF of 100 or more:

   a. Below-ground basement areas of multistory (over three stories) commercial or apartment type buildings of concrete or masonry construction with typical concrete floor construction. 3/

   b. Central floor areas of multistory commercial or apartment type buildings (excluding upper two and lower two floors) having heavy floors and exterior walls. For example, in a six-story building, the central areas in the third and fourth floors may have 100 PF.

   c. Below-ground basement areas of one or two story nonresidential buildings of 4,000 square feet floor area, or less, which have a basement ceiling of at least 10 inches of concrete or a total thickness of 10 inches of concrete in the barriers between the occupied areas and the building exterior. For example, a 6-inch basement ceiling with floor and roof slabs above totaling at least 4 inches, and the exterior walls of the floor above the basement averaging at least 4 inches of concrete, would have a PF of 100.

3/ Note on Basements: When basements are not completely below ground, the exposed walls should be of at least 16 inches of masonry with no windows except windows completely in wells. Where materials have been made readily accessible for emergency blocking of windows not already in wells with sandbags or blocks, the areas may be acceptable for a monitoring station.

d. Below-ground basement areas of heavy monumental type buildings (usually local government buildings) with heavy masonry exterior walls, wooden floors, and heavy masonry interior partitions (6 inches of masonry or more) and at least three stories high would have a PF of 100. Square footage of area involved within partitions should not be in excess of 500. (See footnote 3, preceding page)

3. The following types of structures do not provide a PF of at least 100 unless a special fallout shelter has been constructed inside the building:

   a. Typical private residential buildings, either masonry or frame construction, with or without basement, and one to three stories high.
   b. Typical commercial buildings, either masonry or frame construction, with or without basements, and one to three stories high.
   c. Typical sheet metal warehouses or garage-type buildings.
   d. Modern construction (schools, etc.) one or two stories without basements.
   e. One or two story nonresidential buildings with basements completely below grade, masonry walls, and a floor area of 4,000 square feet or more, which have a basement ceiling of less than 10 inches of concrete or total thickness of less than 10 inches of concrete in the barriers between the occupied areas and the building exterior.
   f. Any building basement (regardless of overhead protection) which is not below ground level, and which has exposed walls (walls above ground) of less than 16 inches of masonry and/or with windows opening directly to grade.

4. If a building does not fall into one of the categories described above, it may be evaluated by local architects and engineers who have taken the Fallout Shelter Analysis Course, or assistance should be requested from the State civil defense office. To make such an evaluation, it may be desirable to forward an accurate sketch of the building with complete information on building construction. Local building inspectors, city engineers, or building contractors may be consulted for preparing the sketch and providing the needed information. Information required is shown on page 8-13, Data Collection Form OCD 341.

SUPERSESSION

The information furnished in this annex supersedes that previously given in OCD Instruction 9667.1 and Change 1.

Department of the Army
Office of the Secretary of the Army
Office of Civil Defense

ATTACHMENT A

SUPPLEMENT TO APPLICATION FOR GRANT OF OPERATIONAL MONITORING EQUIPMENT

To be prepared in duplicate; one copy to be retained by the State, and the original submitted to the OCD Region.

---

1. MONITORING STATION NO. ______ Type of Installation (Police, Fire, etc.) ______

Street Address ______ City, County, and State ______

Monitors

	Name	Street Address
a.		
b.		
c.		
d.		
e.		
f.		

Communications

a. Type of Communications ______ (Radio or Telephone)

b. Reports to: ______

Protection Factor

a. PF 100 or greater ______
b. PF 40 to 100* ______
c. PF less than 40* ______

Shelter Facility No. ______
Shelter Category (if applicable) ______

*(A separate justification will be submitted indicating the local plans for the subsequent achievement and estimated completion date of the required fallout protection at each station that does not have a protection factor of at least 100)

---

2. Monitoring Station No. (etc.) (Add additional sheets as required for each monitoring station, in similar format.)

OCD Form 342 A Supersedes OCD Form 347, August 1964, which may be used.

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY OF THE ARMY
OFFICE OF CIVIL DEFENSE

DATA COLLECTION FORM*

Form Approved
Budget Bureau No 120.R026

1. NAME (*Inspector*)	2. DATE

3. LOCATION

4. DESCRIPTION OF SURROUNDINGS

5. DESCRIPTION OF STRUCTURE

a. GENERAL DIMENSIONS	b. NUMBER OF FLOORS
c. FLOOR HEIGHTS	d. SILL HEIGHTS
e. BASEMENT FLOOR LEVEL	f. GROUND FLOOR LEVEL
g. PERCENT BASEMENT WALL EXPOSED	h. PERCENT AREAWAYS

6. STRUCTURAL INFORMATION

a. ROOF	APERTURE PERCENT
b. GROUND FLOOR	APERTURE PERCENT
c. HIGHER FLOORS	APERTURE PERCENT
d. EXTERIOR WALLS	APERTURE PERCENT
e. INTERIOR WALLS	APERTURE PERCENT
f. BASEMENT WALLS	APERTURE PERCENT

7. NONSTRUCTURAL INFORMATION

a. OCCUPANCY	BUSINESS HOURS	OTHER TIMES

b. ENTRANCES, EXITS	c. VENTILATION
d. SANITATION	e. WATER SUPPLY
f. POWER SUPPLY	g. HAZARDS

8. ADAPTABILITY FOR FALLOUT SHELTER

9. REMARKS

ATTACHMENT B

* *This form is to be forwarded to the State Civil Defense Office if assistance is required in determining the protection factor of a facility*

OCD FORM 341, AUGUST 1964 . SUPERSEDES OCD FORM 341, NOV 62, WHICH MAY BE USED

ATTACHMENT B

INSTRUCTIONS FOR OCD FORM 341

1. Name of inspector.

2. Date data was collected.

3. Street address and name of subdivision, tract, precinct, etc.

4. Land use *(industrial, commercial, residential, etc.)*. Height and general description of adjacent buildings; e.g., four-story brick loft building and two-story brick residence. In urban areas, include distances to adjacent buildings.

5. a. Overall length, width, and height; L-shaped, T-shaped, U-shaped, etc. Make sketch on graph paper on reverse side of Data Collection Form.

b. Self-explanatory.

c. Give basement floor height as, e.g. B10½ ft; ground floor height as, e.g. G15 ft; and upper floor heights as, e.g. U9½ ft.

d. Self-explanatory.

e. Distance from basement floor to average ground line outside *(level lot)*. Distance from basement floor to highest and lowest ground line *(sloping lot)*.

f. Distance from ground floor to average ground line outside.

g. Estimate percent of basement wall above grade.

h. Estimate percent of basement wall in areaways.

6. a. State type of roof construction and estimate percent of roof area with skylights, hatches, etc.

b. and c. State type of floor construction and estimate percent of floor area with stairwells, elevator shafts, etc.

d, e, and f. State type of wall construction and estimate percent of wall area with windows, doors, or duct openings.

7. a. After "Occupancy" state whether residential, commercial, industrial, storage, public building, etc. After "Business Hours" state number of employees and transients normally in building. After "Other Times" state number of employees and transients in building after the normal business hours of the community.

b, c, d, e, f, and g. To explain these conditions, use the graph paper on reverse side of the Data Collection Form for notes and sketches.

8. Indicate area(s) in building with fallout shelter potential.

9. Sources of information may be noted here.

NOTE: Photographs may be useful in identifying a particular problem or structure. Attach to form.

AVAILABILITY OF RADEF MONITORING SUPPORT SET (CD V-777A) FOR OPERATIONAL MONITORING STATIONS

The supplementary set of radiological defense equipment is made available to selected operational monitoring stations to accomplish the following objectives:

1. Allow on-station measurement of high radiation dose rates with minimal exposure to monitors.
2. Increase the availability of sur ey meters to those stations which are assigned extensive mobile monitoring responsibilities, or ground support of aerial monitoring operations.

This annex contains information on requirements and procedures relating to the availability of the Radef Monitoring Support Set for operational monitoring stations.

RADEF MONITORING SUPPORT SET (CD V-777A)

The Radef Monitoring Support Set (CD V-777A) consists of the following items, in the quantity indicated:

Item	Quantity
CD V-700 Geiger counter (0-50 r/hr)	1
CD V-715 Survey meter (0-500 r/hr)	1
CD V-717 Survey meter, remote sensor (0-500 r/hr)	1
CD V-742 Dosimeter (0-200 r)	3
CD V-750 Dosimeter charger	1

To obtain a Radef Monitoring Support Set, CD V-777A, the requirements for obtaining the issue of a Radiological Defense Operational Set, CD V-777, must be met, and in addition:

1. At least four trained radiological monitors for each monitoring station are required.
2. The monitoring station must have a major assignment for mobile monitoring or must be located at or near an airport to support aerial monitoring operations.
3. The monitoring station has a minimum PF of 40 and plans have been established to increase this protection factor to 100 or better. Annex 1 of this chapter, page 8-9, will assist in the evaluation of the protection factor of a facility in those cases where the building has not been surveyed previously under the National Shelter Survey Program.
4. The CD V-717 instrument has not been, and will not be requested for the station.

PROCEDURES FOR OBTAINING THE RADEF MONITORING SUPPORT SET (CD V-777A)

The procedures for obtaining the CD V-777A Radef Monitoring Support Set will be the same as those specified in Annex 1, "Procedures for Obtaining Radiological Operational Set CD V-777." Additionally, on the reverse side of OCD Form 342, the applicant must "write or type" that "all requirements set forth in FCDG-E-5.8.2 have been met." An OCD Form 342A, indicating the current data applicable to each station, must be submitted with the request for each CD V-777A set.

For initial establishment of a monitoring station which fulfills the above requirements, both the CD V-777 and CD V-777A sets should be requested simultaneously to decrease administrative and transportation costs.

RADIOLOGICAL EQUIPMENT AVAILABLE FOR TRAINING

Training equipment is made available for use by qualified instructors in training monitors for shelters and monitoring stations. This annex contains information on requirements and procedures relating to availability of radiological defense equipment for training.

RADIOLOGICAL DEFENSE EQUIPMENT FOR TRAINING

Radiological Defense Training Set (CD V-776). This set consists of the following items, in the quantity indicated:

Item	Quantity
CD V-457 Training/demonstration kit	11
CD V-138 0-200 mr dosimeters	30
CD V-700 Geiger counter (0-50 mr/hr)	15
CD V-715 Survey meter (0-500 r/hr)	15
CD V-717 Survey meter (0-500 r/hr) remote	2
CD V-742 0-200 r dosimeter	2
CD V-750 Dosimeter charger	15

Radiation Training Source Set (CD V-778). This set consists of the following items, in the quantity indicated:

Item	Quantity
CD V-784 Capsules of Cobalt 60 sources,	6
5 mc each (totaling 30 mcs)	6
CD V-791 Lead container, small	1
CD V-792 Lead container, medium	1
Locks for CD V-792	2
CD V-788 Long-handled tongs for handling sources	1
Radiation hazard signs	8
CD V-138 0-200 mr dosimeters	2
CD V-750 Dosimeter charger	1
CD V-700 Geiger counter	1

The specific conditions for obtaining radiological defense training sets and radiation training source sets are stated on the application OCD Form 342.

PROCEDURES FOR OBTAINING RADIOLOGICAL EQUIPMENT FOR TRAINING

As required in the basic chapter, States will submit three copies of their requests for training sets (CD V-776), or radiation training source sets (CD V-778), to the appropriate OCD region, using OCD Form 342.

Requests for source sets (CD V-778) will be accompanied by a copy of the custodian's AEC or State Byproduct Material License for authorization to use the CD V-778. On the OCD Form 342, immediately below the custodian's license number, a statement must be added of the number of CD V-784 and CD V-786 source sets currently in the possession of the custodian. The license will be kept on file by the OCD regional office. The region should carefully check Items 8 and 9 of the Byproduct Material License to (1) verify the total number of CD V-778 sets the licensee is authorized to possess so that the number already in his possession, and the number requested, will not exceed the sum authorized, and (2) assure that he is licensed to use the CD V-778 set for the purpose requested.

SUPERSESSION

The information furnished in this annex supersedes that previously given in OCD Instruction 9667.1 and Change 1.

AVAILABILITY OF DOSIMETERS AND DOSIMETER CHARGERS FOR STATE AND LOCAL EMERGENCY OPERATIONS

In many localities there will be a postattack requirement for carrying out emergency operations before fallout has decayed to levels that would permit unrestricted movement outside of shelters. These emergency operations might include rescue, first aid, and medical attention; firefighting; maintenance of law and order; maintenance or restoration of public services, such as power, water, and sewer systems; restoration of transportation and communications; redistribution of resources from areas of surplus to areas of need; decontamination of streets, buildings, and other critical areas; reactivation of essential industry; and other emergency operations. These would have to be carried out on a calculated-risk basis, and radiation exposure control techniques would be essential to avoid unnecessary radiation injury to personnel. The application of exposure control techniques requires an operational monitoring capability and the availability of dosimeters and dosimeter chargers for use by emergency personnel.

This annex contains information on requirements and procedures relating to the availability of dosimeters and dosimeter chargers for postattack use by emergency personnel.

DISTRIBUTION AND STORAGE

OCD announces an allocation of radiological instruments usually on an annual basis. The prescribed intrastate distribution, percentage remaining in the custody of the State versus percentage placed in the custody of the political subdivions, has been varied with the first and second allocations to accomplish planned distribution on a step-by-step basis.

The first allocation, and accompanying intrastate distribution, was planned to emphasize distribution to the political subdivisions in order to provide limited built-in capability for independent action at the local level. Dosimeters became available under the first allocation in March 1963. The second allocation became effective for FY 1965. Major emphasis is placed on dispersed storage near areas of potential use, but with custody remaining with the State. This will provide flexible supply for the larger scale operations to be directed by the State, and for post-attack issuance to those political subdivisions which have to implement extensive recovery programs requiring extensive dosimetry. Instruments available under those allocations should be requested and distributed promptly. However, those allocations with the respective distribution criteria will remain in effect until rescinded. For example, a State which has not yet requested the dosimeters and chargers made available under the first allocation may request those instruments for distribution under the provisions applicable to that allocation, unless the allocation has previously been rescinded.

The distribution criteria for the first and second allocations are as follows:

First Allocation. Each State allocation will be divided into two portions -- a State portion and a local political subdivision portion. The State portion will be one-fifth of the State allocation, and the remaining four-fifths will be for the local political subdivisions. At their discretion, the State and local civil defense directors may issue for preemergency use up to but no more than 10 percent of their respective portions to employees of regular government services (i.e., policemen, firemen, etc.) having postattack emergency civil defense assignments. The remaining 90 percent of each portion will be held in ready reserve for postattack issue as required.

Second Allocation. Custody will be retained by the State, and storage will be at dispersed locations or facilities under the control of the State. The locations selected and the numbers of dosimeters stored at each location should provide capability for (1) prompt issuance to political subdivisions of up to 50 percent of the ready storage in a period of tension, (2) ready postattack issuance to those political subdivisions requiring support for their survival and recovery operations, and (3) instrument support for broad scale supporting operations under the direction of the State.

To provide continuing flexibility in patterns of distribution, it is expected that future allocations will be subject to further revised distribution criteria. These will be distributed as changes to this annex.

The selected storage locations should be dry, provide for physical security, but permit access of authorized personnel in an emergency and for annual inspection and charging. A minimum of two dosimeter chargers should be located with any small (but reasonable) number of dosimeters. A greater number of chargers should be obtained for those locations where large numbers of dosimeters are stored, provided the State allocation is not exceeded. At many storage locations the chargers at monitoring stations and shelters can satisfy a portion of the requirement for dosimeter chargers.

REQUIREMENTS FOR OBTAINING CD V-742 DOSIMETERS AND CD V-750 DOSIMETER CHARGERS

The State will apply OCD criteria for storage distribution of dosimeters and dosimeter chargers in a manner to assure a proportionate ready availability for political subdivisions. Proportionate availability will be based on the ratio of a political subdivision's population to the total State population.

In addition, the State and local civil defense directors (as appropriate) will:

1. Maintain current custody records for dosimeters and dosimeter chargers issued to individuals.
2. Maintain a complete record of the dosimeters and dosimeter chargers held at each State and local storage location, keep the dosimeters and dosimeter chargers in operable condition, and inventory them at least once annually.
3. Recharge the dosimeters at lease once annually.

NOTE: Records required will be made available for review upon request. Instrument serial numbers may be omitted from these records.

PROCEDURES FOR OBTAINING DOSIMETERS AND DOSIMETER CHARGERS FOR EMERGENCY OPERATIONS

As required in the basic chapter, States will submit three copies of their dosimeter or dosimeter charger requests for emergency operations to the appropriate OCD region, using OCD Form 342. Under the "Amount" column, the State will indicate the number of dosimeters or dosimeter chargers requested, and enter "grant" under the column labeled "Condition." The State will also attach a sheet to each copy of OCD Form 342, certifying that the State agrees to abide by the requirements set forth in this annex.

A State should not submit a request for its emergency dosimeters or dosimeter chargers until advised by the region of its annual State quota. Each region will be advised of the annual State quota by separate memorandum.

OPERATIONAL GUIDANCE

As a result of the multiplicity, extent, and possible prolonged duration of the postattack emergency functions to be performed by the local government, a shortage of dosimeters may result in some areas. Where the additional requirement cannot be met from State ready reserves or by redistribution from lightly contaminated areas, dosimeters will be assigned on a mission or a shift basis. They will be charged and read at the time of issue. Upon completion of mission or shift, the individual's mission dose will be recorded and the dosimeter recharged for reissue as required.

SUPERSESSION

The information furnished in this annex supersedes that previously given in OCD Instruction 9667.2A.

AVAILABILITY OF REMOTE SENSOR RADIATION METER (CD V-711) FOR EMERGENCY OPERATIONS CENTERS

The Remote Sensor Radiation Meter, CD V-711, is designed especially for use at blast resistant type Emergency Operations Centers (EOC's). It provides intermittent or continuous surveillance of the outside gamma radiation exposure rate, particularly during early postattack periods when exterior radiation levels are too high to permit leaving the sheltered area for direct manual monitoring. The equipment consists of an outdoor detector unit which senses the presence of gamma radiation; cables for underground interconnection between the outdoor unit and the indicator unit within the shelter; and the indicator unit itself which is calibrated in roentgens per hour (r/hr) and which measures gamma radiation exposure rates present at the detector location in the range 0-1,000 r/hr. The detector unit is mounted on standard piping, and the overall aboveground installation is approximately 4 inches in diameter and 2-½ feet high.

The most desirable location for the detector unit is away from buildings in a smooth, flat area with grass, concrete, or asphalt surrounding the detector unit for at least 100 feet in all directions. Connecting cable is provided in 50, 100, and 150 foot lengths. The indicator unit which can be wall mounted is approximately 12 x 4 x 6 inches. Details of installation, operation, and maintenance are contained in an Instruction and Maintenance Manual for the meter.

Depending upon availability of funds, financial assistance for installation may be made available through the contributions program; not to exceed 50 percent of the actual installation cost.

This annex contains information on requirements and procedures relating to the availability of the CD V-711 Remote Sensor Radiation Meter for installation in blast resistant-type EOC's. States should make this information available only to those political subdivisions where qualified facilities exist.

Requirements for obtaining the blast resistant remote radiation meters on the basis of one per EOC are:

1. The EOC area must provide:

    a. An estimated protection factor against fallout radiation in excess of 500.
    b. An estimated blast overpressure resistance of more than 10 psi.

2. A Radef Officer must be assigned to the EOC.
3. The State must agree to maintain current a directory of EOC's which have been granted CD V-711 meters.
4. States will agree to maintain the CD V-711 equipment in proper operating condition and to calibrate it periodically in accordance with OCD recommendations.

PROCEDURES FOR OBTAINING REMOTE SENSOR RADIATION METERS (CD V-711)

The State will submit four copies of its request to the appropriate OCD regional office, using Form OCD 342. In the "Amount" column, the State will indicate the number of CD V-711 meters requested and enter "grant" in the "Condition" column. The OCD regional office will provide an information copy of the signed request to the Emergency Operations Division, Office of Civil Defense, Office of the Secretary of the Army, Pentagon, Washington, D.C. 20310. The State must attach a sheet to each copy of the OCD Form 342, certifying that the State agrees to abide by the requirements set forth in this Annex and applicable requirements set forth in Chapter VIII. Additionally, the State will also include on the attached sheet the following data for each EOC:

1. The Standard Location Number or National Location Code (NLC) and Facility Number of the EOC.
2. The estimated date of installation of the CD V-711 meter.

Depending upon availability of funds, financial assistance for installation may be made available through the Contributions Program; not to exceed 50 percent of the actual installation cost.

EXCEPTIONS

Exceptions to the criteria established above may be requested of OCD. Such requests, with attached justification, should be submitted to the Emergency Operations Division, Office of Civil Defense.

In cases where the justification for exception is not deemed sufficient by OCD, a CD V-717 Radiological Survey Meter should be used at the EOC instead of a CD V-711.

AVAILABILITY OF AERIAL MONITORING SETS FOR STATE AND LOCAL EMERGENCY OPERATIONS

Aerial monitoring will supplement fixed station and mobile monitoring through its capability to:

1. Obtain radiological information in areas where information cannot be obtained from monitoring stations due to destruction of stations, failure of communications, inoperable instruments, or absence of the trained monitors to man the stations.
2. Monitor areas of high radiation intensities where surface mobile monitoring would result in excessive exposure of monitors.
3. Accomplish early rapid monitoring of broad areas and transportation routes for planning remedial movement of personnel and high priority transport of equipment, supplies, and emergency workers.
4. Accomplish early monitoring at and in the vicinity of essential facilities as a basis for planning early recovery.
5. Monitor agricultural lands for planning the disposition of livestock, harvesting of crops and future land utilization for the production of food.

The State Civil Defense Director is responsible for over-all planning and implementation of aerial monitoring programs in consonance with provisions of the Federal Aviation Agency Circular 00.7, "State and Regional Defense Airlift (SARDA) Planning," and plans for emergency dispersal of aircraft. Support by local civil defense directors is essential for implementing aerial monitoring plans.

To provide appropriate aerial monitoring coverage for all areas, the State plan will delineate areas of operations (sectors) with major attention being directed to size and configuration of areas suited to the useful range of light aircraft; numbers and locations of suitable aviation facilities; availability by area of suitable aircraft and personnel; and availability of sheltered locations suitable for bases of operations.

A base of operations is a facility meeting OCD requirements for radiation protection, communications, proximity to airport, and established surface monitoring capability. A primary base of operations is the facility adjacent to that airport having a superior location within the sector. Secondary bases of operations are additional bases of operations at other airports within a sector required for adequate sector coverage.

A surface monitoring station providing on-station and mobile monitoring capabilities should be established at or near each civil airport or landing field having fueling facilities. This will provide monitoring support for operations utilizing civil aircraft and serve as primary or secondary bases of operations for aerial monitoring.

The specially designed aerial radiological monitoring set is relatively expensive and procurement has been somewhat limited. Therefore, great care should be exercised in the selection of sites for the primary bases of operations employing the CD V-781. Normally, aerial radiological monitoring equipment should be kept at the primary base of operations. Some of the important considerations in the selection of locations are:

1. The relative vulnerability of the available sites to blast and thermal effects. These bases of aerial monitoring operations should be remote from centers of dense population, large industrial areas, or large military installations.
2. The number and type of aircraft available which are readily adaptable for aerial survey operations and the availability of flight organizations with potential training and operational capabilities.
3. The appropriate distribution of aerial survey capability to assure coverage of all areas.
4. The availability of communications equipment with existing or potential capability to communicate operationally with appropriate control agencies.
5. The availability of facilities for bases of operations having adequate existing or potential fallout protection.
6. The availability of housing or acceptable cover for aircraft to protect against fallout contamination.

All States, Puerto Rico, and the District of Columbia have executed agreements with the Civil Air Patrol (CAP) for support of civil defense. These agreements include provisions for aerial monitoring and survey. However, CAP aircraft comprise only about 4,500 of the available 80 to 90 thousand active non-air-carrier aircraft. Therefore, consideration should also be given to the utilization of non-air-carrier aircraft other than those available through the CAP organization.

This Annex contains information on policies, requirements, and procedures relating to the availability of aerial monitoring equipment for training and postattack operational use of trained aerial monitoring and survey personnel.

AERIAL SURVEY METER (CD V-781)

The Aerial Survey Meter (CD V-781) is specially designed for aerial radiological monitoring. It is adaptable to quick mounting into a light aircraft and may utilize the aircraft power source or the self-contained power pack. This set consists of the following:

1. Detector Unit. This unit contains three Geiger-Muller detectors, associated circuits and power supply.

2. Metering Unit. This unit contains three indicating meters, function controls, auxiliary circuits, interconnecting cables, and a headset.
3. Simulator Unit. This unit contains three indicating meters, circuits for generating signals to simulate radiation environments, when substituted for the detector unit, and power supply.
4. Tape Recorder. A battery-powered tape recorder with associated throat microphone, tapes, and remote control unit.
5. Dosimeters. A total of six dosimeters; two CD V-730, two CD V-740; and two CD V-138 will be authorized for each monitoring station being granted a CD V-781 Aerial Survey Meter.

Aerial radiological monitoring equipment will be granted by OCD to States provided the following conditions are met:

1. A monitoring station having on-station and surface mobile monitoring capability has been established at the primary base of operation.
2. The primary base of operations has a minimum PF of 40 and plans have been established to increase this protection factor to 100 or better. (Annex One will assist in the evaluation of the protection factor of a facility in those cases where the building has not been surveyed previously under the National Shelter Survey Program.)
3. The primary base of operation is no more than one mile from the airport or landing field at which designated survey aircraft are located.
4. At least four monitors (of which a minimum of two must be aircraft pilots) have satisfactorily completed the regular OCD monitor course (16-hour version) and will be further trained as aerial monitors. These monitors are in addition to the station monitors.
5. Locations designated as secondary bases of operations have on-station and surface mobile monitoring capability. Further, it is desirable that these locations meet the requirements for protection factor and distance from airport as indicated in 2 and 3, above.
6. Each locality maintains a current roster of the trained monitors and the aircraft within its jurisdiction designated for use in aerial survey missions. A certificate from each of the aircraft owners consenting to the use of the aircraft in an emergency will be kept on file. These records will be made available for review by a State or regional civil defense representative upon request.
7. Localities and States will maintain a current directory of the bases of operation and the name of the airports from which the aircraft will operate within their respective jurisdictions.
8. The State will control the issuance of the sets in a manner to assure optimum State utilization and coverage and maintain custody record of the issues. These records will be made available for review upon request.

PROCEDURE FOR OBTAINING AERIAL RADIOLOGICAL MONITORING EQUIPMENT

The State will submit four copies of its requests for the CD V-781 to the appropriate OCD region, using Form OCD 342. An information copy will be furnished to Emergency Operations Division, OCD.

Each request for aerial radiological monitoring equipment is to be listed on OCD Form 342 as four line items in multiples of:

1 each CD V-781 Aerial Survey Meter
2 each CD V-730 Radiological Dosimeters
2 each CD V-740 Radiological Dosimeters
2 each CD V-138 Radiological Dosimeters

The word "grant" should be entered in the column labeled "Condition." Additionally, on the reverse side of OCD Form 342, the applicant must write or type that requirements set forth in the document, "Availability of Aerial Radiological Monitoring Equipment for State and Local Emergency Operations," have been met.

Request (Form OCD 342) for aerial monitoring sets (CD V-781) will be accompanied by completed OCD Form 342A, modified as follows:

1. Under the form heading "Monitoring Station No. ______" insert "Aerial Survey Primary Base of Operation, established jointly with Monitoring Station No. ______" (or other appropriate designation).

2. Place an asterisk to the left of the name of each monitor/pilot (monitor who is also a pilot).

3. At the bottom of the form, one of the following statements should be made:

   a. Assigned monitors have satisfactorily completed aerial monitoring training to meet OCD criteria, and/or

   b. Monitors have been assigned subject to satisfactory completion of aerial monitoring training.

4. At the bottom of the form list the airport(s) or landing field(s) from which aircraft will operate and indicate the distance which the airport or landing field is located from the primary base of operation. Place a double asterisk to the left of the airport or landing strip that corresponds to the primary base of operations.

The CD V-715 Radiological Survey Meter granted to all monitoring stations will also be used for aerial monitoring purposes if a CD V-781 is not readily available.

AVAILABILITY OF CD V-717 RADIOLOGICAL SURVEY METER, REMOTE SENSOR, GAMMA ONLY

The CD V-717 remote sensor survey meter is made available to selected operational monitoring stations established under the provisions of Annex 1 to this chapter. This Annex contains information on requirements and procedures relating to the availability of the CD V-717 for operational monitoring stations.

The CD V-717 remote sensor survey meter is essentially a CD V-715 gamma survey meter with a removable detector unit for making remote measurements to distances of 25 feet. The ranges of this instrument are 0-0.5, 0-5, 0-50, and 0-500 r/hr. It was designed for use by radiological monitors in monitoring stations during the early period following a nuclear attack for measuring high radiation intensities with minimal exposure to monitors. It can be readily converted to a portable survey meter for use in mobile monitoring.

To obtain a CD V-717, the requirements for obtaining the issue of a CD V-777 set must be met, and in addition:

1. The monitoring station has a minimum PF of 40 and plans have been established to increase this protection factor to 100 or better. Annex 1 of this chapter will assist in the evaluation of the facility protection factor in those cases where the building has not been surveyed previously under the National Shelter Survey Program.

2. The radef monitoring support set, CD V-777A, has not been, and will not be requested for the station.

PROCEDURES

The procedures for obtaining the CD V-717 will be the same as those specified in Annex 1, "Procedures for Obtaining Radiological Operational Set CD V-777." Additionally, on the reverse side of Form 342, the applicant should "write or type" that "all requirements set forth in FCDG-E-5.8.7 have been met."

For initial establishment of a monitoring station which fulfills the above requirements, both the CD V-777 set and the CD V-717 should be requested simultaneously to decrease administrative and transportation costs.

A monitoring station which <u>is not</u> assigned extensive mobile monitoring responsibilities or ground support of aerial monitoring operations should request <u>only</u> the CD V-717 to supplement its present complement of instruments. A monitoring station which <u>is</u> assigned extensive mobile monitoring responsibilities or ground support of aerial monitoring operations should request the CD V-777A support set to supplement its present complement of instruments.

CHAPTER IX

HANDBOOK FOR RADIOLOGICAL MONITORS

Radiological monitoring is an indispensable service to all civil defense organizations and their operations. In the event of a nuclear attack, trained monitors will be required to furnish information essential for the protection of people. Monitoring services will be required from the period shortly after a nuclear attack until the radiological hazard from fallout diminishes to the point that normal activities may be resumed without significant danger to the population of a community.

Purpose. This chapter provides the radiological monitor with the information and techniques normally required to perform essential duties. It also provides guidance that may be required, but should not be used, unless competent guidance is unavailable from a Radiological Defense Officer. The information and guidance in this chapter is not sufficient to assure that an untrained person can effectively carry out the duties and responsibilities required of a radiological monitor. All personnel assigned monitoring responsibilities should complete, as a minimum, the Radiological Monitoring course prescribed by the Office of Civil Defense, Department of Defense.

Scope. The radiological monitor will perform his duties under a variety of conditions. This chapter furnishes him with information concerning the techniques and procedures to be followed, the protective measures that should be taken, and the application of these techniques and procedures to the various types of monitoring operations that are required.

Monitoring System. The radiological defense information necessary to support postattack civil defense operations requires a minimum nationwide network of 150,000 fallout monitoring stations. In addition, since designated group or public shelters will be strong points of survival from which people will emerge to carry out recovery and rehabilitation, each shelter must have a capability to perform monitoring for the safety of shelter occupants. If the group or public shelters provide appropriate geographic and communications coverage, some will probably be chosen as locations for fallout monitoring stations.

Fallout station monitors provide the primary information for conducting radiological defense operations. It is expected that monitors in these stations will receive technical direction and supervision from their organizational Radiological Defense Officer. Shelter monitors provide at each shelter an independent means of limiting the radiation exposure of shelter occupants. Following the shelter period, both fallout station monitors and shelter monitors will be required to support recovery operations.

Requirements for Monitoring. During the early postattack period when people are in shelter, most monitoring will be performed from fallout

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monitoring stations and from shelters. The radiological information needed by shelter occupants, and by the Federal, State and local governments for survival activities, will require monitoring of personnel, food and water, and monitoring of areas-in-shelter and possibly out-of-shelter. Aerial monitoring may be required for rapid survey of large areas or specific transportation routes. When dose rates have decreased to the extent that limited outside activities can be performed, some shelter monitors and probably all fallout station monitors will become mobile and will support operations of emergency services such as fire, police or rescue.

There is a continuing need for monitoring through the period of gradual relaxation of sheltered living even after gamma radiation no longer seriously restricts unsheltered living. During the recovery period, the need for frequent reports of monitored data becomes less urgent but the requirement for monitoring of specific areas, facilities, personnel and equipment, food and water, and monitoring in support of large-scale decontamination operations increases. Monitoring is required until all radiation hazards are determined to be insignificant.

Aerial monitoring, which may be required during the early postattack period for rapid survey of large areas, is covered in a separate publication. Aerial monitors should be chosen from among the best qualified monitors and should receive special training in this technique.

Duties and Responsibilities. The primary duty of a radiological monitor is to provide timely and accurate information required for the proper analysis and evaluation of the radiological hazard. Whether the monitor is assigned to a fallout monitoring station or to a shelter, which may also be designated as a fallout monitoring station, he must know and be able to do the following:

1. Follow the monitoring SOP (Standing Operating Procedure) 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, when and how to report radiation measurements, and how to maintain required records. If no local SOP exists, follow the procedures in the "Monitoring Operations" section of this chapter.
2. Know the types, uses, and operation of all OCD radiological instruments and related equipment discussed in this chapter.
3. Use the monitoring techniques required both during and following shelter occupancy. These techniques will include surface, personnel, food and water monitoring and monitoring in support of emergency operations.
4. Carry out the protective measures necessary to keep personnel exposures to a minimum.

The above knowledges and skills will enable the trained monitor to perform tasks such as the following:

1. Measure the gamma exposure dose of shelter occupants.

2. Monitor levels of radiation inside shelters to locate best shielded areas for use when dose rates are high, and to locate other acceptable areas in the building where shelter areas are located to permit greater freedom of movement and improve living conditions of shelter occupants after dose rates have decreased.
3. Monitor unsheltered levels of radiation at fallout monitoring stations to provide radiological information for emergency operations.
4. Monitor to obtain additional supplies and to recover vital installations at the earliest practicable time.
5. Monitor routes needed for remedial movement and for transportation in general.
6. Monitor in support of emergency operations to accomplish decontamination and recovery activities.

RADIOLOGICAL INSTRUMENTS

OCD has developed several radiological instruments which together provide a wide monitoring capability. All of these instruments are designed to detect and measure gamma radiation. Some have the additional capability of detecting beta radiation, but none are designed to detect or measure alpha radiation.

Instruments for radiological defense operations can be divided generally into two classes: (1) survey meters for measuring gamma dose rates in roentgens per hour (r/hr) or milliroentgens per hour (mr/hr), and (2) dosimeters for measuring exposure doses in roentgens (r).

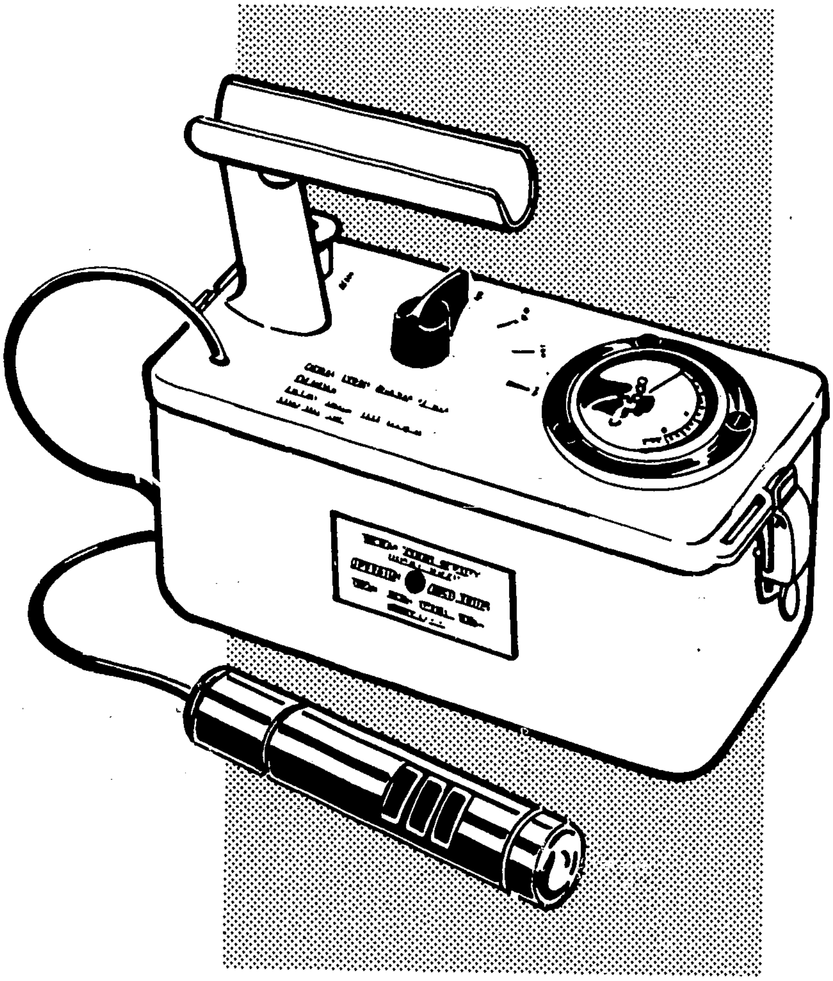
The uses and operation characteristics of each civil defense instrument are discussed in succeeding pages. A monitor must be thoroughly familiar with each of these instruments. The several characteristics common to all instruments are discussed below.

CD V-700, 0-50 mr/hr survey meter, is a low range instrument that measures gamma dose rates and detects the presence of beta. It can be used (1) in long term cleanup and decontamination operations, (2) for personnel monitoring, and (3) for indicating the degree of radioactive contamination in food and water. The CD V-700 is designed for low level measurements and has limited usefulness in areas of high contamination.

When the probe shield on the CD V-700 is closed, beta is stopped and only the gamma dose rate is measured. When the shield is open, both beta and gamma 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 by qualified radiological personnel.

If an audible indication is desired, a headphone may be attached to the connector at the lower left corner of the instrument cover. The c/m scale on the meter should be disregarded by the monitor.

Controls. There is only one control on the CD V-700. This control, a selector switch, can be moved to the OFF position and three ranges labeled X100 (times 100), X10 (times 10), and X1 (times 1). On the X1 range, the measured dose rate is read directly from the meter. On the X10 and X100 ranges, the meter readings must be multiplied by 10 and 100 respectively to obtain the measured dose rate.



CD V-700.

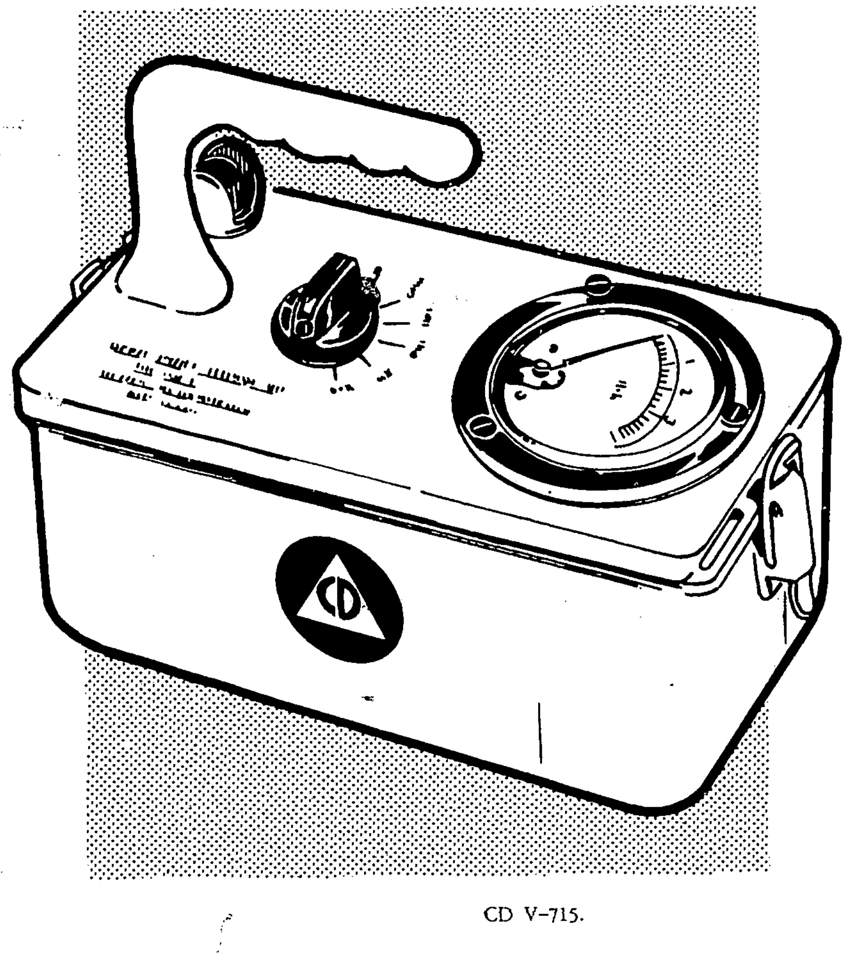
Operational Check. Prior to use, the CD V-700 should be checked to assure that it is operating properly. The "operational check" should be performed in a radiation free area as follows: (1) turn the selector switch to the X10 range and allow at least 30 seconds for warm up, (2) rotate the shield on the probe to the fully open position, and (3) place the open area of the probe as close as possible to the operational check source located on the instrument case. The meter should read between 1.5 and 2.5 mr/hr. If the reading is not within this interval and if the CD V-700 has been recently calibrated, the reading from the check source should be noted. This reading should remain the same during future operational checks.

The operational check source should be used to determine that the CD V-700 is operating properly. Its use does not replace the need for calibrating the instrument. During an emergency, the presence of external radiation from fallout may prohibit the performance of an operational check. In this event, the monitor should assume a calibrated CD V-700 is operating properly if it indicates radiation levels above normal background.

Jamming. One particular operating characteristic of the CD V-700 with which the monitor should be familiar is "jamming" or "saturation." Radiation dose rates from 50 mr/hr to 1 r/hr will produce off-scale readings. However, when dose rates materially exceed 1 r/hr, the CD V-700 may "jam" or "saturate" and read zero or less than full scale. A higher range instrument is required for measurement of dose rates higher than 50 mr/hr.

CD V-715, 0-500 r/hr survey meter, will measure gamma dose rates only and is used for general postattack operations. It is designed (1) for ground survey, (2) for use in fallout monitoring stations and community shelters, and (3) as an interim aerial survey instrument. It will be used by the monitor for the major portion of survey requirements in the period immediately following a nuclear weapon attack. The CD V-715 has no beta detection capability.

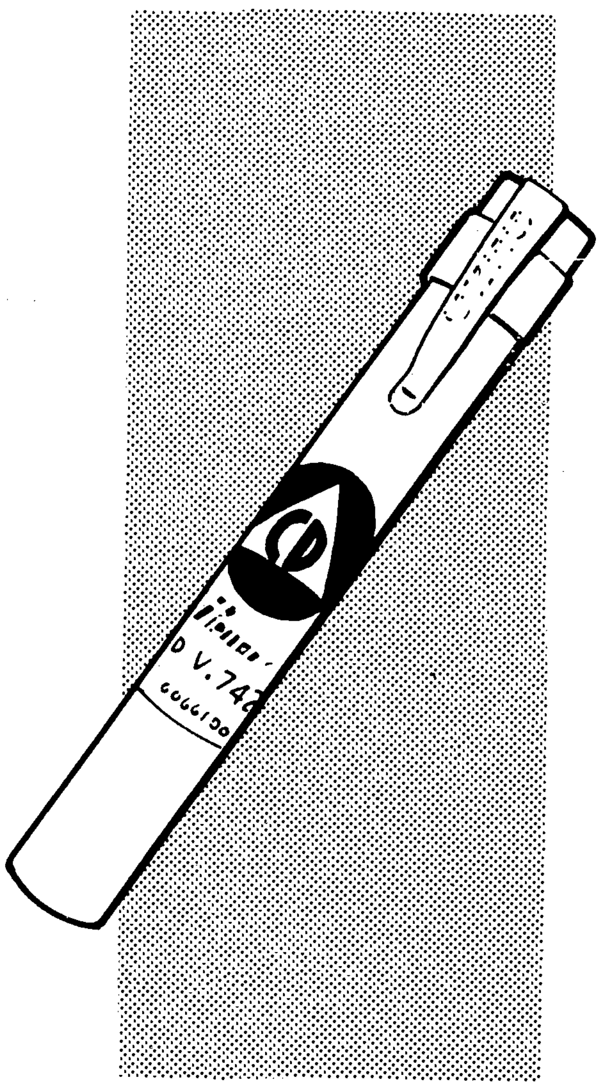
Controls. Two controls are provided on the CD V-715. One control, a selector switch has seven positions: CIRCUIT CHECK, OFF, ZERO, and X100 (times 100), X10 (times 10), X1 (times 1) and X0.1 (times 0.1) ranges. On the X1 range, the measured dose rate is read directly from the meter. On the X0.1, X10, and X100 ranges, the meter readings must be multiplied by a factor of 0.1, 10, or 100 respectively in order to obtain the measured dose rate. A second control, the zero control, is used to adjust the meter reading to zero during the operational check, and to adjust for "zero drift" during long periods of operation.



CD V-715.

Operational Check. Prior to use, the CD V-715 should be checked to assure that it is operating properly. The "operational check" is performed as follows: (1) turn the selector switch to the ZERO position, allow at least two minutes for warm up, and adjust the zero control to make the meter read zero, (2) turn the selector switch to the CIRCUIT CHECK position, (the meter should read within the red band marked "circuit check"), (3) recheck the zero setting as the selector switch is turned to the four ranges: X100, X10, X1, and X0.1. When only normal background radiation is present, the meter should read not more than two scale divisions upscale on any range.

Modification (CD V-717). Some of the CD V-715's will be equipped by the manufacturer with a removable ionization chamber attached to 25 feet of cable. This modification, called the CD V-717, will provide a remote reading capability for the fallout monitoring stations. The operating characteristics are identical to the CD V-715, except that the removable ionization chamber may be placed outside the shelter in an unshielded area and protected from possible contamination by placing it in a bag or cover of light-weight material. Readings may then be observed from within the fallout monitoring station. After the early period of high fallout radiation dose rates, and the requirement for a remote reading instrument diminishes, the removable ionization chamber should be checked for contamination with the CD V-700; decontaminated, if necessary, and returned to the case. The CD V-717 may then be used for other monitoring operations.



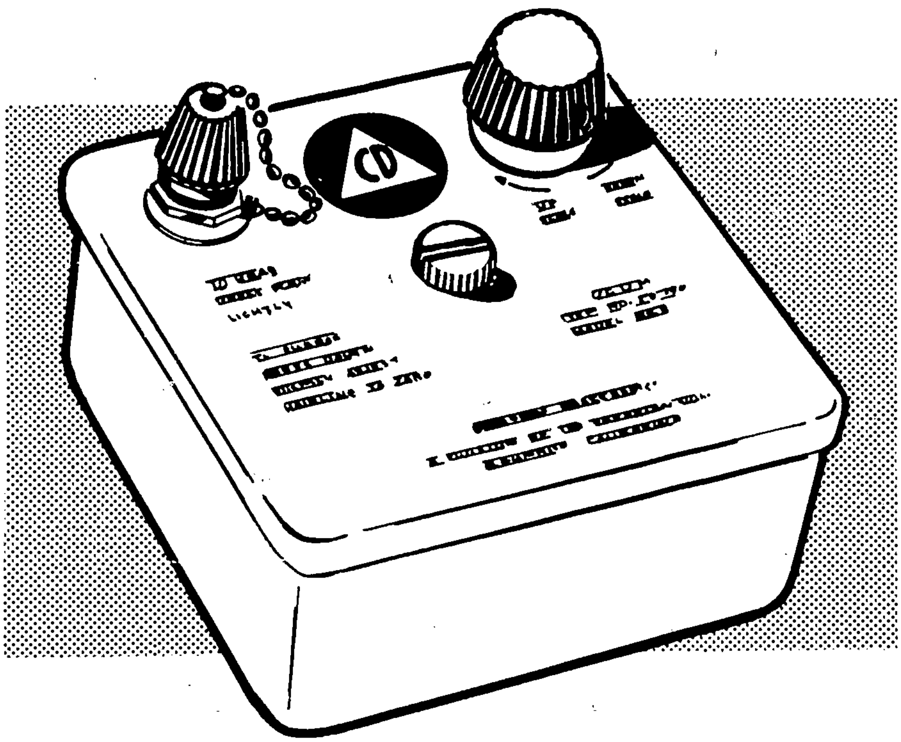
CD V-742

CD V-742, 0-200 r dosimeter, is designed for measuring accumulated exposure doses of gamma radiation to operations personnel and shelter occupants. It can be read by holding it toward any light source sufficient to see the scale and hairline.

Initial Check. There is no "operational check" for dosimeters similar to the check for survey meters. However, when dosimeters are received, the monitor should zero them, and check their electrical leakage characteristics. 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 per 4 days, the dosimeters should not be used provided other dosimeters are available. If no other dosimeters are available, the leakage rate should be determined and the contribution from electrical leakage subtracted from the dose as measured by the leaking dosimeter.

Storage. Most civil defense dosimeters will require a "soak in" charge after long-term storage in an uncharged condition. Consequently, 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. When not in use, dosimeters should be charged and stored in a dry place. When performing scheduled checks of instruments, dosimeters should be read and if they indicate more than one-fourth of full scale, they should be recharged to zero.

CD V-750, dosimeter charger, is used to charge (zero) and read civil defense dosimeters. Instructions for charging dosimeters are printed on each charger. If no light source is available, a dosimeter may be read on a charger as follows: (1) remove the dust cover from the charging receptacle, (2) place the dosimeter on the charging contact, and (3) press lightly to light the lamp. Do not press firmly, since the hairline may change position if the charging switch is closed.



CD V-750.

Characteristics Common to All Instruments - Batteries. Refer to the manufacturer's instruction manual for the proper battery installation procedure. Particular attention should be given to correct battery polarity during installation. For instruments subject to intermittent use, batteries should be removed monthly and the battery contacts inspected for any dirt or corrosion present. Dirty contacts should be cleaned. If the instrument is to be stored for more than one week, batteries should be removed from the instrument and stored in a cool dry place. Whenever an instrument is not in use, make certain that it is turned off; otherwise, the batteries will be discharged and the instrument rendered ineffective and/or permanently damaged by battery leakage. With good batteries, all instruments should operate continuously for 100-150 hours. Intermittent use should extend the operating life two or three times.

Calibration. Each instrument should be calibrated annually or in accordance with the local calibration schedule. Although the monitor may be requested to inform the Radef Officer or other civil defense official when instruments are due for calibration, he is not responsible for assuring that it is done. The monitor must not attempt calibration adjustment or corrective maintenance, which can be adequately performed only by specially trained personnel using specialized equipment. If the operational check of a calibrated instrument is satisfactory, a monitor must rely on the instrument reading and accept it as an accurate measurement of the gamma dose or dose rate.

Environmental Effects. Monitoring instruments are manufactured to operate satisfactorily under normally encountered environmental conditions of pressure, temperature and humidity.

Response Time. Survey meters do not respond instantaneously to changes in dose rate or to changes in the range position. A period of at least fifteen seconds should be allowed for meter response before readings are observed. Dosimeters respond instantaneously to changes in the accumulated dose. During any emergency operation, a monitor should accept the reading on his dosimeter as a measurement of his exposure dose.

Care. The monitor should prevent radiological contamination of the instruments at all times. Instruments can be placed in a plastic bag to prevent contamination. This is desirable, but not mandatory. In case an instrument becomes contaminated, it can be cleaned with a cloth dampened in a mild soap solution. After decontamination, each instrument should be monitored with a CD V-700, to assure that contaminating material is removed.

Limited Standard Items. Several radiological instruments are no longer being procured by OCD. These instruments, which have slightly different operating characteristics, ranges, or detection capabilities, are not obsolete instruments and should be used by civil defense organizations possessing them. The CD V-710, 0-50 r/hr gamma survey meter, and the CD V-720, 0-500 r/hr beta-gamma survey meter, are limited standard items. The CD V-715 has superseded these two instruments and is the standard civil defense high range gamma survey meter. However, the CD V-710 and CD V-720, together provide the same gamma capability and have almost identical operating characteristics as the CD V-715. The CD V-730, 0-20 r dosimeter, and the CD V-740, 0-100 r dosimeter, are also limited standard instruments and have been superseded by the CD V-742. The CD V-710, CD V-720, CD V-730, and CD V-740 should be used for measuring radiation dose or dose rates where they have been issued as components of the radiological monitoring kits.

PROTECTIVE MEASURES

Radiation protection measures are based on the assumption that all radiation exposure is harmful. However, experience and research have shown that if exposure is kept below a certain level, medical care will not be required for the majority of the people. Therefore, adequate methods and procedures for limiting radiation exposure and contamination must be established.

Radiation Hazards. Radiation is emitted from some fallout particles. The air through which fallout passes and the surfaces on which it settles do not themselves become radioactive. It is the radiation originating from these particles that constitutes the hazard to living things. Of the three types of radiation associated with fallout material, gamma is considered to be the most hazardous. Alpha and beta radiation are relatively easy to shield against, while gamma can require considerable amounts of dense materials or distance between persons and its source in order to prevent radiation damage.

The major protective measure to be taken by monitors against fallout radiation in the early postattack period is shelter. In addition, other protective measures such as control of radiation exposure, control of the contamination, and decontamination may be employed from the time of fallout arrival until the radiation hazard no longer restricts living conditions.

Individual Protection. If the presence of fallout is suspected before the monitor can reach his assigned shelter, the following actions will help minimize its effects:

1. Cover the head with a hat, or a piece of cloth or newspaper.
2. Keep all outer clothing buttoned or zipped. Adjust clothing to cover as much exposed skin as possible.
3. Brush outer clothing periodically.
4. Continue to destination as rapidly as practicable.

Assume all persons arriving at a shelter or a fallout monitoring station after fallout arrival, and all individuals who have performed outside missions are contaminated. All persons should follow the protective measures outlined in this paragraph.

1. Brush shoes, and shake or brush clothing to remove contamination. This should be done before entering the shelter area.
2. Go to the preselected location in the shelter as described in the "Personnel Monitoring" section of this chapter.
3. Use the CD V-700, with probe shield open, to monitor the clothing after brushing and shaking to determine if further decontamination is necessary.
4. Remove and store all outer clothing in an isolated location if contamination levels after brushing and shaking are too high to be measured with the CD V-700.
5. Wash, brush, or wipe thoroughly, contaminated portions of the skin and hair, being careful not to injure the skin.
6. Monitor the contaminated portions of skin and hair to determine the need for further decontamination. Decontaminate until the CD V-700 indication is approximately equal to the background reading in the shelter.

Collective Protection. During fallout deposition, all windows, doors, and nonvital vents in sheltered locations should be closed to control the contamination entering the shelter. Similar protective measures should be applied to vehicles.

When radiation levels become measurable inside the shelter, make a survey of all shelter areas to determine the best protected locations. Repeat this procedure periodically. This information is used to limit the exposure of shelter occupants.

Tasks Outside of Shelter. When personnel leave shelter, appropriate protective measures should be taken to prevent the contamination of their bodies. Clothing will not protect personnel from gamma but will prevent most airborne contamination from depositing on the skin, and reduce the need for extensive washing or scrubbing of the body for prevention of beta burns. Most clothing is satisfactory; however, loosely woven clothing should be avoided. Instruct shelter occupants to:

1. Keep time outside of shelter to a minimum when dose rates are high.
2. Wear adequate clothing and cover as much of the body as practicable. Wear boots or rubber galoshes, if available. Tie pant cuffs over them to avoid possible contamination of feet and ankles.
3. Avoid highly contaminated areas whenever possible. Puddles and very dusty areas where contamination is more probable should also be avoided.
4. Under dry and dusty conditions, do not stir up dust unnecessarily. If dusty conditions prevail, a man's folded handkerchief or a

folded piece of closely woven cloth should be worn over the nose and mouth to keep the inhalation of fallout to a minimum.

5. Avoid unnecessary contact with contaminated surfaces such as buildings and shrubbery.

Monitors using vehicles for outside monitoring operations should remain in the vehicle, leaving it only when necessary. To prevent contamination of the interior of the vehicle, all windows and outside vents should be closed when dusty conditions prevail. Vehicles provide only slight protection from gamma but they provide excellent protection from beta and prevent contamination of the occupants.

Food and Water. To the extent practicable, prevent fallout from becoming mixed into food and water. Food and water which is exposed to radiation, but not contaminated, is not harmed and is fit for human consumption. If it is suspected that food containers are contaminated, they should be washed or brushed prior to removal of the contents. Food properly removed from such containers will be safe for consumption.

Water in covered containers and underground sources will be safe. Before the arrival of fallout, open supplies of water such as cisterns, open wells, or other containers should be covered. Shut off the source of supply of potentially contaminated water. All food and water suspected of contamination should be monitored.

Equipment. Vehicles and equipment that are required for postattack operations should be protected from fallout contamination. When practical, all such equipment should be kept under cover in garages and warehouses, or under covers of fabric or plastic. Windows and doors of vehicles and storage areas should be closed.

Control of Exposure. Monitors are responsible for limiting their exposure and maintaining their personal radiation exposure records. (See Attachment A). Radiation exposures of monitoring personnel are likely to lack a uniform pattern. After a period of low exposure, an operational mission may require a high exposure. This may be followed by several days of relatively low exposure before the situation requires an additional heavy exposure. The only reliable method for keeping track of variable exposures is through the use of personal dosimeters and the keeping of complete exposure records.

All but the most important survival operations should be postponed as long as practicable to take advantage of the decay of fallout. In carrying out high priority tasks exposures should, where practicable, be more or less evenly distributed among operations personnel. Guidance for limiting exposure will be furnished the monitor by the Radiological Defense Officer or other technically qualified civil defense personnel.

MONITORING TECHNIQUES

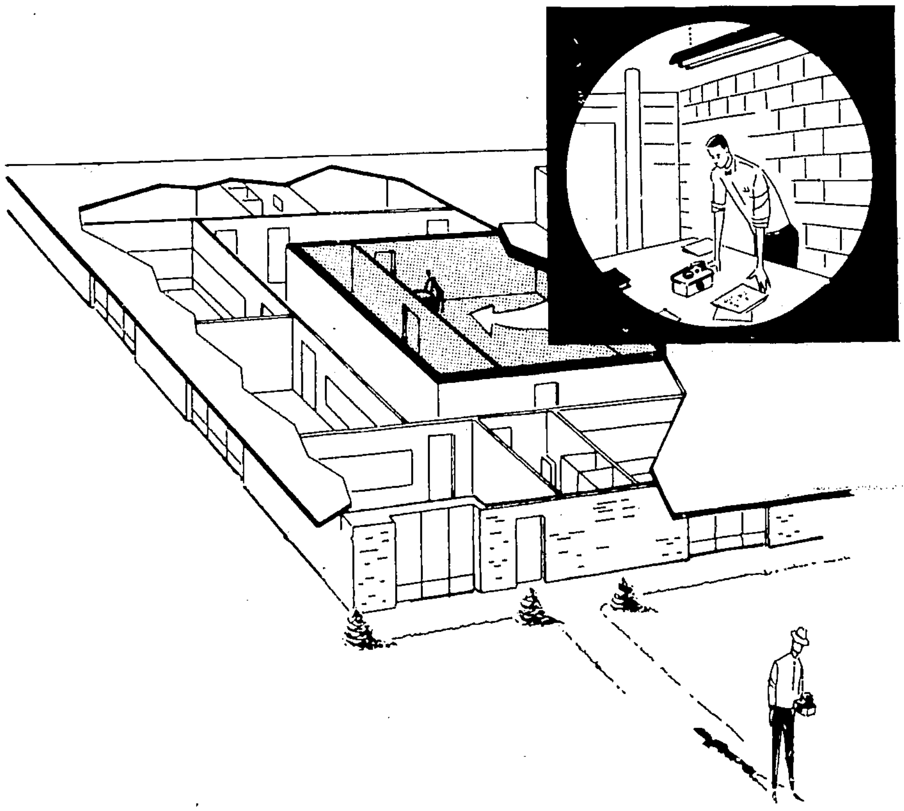
This section describes the detailed techniques and procedures for conducting each type of radiological monitoring activity. Fallout station monitors are responsible for performing all of the monitoring techniques outlined in this section. Shelter monitors are responsible for performing all of the techniques except for "Unsheltered Dose Rate Measurements" and "Unsheltered Dose Measurements."

Shelter Area Monitoring. Dose rates should be measured inside of a shelter or a fallout monitoring station to determine the best shielded portions of the shelter and its immediate adjoining areas. Procedures for this monitoring are:

1. Use the CD V-715.
2. Check the operability of the instrument.
3. Hold the instrument at belt height (3 feet above the ground).
4. Take readings at selected locations throughout the shelter and adjoining areas and record these on a sketch of the area.

Unsheltered Dose Rate Measurements. Fallout monitoring stations report unsheltered dose rate readings. Procedures for observing unsheltered dose rates are:

1. Use the CD V-715.
2. Check the operability of the instrument.

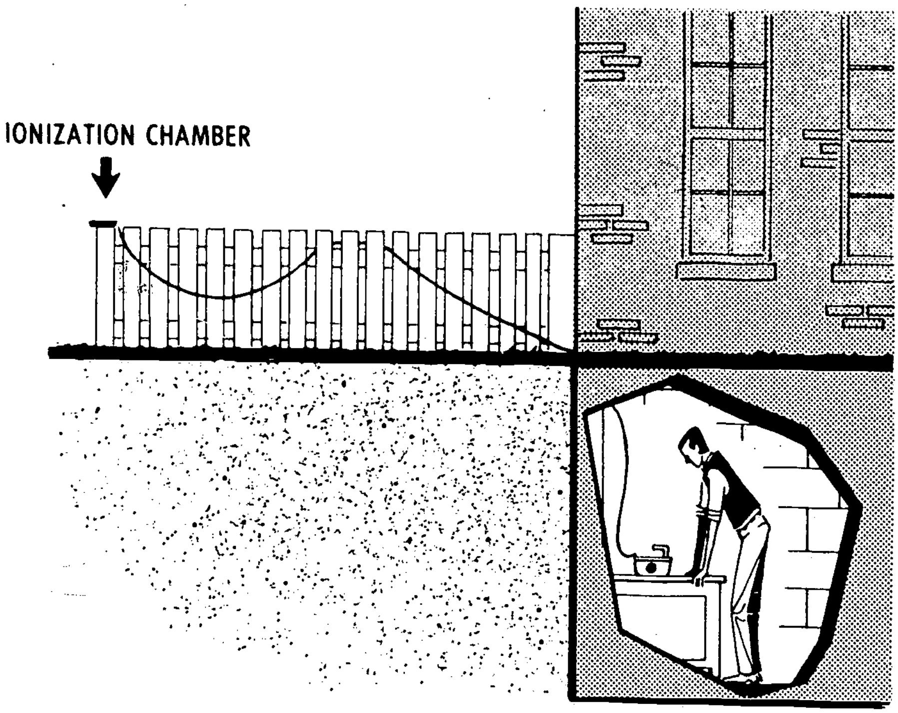


Taking readings with the CD V-715.

3. Take a dose rate reading at a specific location in the fallout monitoring station. This should be done as soon as the dose rate reaches or exceeds 0.05 r/hr.
4. Go outside immediately to a preplanned location in a clear, flat area (preferably unpaved), at least 25 feet away from buildings, and take an outside reading. The outside reading should be taken within three minutes of the reading in 3, above.
5. Calculate the protection factor of the fallout monitoring station by dividing the outside dose rate by the inside dose rate. The protection factor may vary from location to location within the station. The protection factor referred to here is appropriate only for the location where the inside dose rate measurement is observed.
6. Multiply future inside dose rate readings by the protection factor at the selected location to obtain the outside dose rate. For example: If the inside reading is 0.5 r/hr and the outside reading is 80 r/hr, the protection factor can be found by dividing the outside reading by the inside reading. Thus, 80 ÷ 0.5 = a protection factor of 160. If a later inside reading at the same location in the fallout monitoring station is 4 r/hr, the outside dose rate can be calculated by multiplying the protection factor by the inside reading. Thus, 160 X 4 = 640 r/hr.
7. Recalculate the protection factor at least once every 24 hours during the first few days postattack, unless the outside dose rate is estimated to be above 100 r/hr. This is necessary because the energy of gamma radiation is changing, thus changing the protection factor of the fallout monitoring station.
8. Record and report the dose rate measurement in accordance with the organization SOP.
9. Take all dose rate measurements outside after the unsheltered dose rate has decreased to 25 r/hr.

When the CD V-717 remote reading instrument is available, it may be used for taking outside dose rate measurements. The CD V-717 could be used as follows:

1. Position the instrument at a selected location within the fallout monitoring station.
2. Place the removable ionization chamber 3 feet above the ground in a reasonably flat area and at least 20 feet from the fallout station. Preferably this should be done prior to fallout arrival. It is desirable to cover the ionization chamber with a light plastic bag or other light-weight material.
3. Observe outside dose rates directly.
4. Record and report dose rates in accordance with the organization SOP.



Taking reading with the CD V-717.

Unsheltered Dose Measurements. Fallout monitoring stations report unsheltered dose readings. Procedures for taking these readings are:

1. Zero a CD V-742.
2. Measure the unsheltered dose rate.
3. Select an inside location where the dose rate is approximately one-tenth to one-twentieth of the unsheltered dose rate and position the CD V-742 at this location.
4. Determine the protection factor for this location.
5. Read the CD V-742 daily. If the daily dose at this location could exceed 200 r, estimate the time required for a 150 r exposure on the CD V-742. Record this reading, rezero the dosimeter, and reposition it. To determine the daily unsheltered dose, multiply the daily dose at this location by the protection factor.
6. Record the readings and rezero the instrument.

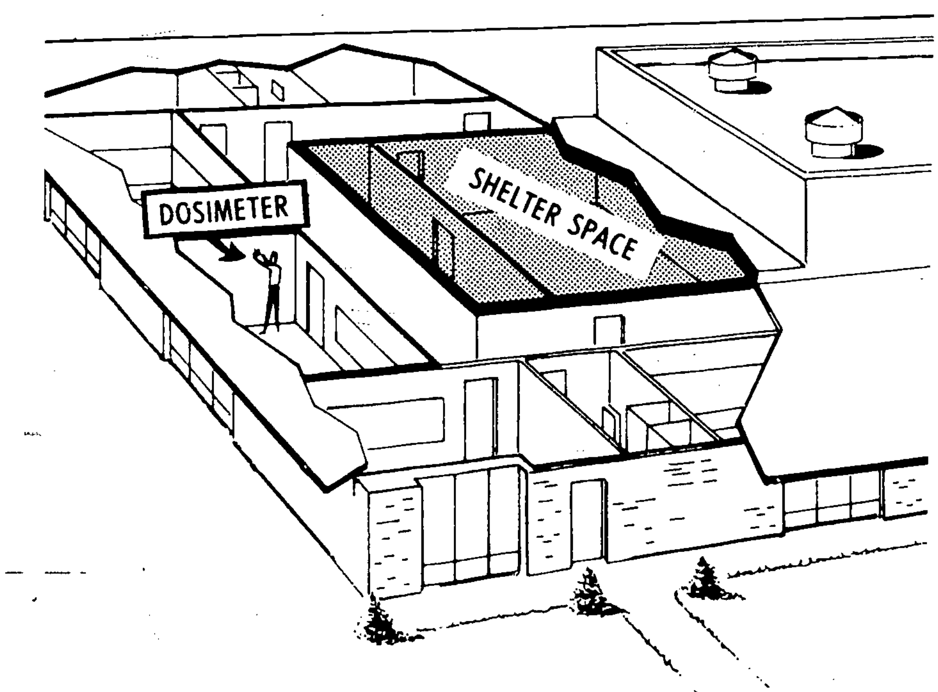
Personnel Dose Measurements. The monitor must determine the daily exposure dose of all shelterees or fallout monitoring station occupants. Procedures for determining daily doses are:

1. Zero all available CD V-742's.
2. Position the dosimeters so that representative shelter exposures will be measured by the instruments. The monitor must exercise

judgment in positioning these instruments. The protection factor may vary considerably at different locations within the shelter. The instruments should be placed within the areas of greatest occupancy, which may change with time. During the early high radiation period, occupancy will be concentrated in the high protection areas of the shelter. Later, the occupancy of the shelter can be expanded. If representative readings are to be obtained, the dosimeters must follow the location shifts of the occupants.

3. If several dosimeters are positioned in one compartment, read the dosimeters each day and average the total doses. Recharge dosimeters which read more than half scale. If some shelters are divided into compartments or rooms that may have different protection factors, the dose should be measured or calculated for each compartment.
4. Instruct the shelter occupants to record their individual doses on their radiation exposure record (See Attachment A), as approved by the shelter manager. Exposure entries should be made to the nearest roentgen. If there is no measurable dose, continue to read the dosimeters each day. Record an accumulated dose for a few days' period, if measurable.

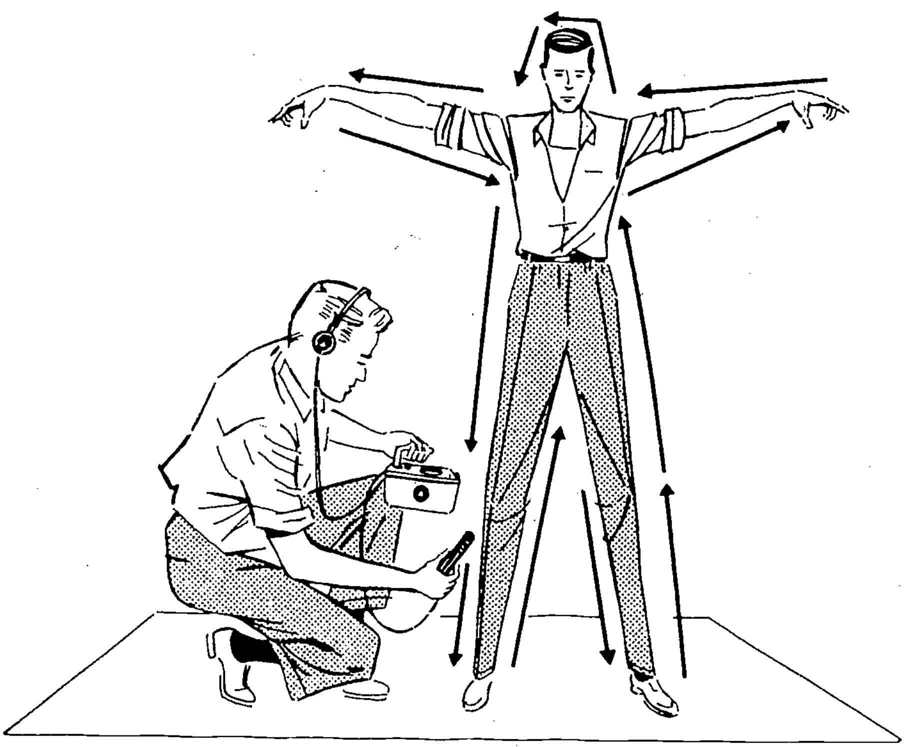
If monitors or other persons are required to go outside, these additional exposures should be measured and the doses recorded.



Unsheltered dose reading with the CD V-742.

Personnel Monitoring. Procedures for personnel monitoring are:

1. Use the CD V-700. Attach the headphone because this allows the monitor to visually follow and better control the position of the probe while monitoring. The headphone also responds more quickly to changes in radiation levels than the meter.
2. Check the operability of the instrument.
3. Place the probe in a light plastic bag or cover of light-weight material to prevent contamination. This is desirable, but not mandatory.
4. Select a reception location for conducting the monitoring operation. Precautions should be taken to prevent contamination of the shelter area. If possible, a reception area for monitoring personnel should be located in a room adjoining the shelter area. If this is not possible, an in-shelter area near the entrance should be selected and restricted to this purpose.
5. Determine the background radiation level periodically at the location where the monitoring is to take place. If the meter indication is above 50 mr/hr with the probe shield open, find a better shielded location that will bring the meter indication below 30 mr/hr. This might be done by selecting a different location in the shelter and/or sweeping the area several times to reduce possible contamination. If this fails, the shielding can be improved by stacking shelter supplies and other materials around the individual to be monitored.



Personnel Monitoring.

6. Open the shield on the CD V-700 probe and put on the headphone.
7. Place the probe about two inches from the person's body being careful not to touch him. Starting at the top of the head, move the probe downward on one side of the neck, collar, shoulder, arm, wrist, hand, underarm, armpit, side, leg, cuff, and shoe. Monitor the insides of the legs and the other side of the body. Monitor the front and back of the body. Pay particular attention to the feet, seat, elbows, armpits, and hairy or moist areas.
8. Decontaminate shelter occupants found to be contaminated.
9. Monitor individuals after decontamination to determine that contamination has been effectively removed. Repeat decontamination procedures if required.

Food and Water Monitoring. Food and water monitoring criteria and techniques are being reevaluated and are subject to change.

Potentially contaminated supplies of food and water should be monitored to determine if they are acceptable for human consumption. A procedure for monitoring food or water follows:

1. Use the CD V-700.
2. Check the operability of the instrument.
3. Select an area that is shielded or can be shielded so that the meter indication is as low as possible. Since the space required to conduct this type of monitoring will be small, it should not be difficult to improvise a shielded area, if needed. Determine the background radiation.
4. Monitor the food or water at a distance of approximately one inch from its surface, with the probe shield open.
5. Observe the meter indication. If it increases above background, contamination is present.

Do not discard contaminated food or water. It should be decontaminated and rechecked, or placed in storage and rechecked at a later date for possible consumption after the contamination has decreased due to radioactive decay. Foods such as fruits and vegetables could be decontaminated by washing, brushing or peeling. Water which is heavily contaminated might be improved by filtering, or by allowing any particles to settle out. If only contaminated food or water is available, the monitor should determine which portions are least contaminated. If its use becomes necessary, the monitor should recommend that supplies with the smallest amount of contamination should be used first.

Area Monitoring. Area monitoring is used to locate zones of contamination and determine the dose rates within these zones. The monitor should be informed by his Radiological Defense Officer concerning routes to be followed, locations where readings are needed, the mission dose, and the estimated time needed to accomplish the mission.

1. Plan to keep personal exposure doses as low as possible.

   a. Know the specific accomplishment, extent, and importance of each monitoring mission.
   b. Know the allowable exposure dose for each mission and the expected dose rates to be encountered.
   c. Make allowances for the exposure to be received traveling to and from the monitoring area. Obtain information about the condition of roads, bridges, etc., that might interfere with the mission and lengthen exposure time.

2. Clothing needed for the mission.

   a. Tie pant cuffs over boots or leggings.
   b. Wear a protective mask, gloves, head covering, and sufficient clothing to cover skin areas when dusty conditions prevail. If no masks are available, cover the nose and mouth with a handkerchief.

3. Equipment needed for the mission.

   a. Use the CD V-715. If the dose rates are expected to be below 50 mr/hr, also carry the CD V-700.
   b. Wear a CD V-742.
   c. Carry contamination signs, if areas are to be marked. This may also require stakes, heavy cord, hammer, and nails for posting the signs.
   d. Carry a pencil, paper, and a map with monitoring points marked.

4. Procedures for area monitoring are:

   a. Zero the dosimeter before leaving the shelter and place it in a pocket to protect it from possible contamination.
   b. Check the operability of the CD V-715 and CD V-700, if it is to be used.
   c. Use vehicles such as autos, trucks, bicycles, or motorcycles when distances are too great to cover quickly on foot. Keep auto and truck cab windows and vents closed when traveling under extremely dusty conditions. The use of a bicycle or motorcycle may be more practical if roadways are blocked.
   d. Take readings at about three feet (belt high) above the ground. If readings are taken from a moving vehicle, the instruments should be positioned on the seat beside the driver. If readings are to be taken outside a vehicle, the monitor should move several feet away from the vehicle to take the reading.
   e. Record the dose rate, the time and location for each reading. If readings are taken within a vehicle, this should be noted in the report.

f. Post markers, if required by the mission. The marker should face away from the restricted area. Write the date, time, and dose rate on the back of the marker.
g. Read the pocket dosimeter at frequent intervals to determine when return to shelter should begin. Allowances should be made for the dose to be received during return to the shelter.
h. Remove outer clothing on return to the shelter and check all personnel for contamination.
i. Decontaminate, if required.
j. Report results of the survey.
k. Record radiation exposure.

Dose Rate Readings From Dosimeters. Survey instruments should always be used to measure dose rates. However, if no operable survey instruments are available, dosimeters can be used to calculate dose rates as follows:

1. Zero a CD V-742.
2. Place the zeroed dosimeter at a selected location.
3. Expose the dosimeter for a measured interval of time, but do not remain in the radiation field while the dosimeter is being exposed. This interval should be sufficient to allow the dosimeter to read at least 10 r. It may take one or two trials before the proper interval can be selected.
4. Read the dosimeter.
5. Divide sixty minutes by the number of minutes the dosimeter was exposed. Multiply this number by the measured dose. Example: If the dose is 10 r for a measured interval of five minutes, the dose rate can be calculated as follows:

$$(60 \div 5) \times 10 = 12 \times 10 = 120 \text{ r/hr.}$$

MONITORING OPERATIONS

Radiological monitors, whether assigned to shelters or fallout monitoring stations, perform essentially similar operations. Any departures from the operations described in this section will be the result of decisions by the State and local civil defense organizations and must be reflected in their SOP's. If local or State SOP's are not in existence, monitors should follow the procedures outlined in this section.

Readiness Operations. During peacetime, all assigned monitors will:

1. Perform an operational check on all survey meters and rezero all dosimeters every two months.
2. Record the results on the Inspection, Maintenance, and Calibration Log (See Attachment B).
3. Initiate action for the repair or replacement of inoperable instruments according to the organizational SOP.
4. Replace batteries annually or sooner if necessary.
5. Make instruments available for calibration as required by the organizational SOP.

6. Participate in refresher training exercises and tests as required.
7. Prepare copies of a sketch of the assigned shelter and adjoining areas for use during shelter occupancy.
8. Plan for a location in the shelter, in coordination with the shelter manager, to serve as the center of monitoring operations.

Shelter Operations. Upon attack or warning of attack, a shelter monitor reports to the shelter manager in his assigned shelter and performs the following checklist of operations in order:

1. Perform an operational check on all survey meters.
2. Charge dosimeters.
3. Position dosimeters at predesignated locations in the shelter.
4. Report to the shelter manager on the condition of the instruments and the positioning of dosimeters.
5. Check to see that doors, windows, or other openings are closed during fallout deposition.
6. Begin outside surface monitoring to determine the time of fallout arrival. Advise the shelter manager when the dose rate begins to increase.
7. Monitor all personnel entering shelter after fallout starts to determine if they are contaminated. Personnel monitoring may be impracticable in some shelters because (1) radiation levels or contamination levels inside the shelter may be too high, or (2) the influx of persons into the shelter may be too large to permit the monitoring of each person. In the event of high radiation or contamination levels, delay monitoring until it can be performed. In the event of a large influx of persons into the shelter, monitor several persons selected at random to determine the extent of personal contamination. If practical, segregate groups suspected of heavy contamination until each individual can be monitored.
8. Insure that all persons who have performed outside missions in contaminated areas follow the necessary protective actions.
9. Monitor all food, water, and equipment brought to a shelter after fallout arrival to determine if they are safe to use. Food and water stored in the shelter should be acceptable for consumption. Leave contaminated items outside the shelter or place them in isolated storage near the shelter.
10. Take readings at selected locations throughout the shelter and record the dose rates on prepared sketches of the area. Particular attention should be given to monitoring any occupied areas close to filters in the ventilating system. Show the time of readings on all sketches.
11. Furnish all sketches to the shelter manager and recommend one of the following courses of action:

    a. Occupy only those areas with dose rates below 2 r/hr.
    b. If dose rates are not uniform and above 2 r/hr throughout the shelter, occupy the areas with lowest dose rates.

c. If space prohibits locating all shelter occupants in the better protected areas, rotate personnel to distribute exposure evenly. Do not rotate personnel unless there is a difference of 10 r in the exposure between the best and the least protected shelter occupants. Under all conditions, give consideration to providing the best available protection to pregnant women, children under 18 years, and personnel assigned to early emergency operations.

12. Repeat the procedures in paragraph 10 at least once daily. If there is a rapid change in the dose rate, repeat at least once every six hours.
13. Inform the shelter manager to notify the appropriate control center and request guidance if: (1) at any time during the shelter period the inside dose rate reaches or exceeds 10 r/hr, or (2) within any two days period of shelter the dose is 75 r.
14. Issue each shelter occupant a Radiation Exposure Record. As approved by the shelter manager, advise each person once daily of their exposure during the previous 24 hours.

During the latter part of the shelter period, when there is less frequent need for in-shelter monitoring, some of the shelter monitors may be required to provide monitoring services in support of other civil defense operations. A monitoring capability should always be retained in the shelter until the end of the shelter period.

At the conclusion of the shelter period, all shelter monitors, except those regularly assigned to emergency services, may expect reassignment.

Monitoring Fallout Station Operations. For his own protection and the protection of all members of a fallout monitoring station, the monitor should perform the same shelter operations as described in the previous section. In addition, the fallout station monitor will measure, record, and report unsheltered dose and dose rates to the appropriate control center. Unless otherwise specified by the local SOP, the monitor will:

1. Make a flash report when the outside dose rate reaches or exceeds 0.5 r/hr. The report will be in the following form: tttt eeeFallout, where tttt is the time of the fallout observation in local time and eee is the identifier for the monitoring station.
2. Record and report dose and dose rates in accordance with the Radiological Reporting Log. (See Attachment C.)
3. Record and report dose rates as follows: tttt eeerrr, where, tttt is the time of the reading in local time; eee is the station designator; and rrr is the measured dose rate. Using the Time Conversion Chart (Attachment D) enter above each "Z" time designation the corresponding time for your locality. "Z" time is a common reference time essential to analysis and

evaluation of radiological data by Radiological Defense Officers and is often referred to as Greenwich Meridian Time. It is important that the monitor convert and record these times in the appropriate spaces on his log to assure that all reports have a common reference time.

Dose rates will be reported in roentgens per hour (r/hr) as a three digit number. Example: For readings of less than 100, the first digit will be zero. A reading of 75 r/hr will be reported as 075. If the reading is less than 10 r/hr, then there will be two zeros followed by the reading. Thus, a reading of 5 r/hr will be reported as 005. Dose rates which equal or exceed 1 r/hr will be reported to the nearest whole r/hr. Thus, 1.4 r/hr will be reported as 001, and 1.5 r/hr will be reported as 002. When dose rates that have exceeded 1 r/hr have decreased to less than 1 r/hr, they will be expressed in tenths, hundredths, or thousandths of r/hr as required. Thus, 1/10 r/hr will be reported as .100; 50 mr/hr will be reported as .050. The number or letter designation of the fallout station will be assigned by the civil defense organization and should always be reported exactly as assigned.

4. Record and report dose measurements as follows: dose eeerrrr, where, eee is the station designator and rrrr is the total dose in roentgens to date.

<u>Monitoring in Support of Emergency Operations</u>. As soon as radiation levels decrease sufficiently to permit high priority operations and later, as operational recovery activities including decontamination of vital areas and structures are begun, all fallout station monitors and most shelter monitors are required to provide radiological monitoring support to these operations. Radiological Defense Officers will direct the systematic monitoring of areas, routes, equipment and facilities to determine the extent of contamination. This information will help the civil defense organization determine when people may leave shelter, what areas may be occupied, what routes may be used, and what areas and facilities must be decontaminated.

Many emergency services personnel, such as fire, police, health, and welfare personnel, will serve as shelter monitors or fallout station monitors during the shelter period. However, as operational recovery activities are begun, they will have primary responsibility in their own fields, with secondary responsibilities in radiological defense. Most services will provide for a radiological monitoring capability for the protection of their operational crews performing emergency activities. The capability is provided until the Radiological Defense Officer determines that it is not required. Services provide this capability from their own ranks, to the extent practical, supported by shelter monitors and fallout station monitors, when required.

When a service is directed to perform a mission, the control center furnishes the following information:

1. The time when the service may leave shelter to perform its mission.
2. The allowable dose for the complete mission; that is, from time of departure until return to shelter.
3. The dose rate to be expected in the area of the mission.

The monitor supporting emergency operations will:

1. Read his instruments frequently during each operation and advise the individual in charge of the mission on necessary radiological protective measures and when the crew should leave the area and return to shelter to avoid exceeding the planned mission dose.
2. Determine the effectiveness of decontamination measures, if supporting decontamination operations.
3. Monitor all personnel and equipment on return to shelter, or base of operations, to determine if they are contaminated.
4. Direct decontamination of personnel and equipment, if necessary, and assure that decontamination procedures have been effective.

GUIDANCE FOR INDEPENDENT OPERATIONS

All monitors receive technical direction and guidance from the Radef Officer or other qualified civil defense personnel. However, under the conditions of nuclear attack, communications with the control center could be disrupted. At any time during the shelter period that communications with the assigned control center are disrupted, an effort should be made to contact a neighboring shelter or fallout monitoring station through which radef advice and guidance could be relayed. If this effort is unsuccessful, the monitor may, after consultation with the shelter manager or individual in charge of the fallout monitoring station, use the following guidance AS A LAST RESORT. The guidance equips the monitor with a means of making very rough approximations on which to take critical actions.

Permissible Activities. When the dose rates inside and outside of the shelter or fallout monitoring station are known, use the following as a guide for permissible activities. This guidance is based on observations made on large groups of people and, therefore, should be used with caution with small groups of individuals. Again, it is furnished only as a LAST RESORT GUIDE. The data must be modified as early as possible, taking into account the age of the fallout. If the fallout is relatively young (2 or 3 hours old) greater relaxation of shelter control can be tolerated than that indicated below. Conversely, if the fallout is relatively old (several days or weeks), more rigid control would be required. If in-shelter doses exceed 75 r, activities should, if possible, be restricted even more than indicated below.

If the outside dose rate has fallen to: (in r/hr)	Permissible Activities
Less than 0.5	No special precautions are necessary for operational activities. Keep fallout from contaminating people. Sleep in the shelter.
0.5 to 2	Outdoor activity (up to a few hours per day) is acceptable for essential purposes such as: firefighting, 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.
2 to 10	Periods of less than an hour per day of outdoor activity are acceptable for the most essential purposes. Shelter occupants should rotate outdoor tasks to distribute exposures. Outdoor activities of children should be limited to 10 to 15 minutes per day. Activities such as repair or exercise may take place in less than optimum shelter.
10 to 100	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.
Greater than 100	Outdoor activity of more than a few minutes may result in sickness or death. Occasions which might call for outside activity are: (1) risk of death or serious injury in present shelter from fire, collapse, thirst, etc., and (2) present shelter is greatly inadequate--might result in fatality--and better shelter is known to be only a few minutes away.

If communications are disrupted, the monitors at the fallout monitoring stations will continue to record the required information and report the information to a control center as soon as communications are restored.

Symptoms of Radiation Injury. Radiation from fallout causes injury to body tissue. Over a period of time the body is able to repair most of this injury, provided the individual survives. Observable symptoms of radiation sickness are nausea, vomiting, diarrhea, fever, listlessness, and a general feeling of fatigue. Some or all of these symptoms may appear within the first three days. They may then disappear, reappearing after a week or so, sometimes accompanied by bloody diarrhea and swelling of the nasal passages, mouth and throat. Generally speaking, the greater the dose, the earlier the symptoms will appear. They will be more severe and last longer.

Beta burns will result from significant amounts of fallout remaining in direct contact with the skin. Early symptoms include itching and burning sensations which may soon disappear. After two weeks or more, there may be a loss of hair, which will return in about 6 months. Development of darkened or raised skin areas or sores appears within one or two weeks depending on the severity of the burn. The harmful effects of fallout taken into the body may be long delayed and are not readily recognized.

The severity of effects on individuals exposed to the same dose will vary widely. However, short-term effects on humans from external gamma exposures of less than four days can be estimated as follows:

Short-term dose	Visible effect
50 r	No visible effects.
75-100 r	Brief periods of nausea on day of exposure in about 10% of the group.
200 r	As many as 50% of the group may experience some of the symptoms of radiation sickness. Although only 5% to 10% may require medical attention, no deaths are expected.
450 r	Serious radiation sickness in most members of the group followed by death to about 50% within two to four weeks.
600 r	Serious radiation sickness in all members of the group followed by death to almost all members within one to three weeks.

Care of Radiation Casualties. If a person becomes ill from exposure to radiation, he should be placed under the care of a physician or medical technician, if possible. In the postattack situation, medical care may be very limited. Care consists primarily of keeping the patient comfortable and in bed. Keep the patient clean and isolated from infectious diseases. The ill person should have liquids to replace the body fluids lost as a result of vomiting and diarrhea as soon as he can tolerate them. Nourishing foods should be given the patient since they are needed for recovery.

Beta burns are treated in the same manner as burns resulting from heat. If possible, allow a physician or medical technician to treat the beta burns.

Exposure Criteria. Keep the exposure of shelterees as low as practicable. With a good shelter in most fallout areas, it should be possible to keep exposure doses below 100 r during the first 2 weeks. Keep the total exposure of personnel on emergency missions below 200 r during the first month of operations. Keep additional exposures to less than 25 r/week for the next 5 months.

Dose and Dose Rate Calculations. Nomograms, based on theoretical fallout radiation decay characteristics, may be used for rough estimates of future dose rates and radiation doses that might be expected in performing necessary tasks outside the shelter. However, when fallout from several nuclear weapons detonated more than 24 hours apart is deposited in an area, the decay rate may differ markedly from the assumed decay rate. For this reason, calculations using nomograms should be limited as follows:

1. The time of detonation must be known with a reasonable degree of accuracy--plus or minus one hour for forecasts made within the first twelve hours, and plus or minus 2-3 hours for later forecasts.
2. If nuclear detonations occur more than 24 hours apart, predicted dose rates may be considerably in error. In this case, use the H hour of the latest detonation to compute "Time After Burst."
3. At the time of calculation, dose rates must have been decreasing for at least 2-3 hours, and forecasts should be made for periods no further in the future than the length of time the radiation levels have been observed to decrease.

For unsheltered emergency missions, the effects of the mission exposure must be weighed against the benefit to be derived and the importance of early mission performance. The longer the task can be delayed without undue penalty, the greater the radioactive decay of the fallout and the less the radiation penalty. Generally, outside missions should be short, not to exceed three hours. Missions will not be started until monitoring indicates that predicted conditions actually prevail. At least one dosimeter will be carried and periodically read to assure limiting the dose to the established value.

To use the Dose Rate Nomogram (See Attachment E) connect a known dose rate in the "Dose Rate at H + t" column with the corresponding time in the "Time After Burst" column. Note the reading on the "Dose Rate at H + 1" column. Connect this reading with the time of the unknown dose rate on the "Time After Burst" column and read the answer from the "Dose Rate at H + t" column.

Example - Given: The dose rate in an area at H + 12 is 50 r/hr.
Find: The dose rate in this area at H + 18.
Solution: Using a straightedge, connect 50 r/hr on the "Dose Rate at H + t" column with 12 hours on the "Time After Burst" column and read 970 r/hr on the "Dose Rate at H + 1" column. Pivot the straightedge to connect 970 r/hr on the "Dose Rate at H + 1" column with 18 hours on the "Time After Burst" column and read the answer from the "Dose Rate at H + t" column.

ANSWER: 31 r/hr

To use the "Entry Time--Stay Time--Total Dose Nomograms" (See Attachment F), connect two known quantities with a straightedge and locate the point on the "D/R_1" column where the straightedge crosses it. Connect this point with a third known quantity and read the answer from the appropriate column.

Example (Total Dose) -
Given: The dose rate in an area at H + 8 is 10 r/hr.
Find: The total dose received if a person enters this area at H + 10 and remains for four hours.
Solution: Find the dose rate at H + 1 (120 r/hr). Using a straightedge, connect four hours on the "Stay Time" column with ten hours on the "Entry Time" column. Find .21 on the "D/R_1" column. Connect .21 on the "D/R_1" column with 120 r/hr on the "Dose Rate at H + 1" column. Read the answer from the "Total Dose" column.

ANSWER: 25 r

Example (Entry Time) -
Given: Dose rate in an area at H + 10 is 12 r/hr. Stay time is 8 hours and the mission dose is established at 50 r.
Find: The earliest entry time into the area.
Solution: Find the dose rate at H + 1 (190 r/hr). Using a straightedge, connect 50 r on the "Total Dose" column with 190 r/hr on the "Dose Rate at H + 1" column. Find .26 on the "D/R_1" column. Connect .26 on the "D/R_1" column with 3 hours on the "Stay Time" column. Read the answer from the "Entry Time" column.

ANSWER: 14 hours

GLOSSARY

The following are the meanings of the indicated terms as they are used in this chapter.

Alpha. Particles emitted from the nuclei of heavy radioactive atoms such as radium, uranium, or plutonium. Alpha particles do not penetrate the skin and, thus, are not an external hazard. If emitted inside the body, they can cause severe damage in the tissue very close to the source. It is unlikely that fallout from efficient nuclear explosions will emit significant amounts of alpha radiation.

Beta. Particles emitted from the nuclei of some types of radioactive atoms. When heavy atoms are split in a nuclear detonation the fragments formed are usually beta emitters. Most fallout beta radiation has sufficient penetrating power to cause skin "burns" if a high concentration of fallout particles remains in contact with the skin for several hours. If fission products are taken into the body, beta radiation can be an internal hazard.

Calibration. Determination of variation in accuracy of radiological instruments. Radioactive sources are used to produce known dose rates. The variation in accuracy of a radiological instrument can be determined by measuring these known dose rates.

Contamination. The deposit of radioactive material on the surfaces of structures, areas, objects, or personnel following a nuclear explosion. This generally consists of fallout in which radioactive bomb fragments and other weapon debris have become incorporated with particles of dirt.

Decontamination. The reduction or removal of contaminating radioactive fallout from a structure, area, object, or person. Decontamination may be accomplished by (1) treating the surface so as to remove or decrease the contamination; (2) letting the material stand so that the radioactivity is decreased as a result of natural decay; and (3) covering the contamination so as to attenuate the radiation emitted.

Dose. Accumulated or total exposure to gamma radiation, commonly expressed in roentgens.

Dose Rate. The rate or dose per unit time of exposure to gamma radiation, commonly expressed in roentgens per hour, r/hr, or milliroentgens per hour, mr/hr.

Emergency Services. Elements of government that are responsible for the protection of life and property, such as fire, police, welfare, and rescue services.

Fallout. The process of the fallback to the earth's surface of particles contaminated with radioactive bomb fragments from a nuclear explosion. Most of the fallout from a surface burst will be deposited within 24 hours after a nuclear explosion and within 400 to 500 miles downwind from ground zero.

Fallout Monitoring Station. A designated facility such as a fire station, police or public works building, or other location which should have a protection factor of at least 100 and relatively reliable communications. It may be established with a minimum of two trained radiological monitors but as promptly as feasible the number should be increased to a minimum of four.

Gamma. Nuclear radiation of high energy originating in atomic nuclei and accompanying many beta particles as they are emitted from the fragments of heavy atoms split in a nuclear detonation. Physically, gamma rays are identical with x-rays of high energy. Gamma rays are very penetrating and for practical shielding considerable amounts of dense material is usually employed.

Milliroentgen. 1/1000 of a roentgen. 1000 milliroentgens equal one roentgen. See roentgen.

Monitor. An individual trained to measure, record, and report radiation dose and dose rates; provide limited field guidance on radiation hazards associated with operations to which he is assigned; and perform operator maintenance of radiological instruments.

Protection Factor. A factor used to express the relation between the amount of fallout gamma radiation that would be received by an unprotected person compared to the amount he would receive if he were in a shelter. For example, an unprotected person would be exposed to 100 times more radiation than a person inside a shelter with a protection factor of 100.

Radiation. Nuclear radiation. Energy and particles emitted from the nuclei of radioactive atoms. The important nuclear radiations from radioactive fallout are beta particles and gamma rays.

Radioactivity. The spontaneous breakdown of nuclei of unstable atoms with the resulting emission of nuclear radiation, generally alpha or beta particles, often accompanied by gamma rays.

Radiological Defense. The organized effort, through detection, warning, and preventative and remedial measures to minimize the effects of nuclear radiation on people and resources.

Readiness Operations. Plans and preparations made during peacetime for survival and recovery operations during and after a nuclear attack.

Remedial Movement. Transfer of people after a nuclear attack to provide better fallout protection. This can be accomplished by moving people to a shelter with a higher protection factor or to an area where the dose rates are lower.

Roentgen. A unit of measure for gamma (or x-ray) radiation exposure.

Shelter. A habitable structure or space stocked with essential provisions and used to protect its occupants from fallout radiation.

Shelter Period. The interval of time from attack, or warning of attack, until dose rates from fallout have decreased to a level which will permit people to leave shelter. This time may vary from a few hours to several days or weeks depending upon the degree of the fallout hazard.

Standing Operating Procedures (SOP). A set of instructions having the force of a directive, covering those features of operations which lend themselves to a definite or standardized procedure without loss of effectiveness.

ATTACHMENT A

RADIATION EXPOSURE RECORD

Name JOHN DOE
Address 227 Moorland, Battle Creek
Soc. Sec. No. 545-26-5535

Date(s) of Exposure(s)	Daily Dose(s)	Total Dose to Date
6/6/62	15	15
6/7/62	5	20
6/7/62	25	45
6/8-10/62	5	50

Date(s) of Exposure(s)	Daily Dose(s)	Total Dose to Date

FRONT SIDE SAMPLE FORM BACK SIDE

Example: From the illustration shown above on June 6 the individual received a sheltered dose of 15 r, and on June 7 he received a sheltered dose of 5 r and an additional outside dose of 25 r. The two June 7 exposures have been recorded as two entries. On June 8 and 9 the dosimeter reading inside the shelter was so low it could not be read. On June 10, a reading of 5 r was measurable. In order to account for the 3 days, a 5 r entry was made on June 10.

ATTACHMENT B

INSPECTION, MAINTENANCE AND CALIBRATION LOG FOR RADIOLOGICAL INSTRUMENTS

DATE	ACTION	REMARKS	SIGNATURE
8/1/62	inspection	O.K.	John Doe
10/3/62	inspection	O.K. except CD V-715	John Doe
	out for repair	CD V-715, #86376	John Doe
10/15/62	returned	CD V-715, #86376	John Doe
12/2/62	inspection	O.K.	John Doe
1/6/63	batteries replaced		John Doe
1/15/63	calibration	O.K.	John Doe

SAMPLE FORM

Directions:

1. Keep this log with the instruments.
2. Inspect all radiological instruments every two months. Perform an operational check on survey meters and, if necessary, rezero all dosimeters. Enter the results of the inspection on this log.
3. Initiate action for repair or replacement of inoperable instruments. Enter the appropriate action on this log.
4. Replace batteries annually or sooner, if necessary. Enter replacement on this log.
5. Make instruments available for calibration as required. Enter action on this log.

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY OF THE ARMY
OFFICE OF CIVIL DEFENSE

RADIOLOGICAL REPORTING LOG

STATION

REPORTED TO

FLASH REPORT (0.5 r/hr. or more)	1st HR THRU 12th HR[3] (Hourly on the hour)			13th HR THRU 24th HR[3] (Every 3 hours)			25th HR THRU 48th HR[3] (Every 6 hours)			AFTER 48th HR[3] ____ [1] (Daily at 0300Z)		
DATE	DATE			DATE			DATE			DATE	DOSE RATE (r/hr)	TOTAL DOSE[2] (r)
TIME		TIME	DOSE RATE (r/hr)		TIME	DOSE RATE (r/hr)		TIME	DOSE RATE (r/hr)			
DOSE RATE (r/hr)	1			1			1					
TIME SENT TO CONTROL CTR	2			2			2					
NOTE: *Flash report of fallout will be made as soon as dose rate reaches 0.5 r/hr.*	3			3			3					
	4			4			4					
REPORT AS FOLLOWS	5			5			TAKE OBSERVATIONS AT					
1. TIME OF OBSERVATION	6			6			____ [1] 0300 Z; ____ [1] 0900 Z					
2. LOCATION	7			7			____ [1] 1500 Z; ____ [1] 2100 Z					
	8			8			[2]TOTAL DOSE TO					
3. FALLOUT	9			TAKE OBSERVATIONS AT			____ [1] 0300 Z ____ r					
	10			____ [1] 0300 Z; ____ [1] 0600 Z								
	11			____ [1] 0900 Z; ____ [1] 1200 Z								
	12			____ [1] 1500 Z; ____ [1] 1800 Z			*If at any time following a period of decay, the dose rate increases materially, file a special report and start new program of observations.*					
				____ [1] 2100 Z; ____ [1] 2400 Z								
	[2]TOTAL DOSE TO ____ [1] 0300 Z ____ r			[2]TOTAL DOSE TO ____ [1] 0300 Z ____ r								
REPORT DOSE RATES AS FOLLOWS	1. TIME			2. LOCATION			3. DOSE RATE			4. DOSE TO 0300 Z ____ [1]		

[1] *Enter local time from reverse side.* [2] *Total dose read from dosimeter - cumulative from arrival of fallout.* [3] *After flash report.*

OCD FORM 841, MAY 64

TIME CONVERSION CHART
(For Alaska and Hawaii, see footnote)

GREENWICH MEAN TIME	ATLANTIC STANDARD OR EASTERN DAYLIGHT	EASTERN STANDARD OR CENTRAL DAYLIGHT	CENTRAL STANDARD OR MOUNTAIN DAYLIGHT	MOUNTAIN STANDARD OR PACIFIC DAYLIGHT	PACIFIC STANDARD
0100	2100*	2000*	1900*	1800*	1700*
0200	2200*	2100*	2000*	1900*	1800*
0300	2300*	2200*	2100*	2000*	1900*
0400	2400*	2300*	2200*	2100*	2000*
0500	0100	2400*	2300*	2200*	2100*
0600	0200	0100	2400*	2300*	2200*
0700	0300	0200	0100	2400*	2300*
0800	0400	0300	0200	0100	2400*
0900	0500	0400	0300	0200	0100
1000	0600	0500	0400	0300	0200
1100	0700	0600	0500	0400	0300
1200	0800	0700	0600	0500	0400
1300	0900	0800	0700	0600	0500
1400	1000	0900	0800	0700	0600
1500	1100	1000	0900	0800	0700
1600	1200	1100	1000	0900	0800
1700	1300	1200	1100	1000	0900
1800	1400	1300	1200	1100	1000
1900	1500	1400	1300	1200	1100
2000	1600	1500	1400	1300	1200
2100	1700	1600	1500	1400	1300
2200	1800	1700	1600	1500	1400
2300	1900	1800	1700	1600	1500
2400	2000	1900	1800	1700	1600

*Add one day to the local calendar date for equivalent date in GMT. Example: Observed Central Standard Time is 10:00 PM *(2200 CST)* on the 14th day of the month *(142200 CST)*. Expressed as GMT, that time would be 0400Z on the 15th day of the month *(150400Z)*.

NOTE: For central Alaska *(Anchorage)* subtract 2 hours *(0200)* from each entry in the "Pacific Standard" Column. For Hawaii subtract 2 hours and 30 minutes *(0230)* from each entry in the "Pacific Standard" Column.

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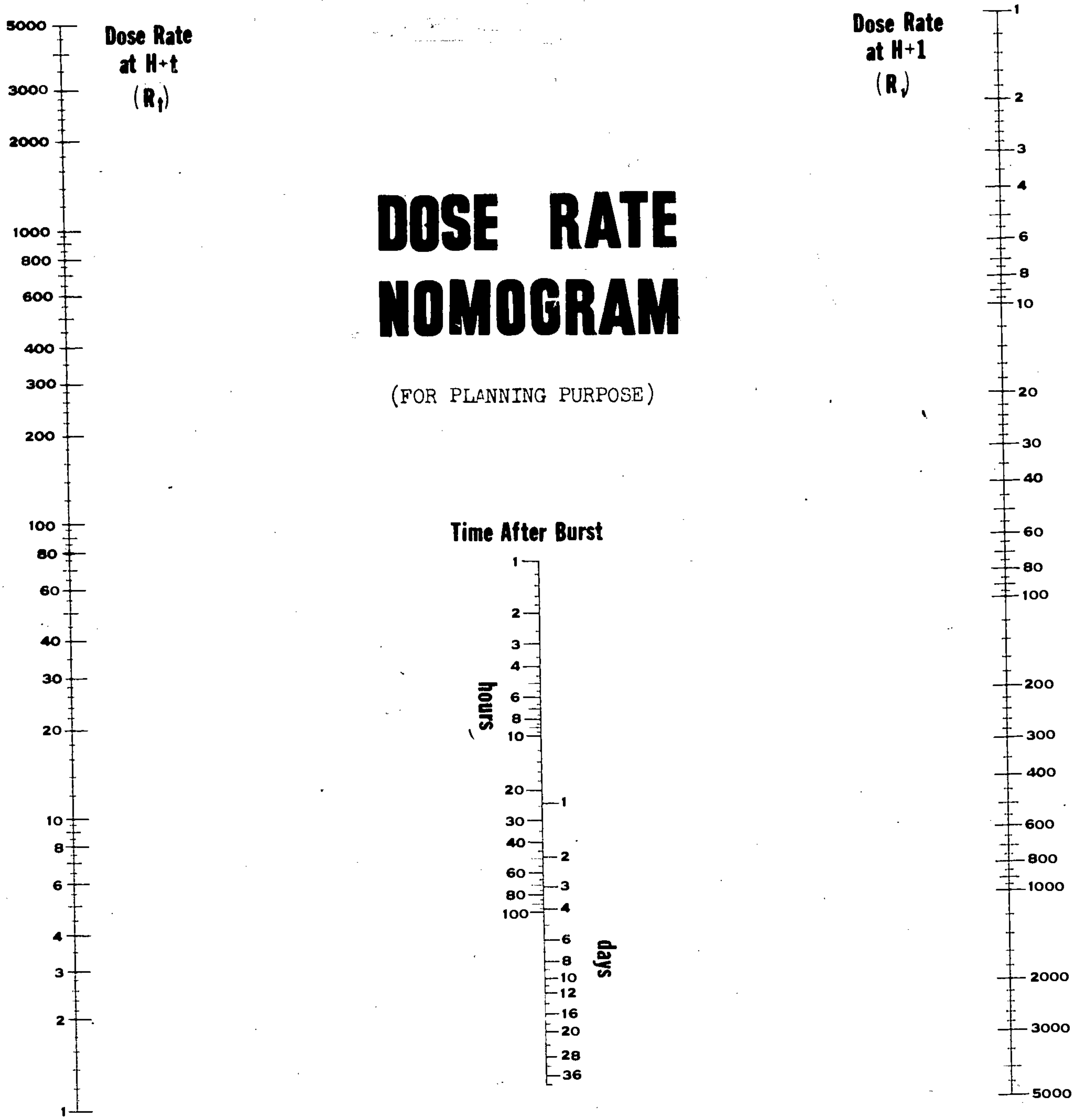
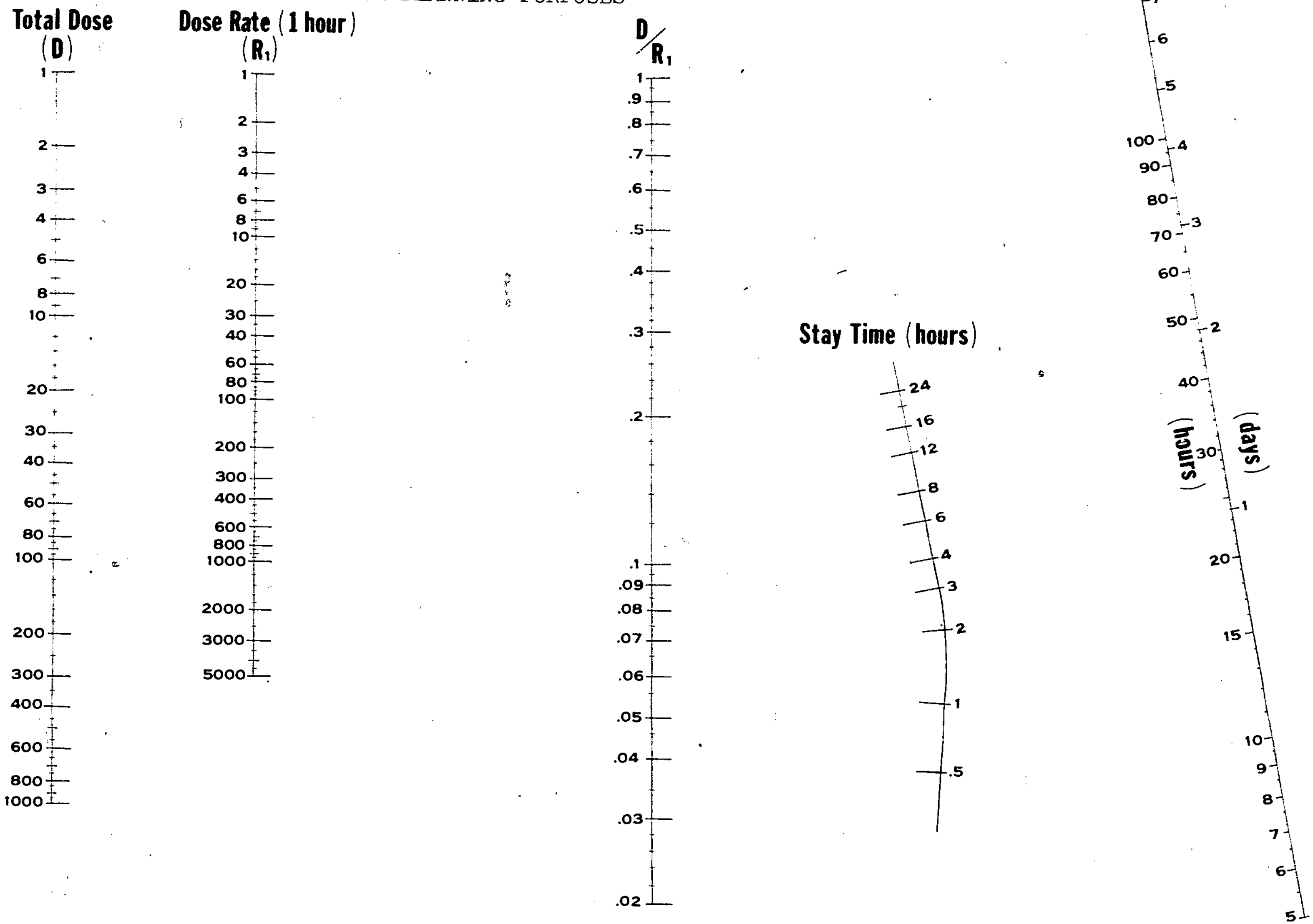
DOSE RATE NOMOGRAM

(FOR PLANNING PURPOSE)



ENTRY TIME - STAY TIME TOTAL DOSE NOMOGRAM

FOR PLANNING PURPOSES



HANDBOOK FOR AERIAL RADIOLOGICAL MONITORS

(Supplement to Handbook for Radiological Monitors)

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

Detailed descriptions of aerial survey techniques, operational procedures and specialized survey equipment are included in this annex. 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 need to be familiar with:

1. The over-all monitoring system.
2. The unique contributions which aerial survey can provide.
3. The principles affecting the success of aerial survey operations.

The OCD basic Handbook for Radiological Monitors (Chapter IX) provides a brief description of the over-all radiological monitoring system, and the functions required of it. The following paragraphs of this section outline:

1. The relationship of aerial survey to the monitoring system.
2. The major contributions to be expected from aerial survey operations.
3. Equipment (aircraft) and personnel requirements.

The next section discusses organizational requirements and presents technical principles affecting survey operations.

THE MONITORING SYSTEM - GENERAL

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 the 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 the 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

Aerial radiological survey can supplement surface monitoring by:

1. 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.

2. Monitoring areas of high radiation intensities where surface mobile monitoring would result in excessive exposure of monitors.

3. 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.

4. Accomplishing early monitoring at, and in the vicinity of, essential facilities as a basis for planning early recovery.

5. Surveying agricultural lands for planning the disposition of livestock, harvesting of crops, and future land utilization.

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

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 the 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.

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:

1. ground speed
2. altitude
3. azimuth (direction)

while flying at low heights above the terrain.

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 described under SURVEY OPERATIONS later in this chapter.

2. Know the types, use, and operation of all OCD radiological instruments and related equipment discussed in "Handbook for Radiological Monitors," (Chapter IX).

3. Know the types, use, and operation of the aerial survey equipment.

4. Use the survey techniques discussed in this Handbook.

5. Promptly advise the pilot on appropriate alterations to flight direction and altitude, when required, to assure reliable monitoring information and personnel safety.

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. (Reference: Chapter IX, and the discussion on aircraft contamination in the next section.)

AERIAL MONITORING PRINCIPLES

<u>Emergency Utilization of Aircraft</u>. 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:

1. General damage assessment reconnaissance.

2. Aerial radiological survey.

3. Airlift of key personnel.

4. 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.

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. 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.

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. The factor for correcting aerial readings to surface dose rates is obtained by multiplying the theoretical HCF by the aircraft absorption factor.

Definition of the Contamination Pattern. 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 aboveground. Figure 1 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, in this 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.

Correction Factor Determination - Field. 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 altitudes* for use in computing 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 percent 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.

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. 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

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

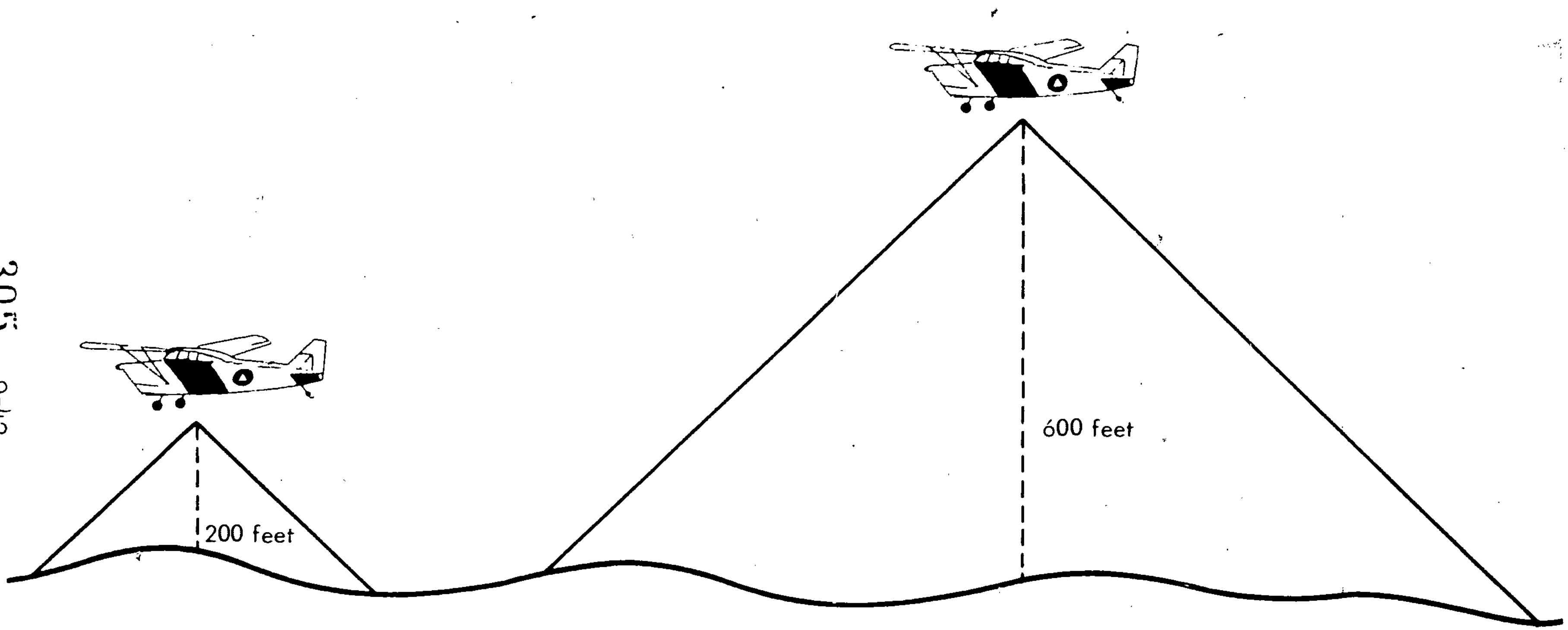


Figure 1 - Aerial monitoring: effects of height. At low heights the instrument "sees" a relatively small area; and at greater heights; a larger area.

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 1/5 to 1/9 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.

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 areas.

Optimum Survey Speed. Optimum speed is related to the nature of the survey. Very low speed is desirable for a detailed small area survey. 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 characteristics of the aircraft should be matched to the mission requirements.

The characteristics of the radiation survey instruments are related to allowable speed. For example, it takes a CD V-715 instrument up to nine seconds to indicate 95 percent of a sudden change in the radiation field. At 150 m.p.h. 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. 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. 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.

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.

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 (a lake, bay, or 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 decreased in the survey meter reading. The continuing radiation reading would be the background due to aircraft contamination.

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.

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.

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 materially reduce the contamination. If significant amounts of fallout have penetrated inside of 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 previously.

Contamination of the aircraft with airborne fallout could occur while a survey mission is being performed. Low concentrations of airborne 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.

If contamination with airborne fallout is suspected, evaluation of any resultant background can be accomplished. If significant contamination is indicated, the advice of the responsible Radef Officer should be requested when the 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.

SURVEY TECHNIQUES

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. 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 (1) Course Leg Technique, (2) Route Technique, and (3) 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 the section on Survey Operations. Basic elements of the techniques are outlined below.

Course Leg Technique. 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.

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. Types of maps suitable for aerial survey, and their availability are discussed in the section on Equipment.

Route Technique. 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 intermediate checkpoints because ground speed is likely to be more variable as direction is changed in following the route. There may be more frequent requirement for change in altitude at specified checkpoints during the survey of the route.

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.

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.

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. 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.

Exploratory Survey. 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 and early postattack period when:

1. Radiation dose rates might be high and could vary greatly over short distances.

2. Blast damage might be extensive, obliterating many landmarks.

3. 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 the previous section on Aerial Monitoring Principles.

SURVEY OPERATIONS

Maps. Maps appropriate to the mission are essential to the most effective survey operations.

Protective Measures. Although major responsibilities for planning and directing aerial survey rest at State level, the members of the survey team and ground support personnel are directly responsible for knowing and observing radiological protective measures. The Handbook for Radiological Monitors, Chapter IX, provides guidance for surface operations. These are also directly applicable during preparations for an aerial mission.

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.

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. 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 the section on Aerial Monitoring Principles, 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 earlier. If necessary, simple decontamination procedures might be employed, followed by reevaluation of the contamination level.

Equipment Mounting. The major components of the Aerial Survey Equipment used in training are (1) the Detector Unit, (2) the Metering Unit, (3) the Tape Recorder, and (4) the Simulator Unit. 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.

Each locality can fabricate a mounting device best adapted to the particular aircraft being used. Figures 2 and 3 show the metering unit

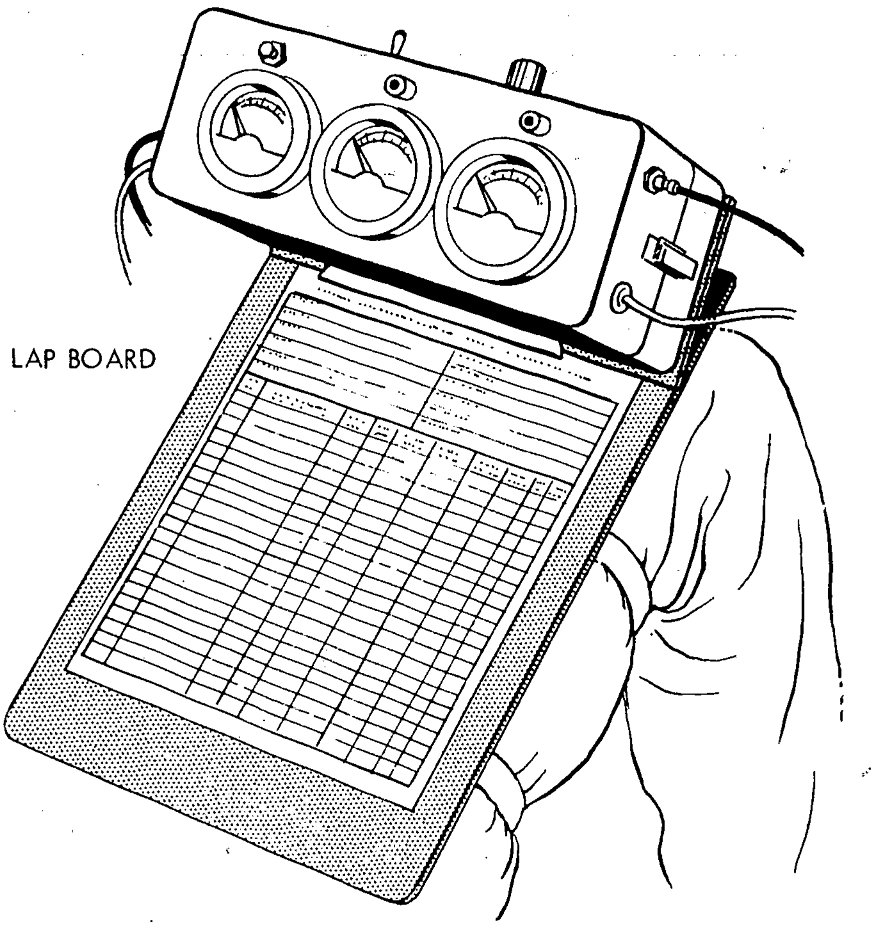


Figure 2

METERING UNIT MOUNTED ON LAP BOARD

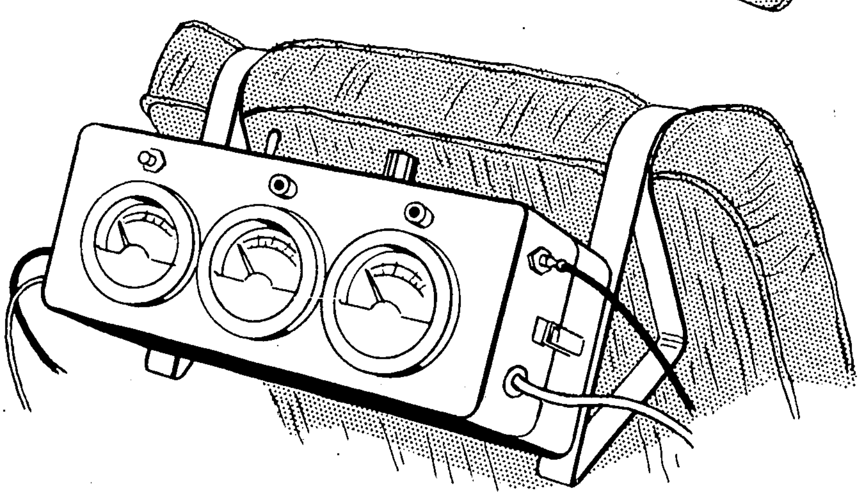


Figure 3 METERING UNIT MOUNTED ON BACK OF SEAT

(TWO PLACE INLINE AIRCRAFT)

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.

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.

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.

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

The Survey Briefing. The planning, direction, and the 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.

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 EOC Radef Officer, these should be resolved before commencing the mission. The pilot makes all appropriate flight arrangements.

Survey Data Sheet. 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 used 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 - L inc.) will be filled out on the first sheet only.

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.

Recording and Reporting Data. Data may be recorded directly on the data sheet as suggested above, or on tape. Operation of the tape recorder is described in the Equipment section. 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, the 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.

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 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 following examples and accompanying illustrations clarify the flexible requirements for readings and the times at which radiation measurements were made.

Air-Drop Report. 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 playback at the tape-speed used in recording.

Survey Examples. The general procedures to be followed in performance of an aerial survey have been presented above. The examples below illustrate the application of the several techniques described in the section on Survey Techniques and should serve as guides in the preparation of SOP's and the execution of survey missions.

Preflight 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.

1. Participate in survey briefing.

2. Prepare survey mission data sheets.

3. Prepare appropriate maps (Figures 5 and 7).

4. Check the list of equipment (reverse side of data sheet).

5. Perform instrument operational checks.

6. Zero dosimeters and position on survey team personnel.

7. Check tape recorder. (If scheduled for use, record the preliminary information from the Survey Data Sheet.)

8. Position equipment in aircraft.

9. Set altimeter - set the latest barometric data in the Kollsman window of the altimeter and correct for nonstandard surface pressure. Note that the validity of aerial radiological survey data is directly related to the accuracy of altitude determinations.

10. Proceed with survey.

Point Technique - Figure 4 is an "exploded" view of a Survey Data Sheet for an example point technique survey. The information in the heading

DEPARTMENT OF THE ARMY OFFICE OF THE SECRETARY OF THE ARMY OFFICE OF CIVIL DEFENSE **AERIAL RADIOLOGICAL SURVEY DATA SHEET**	MISSION NUMBER: S-5 DATE: January 18 1966
a. REQUESTED BY: State of Virginia EOC	g. MAP IDENTIFICATION AND SCALE: Geological Survey Falls Church 1:24,000
b. REPORT TO: Alexandria, Va., Radef. Officer	h. AUTHORIZED MISSION DOSE: 15 R
c. CONTROLLED BY: " " " "	i. MISSION DOSE RECEIVED: 8 R
d. PILOT'S NAME AND ORGANIZATION: Maj. A.N. Able, Dulles Comp. Sq. Sterling (CAP)	j. AIRCRAFT CORRECTION FACTOR: 1.2
e. MONITOR'S NAME AND ORGANIZATION: Capt. Ben Rodgers, " " " "	k. RADEF INSTRUMENT USED: CD V-781, Model 1.
f. AIRCRAFT TYPE AND NO.: Piper PA 18, N2418 A	l. COURSE LEG OR ROUTE TIME INTERVAL: NA

Completed during briefing by RADEF Officer (Except Item i)

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	Chain Bdge + Great Falls Rds.	615	"	7.0	10:10 a.m.	367	250	5	35
2	1st Intersection SW on Chain Bdge Rd.	595	"	5.0		345	"	"	25
3	Tysons Corner	735	"	4.2		483	"	"	21
4	Chain Bdge + Court House Rds.	725	"	5.3		476	"	"	26.5
5	Wolftrap + Woodford Rds.	720	"	4.7		469	"	"	23.5
6	Freedom Hill Sch.	730	"	7.5		485	"	"	37.5
7	Leesburg Pk. + Loring Rd.	725	"	6.5		476	"	"	32.5
8	Pimmit Hill Sch.	745	"	7.2		496	"	"	36
9	Sewage Disposal Pt. E. Pimmit Dr.	550	"	5.4		300	"	"	27
10	Lemon Rd Sch.	615	"	5.6		365	"	"	28
11	Water Tk. N. Leesburg Pk. + Pimmit Dr.	650	"	6.0		400	"	"	30
12	Water Tk. 1/2 mi. N. Leesburg Pk.	645	"	5.8		495	"	"	29
13	Loring Rd. + Shreve Lane	735	"	6.7		483	"	"	33.5
14	Woodford Rd. + Electric Ave.	700	"	7.0		449	"	"	35
15	R.R. + Shreve Ln.	670	"	5.4		417	"	"	27
16	Dunn Loring Sch.	720	"	6.8		467	"	"	34
17	Irwin Memor. Ch.	720	"	7.2		472	"	"	36
18	George Mason Sch.	660	"	7.0	11:25 a.m.	410	"	"	35
19	(End of Survey)								
20	Map atch'd.								

OCD FORM 842, Mar 64

Section - 1: Provided by RADEF Officer

Section - 2: Recorded in Flight

Section - 3: Data processed by EOC RADEF Staff

Figure 4 --POINT TECHNIQUE SURVEY --EXAMPLE DATA SHEET
(Prescribed altitudes to result in readings at 250' above designated locations)

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; 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 EOC on the basis of reported data.

Map Preparation - The prescribed survey point locations are indicated on a suitable map by the column 1 survey sequence point numbers as shown in Figure 5. 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.

In-flight operations - The following procedure is used to conduct the example point survey as illustrated.

1. 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.

2. Just prior to approaching the point, the pilot alerts the monitor and when directly over the point the pilot signals "record," followed by the altimeter reading if it varies from the prescribed altitude.

3. 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 2, above, the altimeter reading.

4. The monitor records the time, 10:10 a.m. under the heading "Time of Reading."

5. The above procedure is continued until all points have been monitored.

6. For the last point in this example - No. 18, George Mason School - the time is again recorded. Note that 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.

7. Upon completion of the mission, personal dosimeters are read and the radiation exposure recorded under Item I.

8. Reporting requirements have been discussed previously.

Course Leg Technique - The general nature and applications of this technique were discussed in the section on Survey Techniques. 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, Figure 6, the prescribed time intervals

Figure 5. --POINT TECHNIQUE--PREPARED MAP

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

a. REQUESTED BY: State EOC, Richmond, Virginia

b. REPORT TO: E.V. Evans, Radef O., Front Royal, Va.

c. CONTROLLED BY: Front Royal EOC

d. PILOT'S NAME AND ORGANIZATION: Capt. Dan Kent, Front Royal Comp Sq (CAP)

e. MONITOR'S NAME AND ORGANIZATION: Sgt. Al Boyd, " " " " "

f. AIRCRAFT TYPE AND NO.: Cessna 180 N2038U

g. MAP IDENTIFICATION AND SCALE: Army Map Sv. E. U.S, Wash. 1:250,000

h. AUTHORIZED MISSION DOSE: 20 R

i. MISSION DOSE RECEIVED:

j. AIRCRAFT CORRECTION FACTOR: 1.3

k. RADEF INSTRUMENT USED: CD V-781, Model 1

l. 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 CF	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					Pt. B +28 Sec.				
16									
17									
18									
19									
20									

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Figure 6 --COURSE LEG TECHNIQUE

of 30 seconds between radiation measurements were selected to provide data at approximately 1-1/2 mile intervals at the cruising speed of the 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.

Map Preparation - The prescribed course legs are laid out on a suitable map and lettered in the prescribed sequence as shown in Figure 7. 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.

In-flight Operations - The following procedure is used to conduct the course leg survey.

1. 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.

2. The pilot flies the aircraft on the proper course to pass over point "A" on a straight path towards Manassas.

3. When on course, the pilot alerts the monitor.

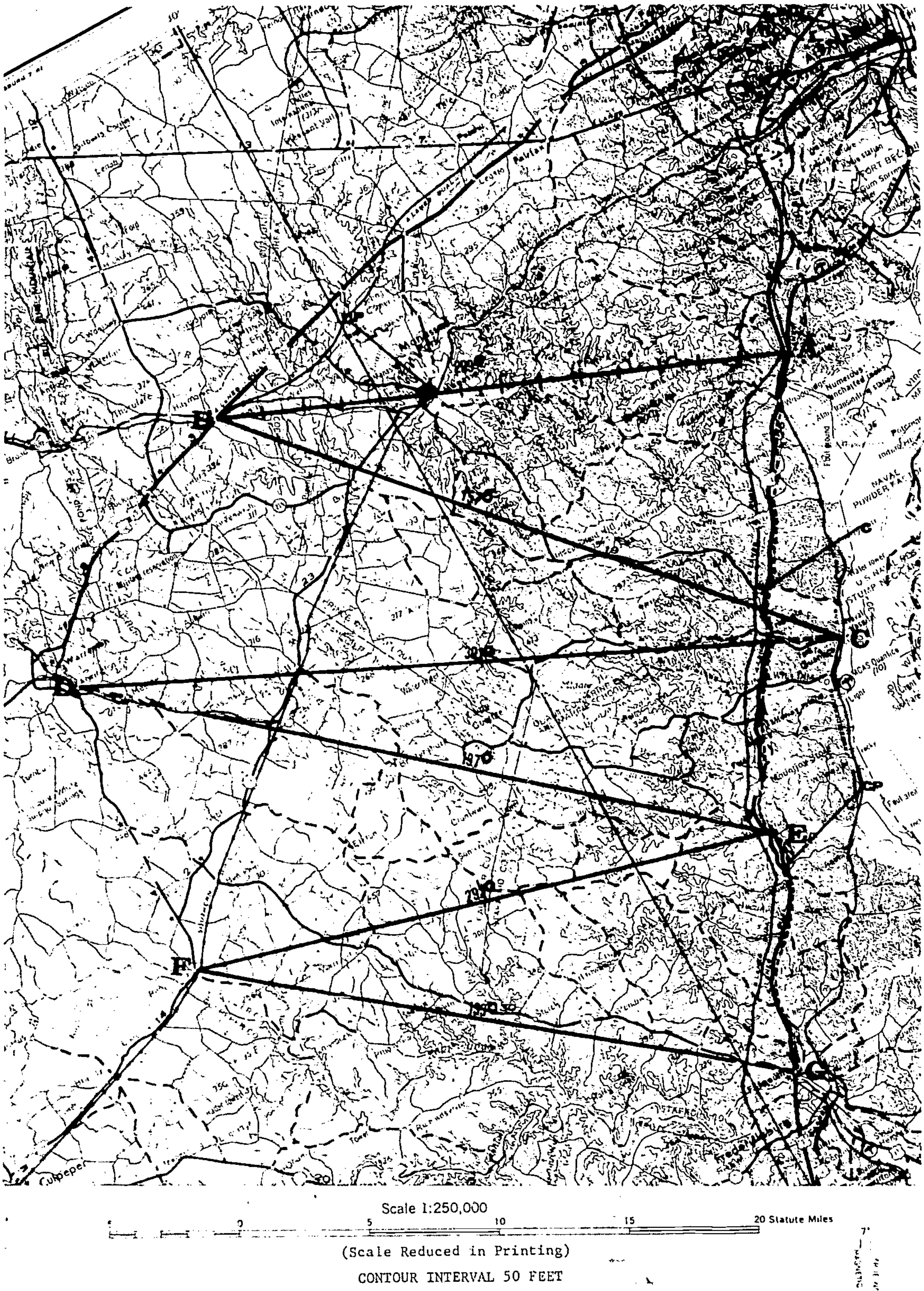
4. As the aircraft passes directly over point "A," the pilot signals, "record," followed by the altitude reading if it varies from the prescribed altitude.

5. 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 4, above, the altitude reading.

6. Upon passing over the checkpoint - Manassas - 20 seconds had elasped since reading "9" was taken. This is indicated on the data sheet by the special notation "+20 sec. C.P."

7. 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.

8. The monitor records the time of the last reading and indicates the elapse of time since reading "14" was taken.



———— COURSE LEG TECHNIQUE
- - - - - - ROUTE TECHNIQUE

Figure 7 .--COURSE LEG AND ROUTE TECHNIQUES

9. Similarly, the above procedures are employed in surveying the remaining course legs.

Explanatory 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.

Route Technique - This technique is similar to that for a single course leg, described above. Figure 7 includes a map layout of an example route survey. The accompanying Survey Data Sheet, Figure 8, is self-explanatory.

Exploratory Survey - In this kind of aerial survey 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.

EQUIPMENT

Maps. 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 Figure 5, the scale (reduced for printing) is 1:24000 - about 2-1/2 inches per mile - and the contour interval is 10 feet. In Figure 7, the map scale selected is 1:250,000 - about 4 miles per inch - and the contour interval is 50 feet. The latter figure 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.

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.

Aerial Survey Meter, CD V-781, Model 1. 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, Figure 9. A comprehensive instruction and maintenance manual is supplied with the instrument. For ready availability to all monitors, operational procedures are outlined below.

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. REPORT TO

c. CONTROLLED BY

d. PILOT'S NAME AND ORGANIZATION

e. MONITOR'S NAME AND ORGANIZATION

f. AIRCRAFT TYPE AND NO.

See Page 1

g. MAP IDENTIFICATION AND SCALE

h. AUTHORIZED MISSION DOSE

i. MISSION DOSE RECEIVED: 9 R

j. AIRCRAFT CORRECTION FACTOR

k. RADEF INSTRUMENT USED

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	Pt. A 25 Sec				
20									

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Figure 8 --ROUTE SURVEY TECHNIQUE

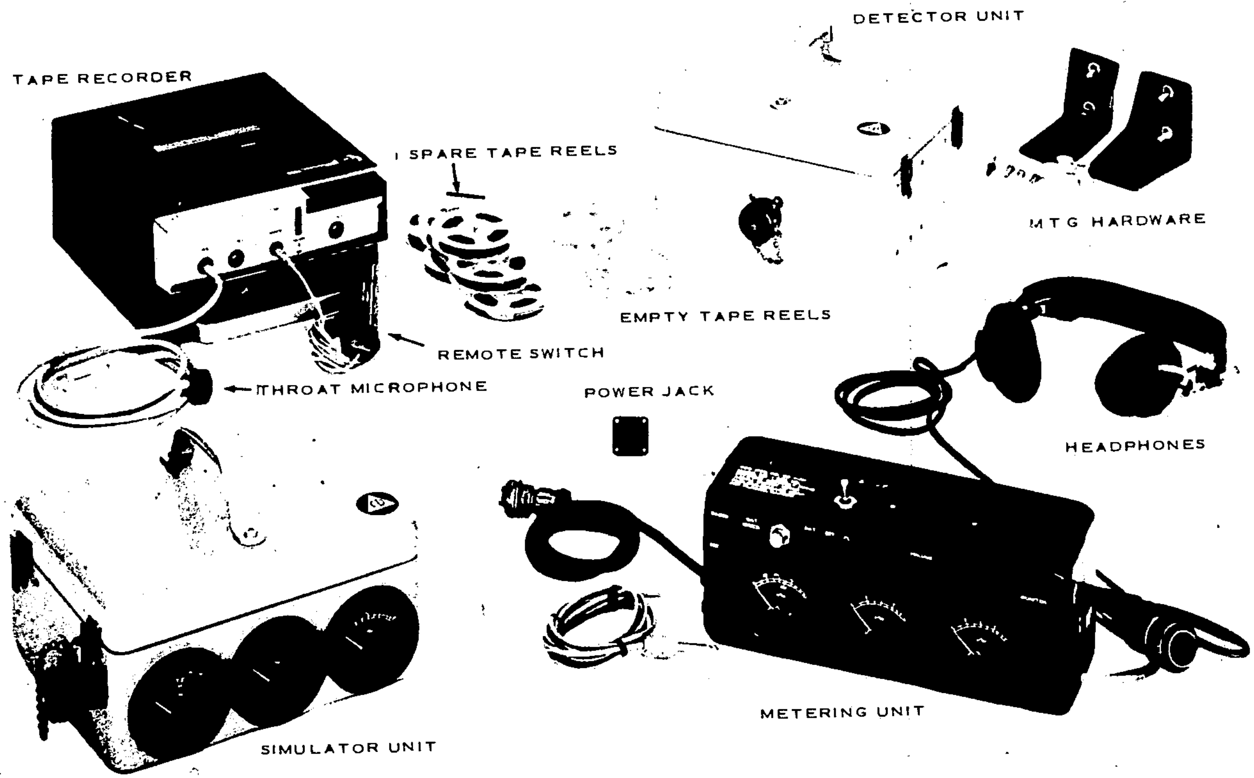


Figure 9 - AERIAL SURVEY METER, CD V-781, MODEL 1

1. 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:

   a. Attach the cable of the metering unit to the connector provided on the simulator unit.

   b. Position the power switch on the metering unit to "Battery" power position and allow the instrument a warmup period of at least two minutes.

   c. By rotation of the meter reading control knob on the simulator unit, check each of the three meters at half scale.

   d. Starting with the metering control knob in the extreme counterclockwise 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.

   e. 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.

2. After installation of the CD V-781 Aerial Survey Meter into the aircraft, the operational check is performed as follows:

   a. Instrument Battery Supply - Observe meters prior to turning on instrument. Meters should indicate zero within one scale division (the instrument has no zero adjustment).

      (1) Position the power switch on the metering unit to the "Battery" power switch position and allow the instrument a warmup period of at least two minutes.

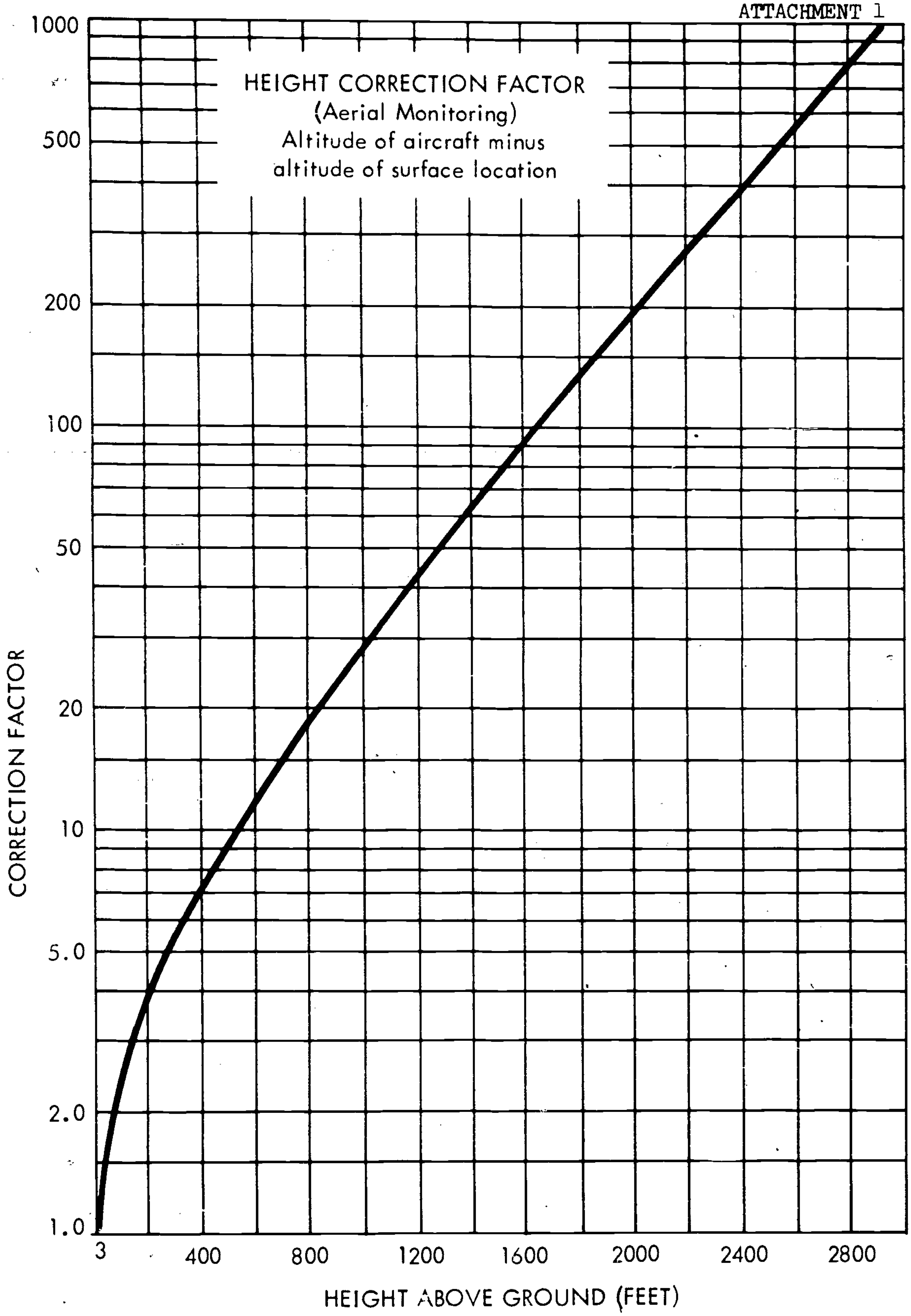
      (2) Observe the meters after the warmup period. Meters should continue to indicate zero within one scale division when only normal background radiation is present. In the event external radiation from fallout prohibits this check, it should be assumed the instrument is operating properly if it indicates radiation levels above normal background.

      (3) Press the "Battery Check" switch. The 0-0.1 r/hr meter should read at, or slightly above, the battery checkpoint.

b. Aircraft Power Supply - When the aircraft electrical power source is used, position the power switch on the metering unit to the "Plane" power position.

(1) Repeat steps (2) and (3), above.

Tape Recorder. The manufacturer's manual supplied with the recorder indicates precautions to be observed and provides detailed instruction for operation. A monitor, expecting to use the recorder, should practice using it until proficiency is assured. 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.


HEIGHT CORRECTION FACTOR
(Aerial Monitoring)
Altitude of aircraft minus
altitude of surface location
CORRECTION FACTOR
1000
500
200
100
50
20
10
5.0
2.0
1.0
3
400
800
1200
1600
2000
2400
2800
HEIGHT ABOVE GROUND (FEET)

ATTACHMENT 2

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	g. MAP IDENTIFICATION AND SCALE
b. REPORT TO	h. AUTHORIZED MISSION DOSE
c. CONTROLLED BY	i. MISSION DOSE RECEIVED
d. PILOT'S NAME AND ORGANIZATION	j. AIRCRAFT CORRECTION FACTOR
e. MONITOR'S NAME AND ORGANIZATION	k. RADEF INSTRUMENT USED
f. 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									
4									
5									
6									
7									
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18									
19									
20									

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247-884 O - 67 - 22

Equipment for Aerial Monitoring Mission

CD V-781 Aerial Survey Meter (less simulator unit)

CD V-715 Survey Meter

CD V-138 Dosimeter (2 each)

CD V-730 Dosimeter (2 each)

CD V-740 Dosimeter (2 each)

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 Air-Drop

Pencils

Other items, as required

CHAPTER X

PEACETIME RADIOLOGICAL INCIDENTS

The purpose of this chapter is to transmit basic information concerning appropriate "at the scene" actions by members of the State and local emergency services; suggest the general responsibilities of State and local governments for dealing with peacetime radiological incidents; provide guidance for the development of State and local radiological assistance plans; and suggest appropriate division of local responsibilities within the local government organization; for example, the public health department and the emergency services, such as the fire and police departments. Discussion of responsibilities of State and local governments for coping with radiological incidents is intended to serve only as a frame of reference for delineating the assignment of basic responsibility for peacetime radiological incidents to the appropriate agencies.

A radiological incident may be described as a situation in which the normal control over radioactive materials is accidentally lost, with resulting actual or potential hazard to the health and safety of the general public. Radiological incidents may involve nuclear weapons, nuclear reactors, fire or explosions in buildings or facilities where radioactive materials are stored or used, industrial activities, medical uses, research and development laboratories, educational institutions, or the transportation of radioactive materials.

Regulations established and enforced by Federal, State, and local governments protect the public health and safety. In the Federal Government the U. S. Atomic Energy Commission (AEC) has established regulations under which private industry and others are licensed to use source, special nuclear, and byproduct radioactive materials, as defined in the Atomic Energy Act. State governments that have agreements with the AEC, pursuant to Section 274B of the Atomic Energy Act, are authorized to issue licenses for certain kinds of radioactive materials. The States issue these licenses, under their regulations, and are responsible for enforcing the health and safety requirements that must be met by the licensee.

Except for certain quantities of radioisotopes that have been declared exempt from the AEC and State regulations, a license is required to obtain, possess, use, or store any radioactive byproduct, source, or special nuclear material. The licensee must follow the radiation protection standards set by the AEC or State regulations.

Certain regulations of the Interstate Commerce Commission (ICC), Federal Aviation Agency (FAA), Post Office Department, and U. S. Coast Guard apply specifically to the shipment of radioactive materials. These regulations require appropriate safeguards designed to minimize the radiation exposure of people or property during normal transport of shipments, or in event of accident. State and local government codes and regulations govern the use of radiation sources such as radium, X-ray machines, and radioactive materials not subject to licensing under Federal regulations.

Immediate responsibility for safeguards relating to radioactive materials belongs to the party who has legal possession of the material. This is true at the time of any incident, including while such materials are in transit. Following an incident, that party is responsible for prompt action to minimize radiation exposure to the general public, and for control and recovery of the materials. When an accident occurs, however, the responsible party may not be immediately available; or he may need emergency assistance to regain control of the radioactive material, and to protect the public health and safety.

As examples, radioactive materials in a laboratory, hospital, or industry might be spread by fire or explosion, beyond the limits of the facility under jurisdiction of the licensee; or, during shipment, an accident could result in loss of control of radioactive materials, and creation of a public hazard. Again, an accident involving a nuclear weapon could result in the spread of nuclear material over public or private property; or, an accident to a nuclear reactor could release radioactive fission products beyond the controlled area of the reactor site.

In any of the above situations, some degree of immediate response by State and local public safety personnel will usually be required. Initial action may be by fire or police personnel first at the scene of the incident and acting under normal chain of command. The State or local government is responsible for additional safety measures or precautions that may be required for the protection of the public until control is reestablished by the licensee or other responsible party or agency.

A major radiological disaster might be described as one of such magnitude that severe effects from radiation exposures might be expected over a large area of perhaps tens or even hundreds of square miles. However, the safety features built into processes and devices for the release of nuclear energy, and the comprehensive safety programs administered, make the possibility of a peacetime disaster of such magnitude virtually negligible. For further detail, see Annexes 3 and 4. On the other hand, no matter how remote the chance of such a disaster, it would be folly to be unprepared for effective utilization of all existing capabilities to minimize the effects of such an occurrence. State and local governments should be prepared to utilize promptly their capabilities to monitor and report radiation dose rates, evaluate existing and potential hazards, and carry out appropriate countermeasures to protect people and their possessions in affected areas. The radiological assistance provided under the IRAP plan would complement those of State and local government in case of a major disaster or national emergency.

FEDERAL FUNCTIONS

The AEC and Department of Defense (DOD) have specially trained personnel who would assume responsibility for emergency operations upon arrival at the scene of an accident involving a nuclear weapon or other material under control of the AEC or Department of Defense. The two agencies also have men and equipment available 24 hours a day on request to assist at the scene of other kinds of radiological incidents believed to require capabilities beyond those available locally. These emergency-assistance personnel are prepared to deal with any aspect of a radiological incident. The Military Services have specially trained explosive ordnance disposal (EOD) teams to cope with nuclear weapons hazards.

To minimize the hazards that can be created by radiological incidents, the Interagency Committee on Radiological Assistance (ICRA), under the chairmanship and guidance of the AEC, has developed an Interagency Radiological Assistance Plan (IRAP) and a supporting Organization and Plan for Interagency Operations (see Annexes 1 and 2).

The Plan has three main objectives, which provide for:

1. The expeditious provision of effective radiological assistance to anyone requesting it in case of radiological incidents.

2. The coordination of Federal and local radiological incident assistance operations.

3. The encouragement of the development of local capability to cope with radiological incidents.

The AEC is responsible for the implementation, application, and administration of the provisions of the IRAP, including coordination with participating Federal agencies. State and local health officers, civil defense directors, RADEF officers, and other emergency operations personnel should be familiar with its provisions. Under this plan, OCD is responsible for:

1. Providing guidance, advice, and assistance to participating DOD components on policy and program aspects as to the capability of OCD to supply radiological assistance under the plan.

2. Providing an OCD representative on the ICRA.

3. Providing guidance to State and local civil defense authorities on their roles in dealing with peacetime radiological incidents.

ORGANIZATIONAL CONSIDERATIONS

In the organization of elements of government to cope with radiological incidents, it is important that attention be directed to the detailed nature of the function to be performed, and to the existing and potential capabilities of the several elements of government to plan and direct or support the emergency operations effort.

State and local governments will not usually become involved with minor incidents at laboratories or industrial installations, or with accidents in which radioactive contaminants are completely contained at an AEC, military, or other Federal agency installation--except perhaps in a supporting role to assure that there is minimal danger to the public health and safety.

Radiological incidents of concern are likely to be infrequent in any one area. They can range upward in severity from that of a minor spill in an area accessible to the public, to a major disaster affecting a large geographic area. In a radiological incident, the uncontrolled radioactive material may be in the form of a solid, liquid, or gas; and it may emit alpha, beta, or gamma radiation, or combinations of these radiations. Peacetime standards for personnel radiation exposure and residual levels of contamination are generally applicable as the acceptable levels which must be restored after a radiological incident. In contrast to these peacetime standards, measures to cope with fallout radiation that would result from a nuclear attack place major emphasis on protection from gamma radiation. Further, there is recognition that in fallout areas it would be impossible to occupy the areas and stay within the allowable peacetime limits of exposures and contamination until after a very long period of time. The objective postattack would be to limit exposure to the lowest level feasible, and gradually to work toward radiation exposure controls approaching current peacetime standards for exposure of the public.

Many State and local governments employ public health personnel assigned responsibility for the control of radiation exposures from X-ray machines and radioactive materials. They may be professional health physicists or be otherwise qualified to evaluate the potential hazard from any type of ionizing radiation source. They may also have administrative and inspection responsibilities associated with State or local government regulations for possession and use of radioactive materials or control of their use. In the large jurisdictions, public funding may permit hiring civil defense RADEF officers with professional backgrounds and experience in public health and radiation protection. However, it is not possible to fill all RADEF officer positions with health physicists; and the specialized training for RADEF officers places most emphasis on fallout contamination and on evaluation of gross hazards from only the gamma radiation given off by fallout.

The most effective organization for coping with radiological incidents can be expected only if the best qualified person available is made responsible for developing and implementing a local plan to provide safeguards in relation to radioactive materials, and for dealing with radiological incidents. This responsibility might be assigned to a full-time public health employee, to the RADEF officer, or on a voluntary or part-time basis, to a health physicist or other qualified person associated with a university, a commercial laboratory, or industry. The person or persons assigned need to be able to evaluate each situation to determine the extent of the local actions to be undertaken, and must be assigned responsibility for and authorized to request assistance from Federal agencies such as the AEC, DOD, and U. S. Public Health Service (PHS) when, in his opinion, such assistance is required.

OPERATIONAL REQUIREMENTS

Major Disaster. In event of a major nuclear disaster, emergency government capabilities developed to cope with the effects of a nuclear attack may be implemented consistent with the areas and hazards involved. Actions might include staffing Emergency Operating Centers; alerting the public to the extent and magnitude of the hazard; issuance of advisories and personal safety instructions; monitoring and evaluating radiation hazards; and direction of countermeasures to minimize exposure to radiation, protect from its effects, and speed decontamination.

Radiological Incidents Other Than Major Disaster. Fire, police, and other public safety personnel should become capable of taking actions such as the following in the event of a radiological incident, without assistance or direction of a radiological safety specialist:

1. Rescuing people involved in an incident.

2. Rendering first aid, and evacuating injured requiring immediate hospital care.

3. If a nuclear weapon is involved, reporting the incident immediately to the nearest AEC or DOD installation. This may be done through the local fire or police department.

4. If a nuclear reactor is involved, reporting the incident immediately to the nearest AEC installation. This may be done through the local police or fire department.

5. Reporting details of the incident to the appropriate local government official(s), and to the radiological safety specialist at the scene who acts for the person or agency responsible for the radioactive materials.

6. If a nuclear reactor is involved, and if repeated entry or extensive duty in the area is required, monitoring the area for excessively high gamma radiation levels. Examples of activities that might be required in such an area are rescue or firefighting. Monitoring would also be required if it appears that contamination is spreading into an inhabited area. Civil defense radiological monitoring instruments are suitable for these purposes.

7. Securing the area and preventing the spread of material that might be contaminated with radioactive substances.

8. Fighting or containing fire to save life or minimize injury to people and property.

9. Controlling movement through, from, or around radioactive areas.

The ICRA publication, "Radiological Emergency Procedures for the Non-Specialist," (see Annex 3) is designed to provide information that the layman can use in case he becomes involved in a radiological incident. Special procedures are required in dealing with accidents involving nuclear weapons. Emergency services personnel should be thoroughly familiar with them. Detailed operational instructions for dealing with accidents involving nuclear weapons are contained in the DOD/AEC Technical Information Bulletin, "Atomic Weapon Accident Hazards, Precautions, and Procedures" (see Annex 4). State and local health officials and civil defense directors, RADEF officers, fire and police officers, and members of their staffs should be thoroughly familiar with the procedures described in this Annex.

CONCEPT OF OPERATIONS AT STATE AND LOCAL LEVELS

The civil defense director and his radiological defense officer have the major responsibility for developing State and local survival and recovery plans to cope with radiation hazards resulting from a nuclear war. Selected portions of these plans, and emergency procedures, can be modified to deal with peacetime radiological incidents. However, peacetime incidents may require application of highly specialized procedures. At times, alpha or low-energy beta radiations may be involved. These cannot be monitored with standard civil defense instruments. Further, the amounts of radioactivity in peacetime incidents will generally be quite limited --and a health physicist normally will be required to evaluate the hazards. If State or local government does not have a qualified health physicist on its staff, arrangements should be made for such professional support on a part-time or volunteer basis.

Emergency services personnel arriving early at the scene of an incident will have to know what actions are and are not permissible. Therefore, at State and local levels, the development of operational plans and capabilities to deal with peacetime radiation incidents must be carried out in conjunction with and through utilization of the normal emergency services, such as fire, police, health, welfare, and engineering services, must provide technical and operational support, as appropriate.

In developing the local plan, technical guidance should be obtained from health physicists or from qualified persons in agencies such as AEC, DOD, or PHS. The local plan should be in consonance with the IRAP. For those incidents where the local government can assume full responsibility, the radiation specialist should be responsible for directing the emergency and recovery operations. Radiological monitoring surveys must be performed under the direction of a competent specialist, utilizing recently calibrated instruments appropriate to the task.

The plan must provide for measures to protect personnel, and for the proper training of personnel responsible for carrying out functions associated with radiological incidents.

Major users of radioactive materials in the locality should be listed in an attachment to the plan. The list should include the kinds of radioactive materials, storage locations, quantities, and, in general terms, their use. The listing should include State and AEC licensed source and byproduct materials used in private industry, hospitals, universities, laboratories, and nuclear reactors. It should also indicate for each facility the name of the radiological safety officer or other person assigned responsibility for the radioactive materials, and his business and home address and telephone numbers.

Another attachment to the plan should be a listing of radiological monitoring equipment available in the local area; the storage locations of the equipment; and the names, addresses, and telephone numbers of persons responsible for and trained in the use of such equipment.

Additionally, the plan should include a listing of names, addresses, and telephone numbers of local health physicists and other persons who have had radiation safety training, and who could be called upon for technical assistance or guidance in time of emergency.

All emergency services personnel should have up-to-date lists of the names, addresses, and telephone numbers of whom to contact at nearby AEC and DOD installations, and of the community's radiation specialist and his alternate(s).

A map and listing in Annex 2 give the location and addresses of AEC Regional Coordinating Offices, their respective postoffice addresses, the telephone numbers to use in calling for emergency assistance, and the geographical area for which each office has responsibility.

There should be an attachment listing the names, home and office addresses, and telephone numbers of those State officials who might assist, or to whom reports are to be made, in meeting State and local requirements in radiological incidents. State plans should list those persons at higher levels of government to whom reports should be made, and key contacts for reporting and for emergency operations at county and municipal levels.

The local plan should clearly indicate that local government, or more specifically the community's radiation specialist, should not hesitate to report an incident to the nearest AEC/DOD facility--and request technical radiological assistance, if needed.

Local plans should include detailed procedures for reporting to the State those radiological incidents affecting the general public. Reports to OCD regional and national offices can be made through the National Warning System (NAWAS). A report should indicate the type and time of incident, estimated location, person notified, action taken by local government, and any other pertinent details such as casualties and type and extent of contamination. Further, local government should not hesitate to request assistance from State level or from appropriate Federal agency representatives.

The Director of the State Department of Health (or other State agency assigned major responsibility for action in peacetime radiological incidents), in conjunction with other State government officials, as appropriate, should evaluate each reported incident, and each request to State government for assistance. Upon request for major assistance, this official should act as quickly as possible to provide all assistance legally within the power of the State to provide. If the assistance of Federal agencies is desired, the State should request assistance from the appropriate AEC Regional Office listed in Annex 2. Further, if a major radiological incident has occurred, the Governor of the State should place in effect appropriate portions of emergency plans, and request a Presidential declaration of "major disaster" through appropriate channels.

EDUCATION OF THE GENERAL PUBLIC

State and local plans should provide for educating the general public to the possible hazards of radiological incidents; and what to do if one occurs. The ICRA publication, "Radiological Emergency Procedures for the Non-Specialist," provides guidance for the general public on prompt action to take in case of accident involving radioactive materials.

State and local governments should work closely with news media representatives (radio, TV, and newspaper) in providing facts to the public concerning possible or actual radiological incidents. There usually would be no reason to withhold information, except where such release could be detrimental to the National security. Plans should be made for the release of appropriate, authoritative information. If there is any question, Public Information Offices at AEC and DOD installations can advise on the release of information.

RADIOLOGICAL INCIDENT TRAINING

As part of the IRAP, a radiological training program calls for the "training of appropriate persons" to insure that:

1. Immediate emergency actions at the scene of a radiological incident will be taken to minimize personal injury, loss of life, property damage, and radiological hazards.

2. Action to inform the public and to assist in restoring normalcy will be taken as soon as possible after an incident.

Each Federal agency signatory to the IRAP is charged with providing, upon request, such assistance in training Federal, State, and local personnel and in the dissemination of information as is available through its normal operations. In conformance with this, qualified personnel who might be concerned with emergency operations in radiological incidents can apply, through their local or State civil defense directors, to attend OCD courses for radiological monitor instructors and radiological defense officers. These courses are scheduled several times yearly at the OCD Staff College, and in the States through University Extension programs.

Training courses sponsored by other Federal agencies, such as the AEC and PHS, can also be made available in cooperation with State and local governments.

CIVIL DEFENSE INSTRUMENTS

The OCD grants instruments for training monitors and for carrying out emergency operational monitoring functions. The set of instruments furnished to each civil defense monitoring station includes the following:

One CD V-700 radiological survey meter, Geiger counter probe type, beta/gamma discriminating, 0-0.5, 0-5, and 0-50 mr/hr.

Two CD V-715 radiological survey meters, gamma only, 0-0.5, 0-5, 0-50, and 0-500 r/hr.

Two CD V-742 radiological dosimeters, self-reading, gamma only, 0-200 r.

One CD V-750 radiological dosimeter charger.

(Selected monitoring stations are also furnished one each CD V-717 radiological survey meter, remote-reading, gamma only, 0-0.5, 0-5, 0-50, and 0-500 r/hr.)

These instruments will not detect alpha radiation. Therefore, plutonium, polonium, and a few other radioactive isotopes that emit alpha particles cannot be detected by civil defense monitoring instruments. AEC and DOD radiological assistance teams, however, have instruments that can monitor alpha emitters. Alpha emitters are harmful only if inhaled, ingested, or otherwise gain access to the body. However, very small quantities can be a serious biological hazard.

IMPLEMENTATION

The establishment of an optimum capability to cope with peacetime radiological incidents will normally involve the following:

1. The chief executive's assignment of a qualified person (or department) to prepare an operational plan.

2. Writing and staffing the plan for coping with radiological incidents. The Plan would:

   a. In general terms, describe the nature of the potential hazards, and the procedures to be employed to minimize those hazards.

   b. Describe the organization and functional responsibilities, including (1) designation by department and title of the radiological safety officer, and (2) assignment of specific functions and operational responsibilities for each type of incident to the governmental services best qualified for performing the necessary function(s); for example, public health, fire, police, communications, public works, and public information.

c. Provide for initial training or indoctrination, and subsequent refresher sessions, for field personnel of departments or services with assigned emergency responsibilities.

d. State procedures for alerting personnel, reporting incidents, and requesting assistance.

e. Include, as appendices, those portions of the plan which require frequent updating--such as rosters by organization, name, address, and business and home phone of:

   (1) Executive officers of government, radiological safety officer, his alternate(s), and heads of departments assigned responsibilities.

   (2) Local assistance available from industry and educational institutions.

   (3) Points of contact for outside assistance, including higher levels of government, AEC facilities, and military installations.

   (4) Recipients of reports.

f. List, in a separate appendix, major users of radioactive materials.

3. Signing of the plan by the chief executive--giving it the status of an executive order. A memorandum from the chief executive to the affected departments, summarizing the new responsibilities by department and transmitting the plan, can give additional emphasis to the assignments.

INTERAGENCY RADIOLOGICAL ASSISTANCE PLAN

This Annex is a reprint of the Interagency Radiological Assistance Plan, United States Atomic Energy Commission, July 1961, as revised October 1964.

The Interagency Radiological Assistance Plan was developed by the Interagency Committee on Radiological Assistance as a means for providing rapid and effective radiological assistance in the event of a radiological incident. It also provides a means whereby the participating Federal agencies may coordinate their activities with those of State and local health, police, fire and civil defense agencies.

The Plan provides operating guidelines, a training program, and has as its basic policy and coordinated application of existing competencies, responsibilities and relationships in such a manner as to provide effective action at as local administrative level as possible.

It is anticipated that for at least some years to come, the Atomic Energy Commission and the Department of Defense will exercise major responsibilities for the control of radioactive materials. The Office of Civil Defense, Office of the Secretary of the Army, will continue to exercise its authority and responsibilities during major disasters while the Federal, State and local health agencies will play an increasingly important part in the health implications of this problem. In connection with the declaration of a major disaster, the Office of Emergency Planning, Executive Office of the President, will exercise its authority and coordinating responsibilities. Other agencies, through regulations and responsibilities in specific areas and their various capabilities, can also make important and perhaps the most significant contributions in specific cases. It is recognized that radiological injuries may arise from sources not clearly identified. In such instances first information concerning the situation may become known through civil defense, medical or public health channels and would be transmitted by the cognizant agencies into the information channels provided under this Plan.

Purpose. The purpose of this plan is to provide for:

1. The expeditious supply of effective radiological assistance to anyone requesting it in case of radiological incidents,
2. The coordination of Federal and local radiological incident assistance operations, and
3. The encouragement of the development of local capability to cope with radiological incidents.

Objectives.

1. Establish procedures which will integrate Federal and State and other capabilities available to respond to requests for assistance in radiological incidents.

2. Establish a system for:

   a. Requesting and providing appropriate assistance.
   b. Reporting radiological incidents to the interested agencies and organizations, and to the public.
   c. The exchange of information between interested Federal, State and local agencies and organizations.

3. To develop and execute an informational and training program for Federal, State and local officials to familiarize them with the problems and hazards related to radiological incidents and appropriate action to be taken.

Scope. The provisions of this Interagency Radiological Assistance Plan (IRAP) are applicable to all Federal agencies signatory hereto. Implementation of this Plan will be compatible with and complementary to currently effective assistance plans, agreements, security regulations, and responsibilities based upon Federal Statutes and Executive Orders (See page 10-14). In the event of a disaster or national emergency, radiological assistance resources and capabilities available under this Plan will be available to the agency in charge as an adjunct to other disaster relief and control measures. The radiological assistance provided under this Plan would complement the National Plan for Emergency Preparedness in case of a major disaster or national emergency.

Policy.

1. Federal agencies signatory hereto and possessing facilities which may be used in the development of an integrated Federal radiological assistance capability will make their resources available during radiological incident assistance operations, subject to essential operational requirements in the fulfillment of their primary responsibilities.
2. IRAP operations shall be carried out to make maximum effective use of local as well as Federal capabilities. Each incident should be handled at the lowest coordinating level feasible.
3. A Federal agency making its resources available to another Federal agency or local non-Federal organization or authorities is subject only to superior authority established by its normal chain of command. During the period that resources of a Federal agency are assigned to a coordinating office or a responsible agency they shall be under the direction of such coordinating office or responsible agency.
4. Federal organizations will make radiological incident response and incident training capabilities available to State and local authorities upon request. Local authorities will be encouraged to develop and coordinate plans and procedures for effective utilization of radiological incident response and incident training capabilities available in their locale and establish local coordinating centers as necessary.

Organization and Responsibilities.

1. The Interagency Committee on Radiological Assistance (ICRA) will consist of authorized representatives of those Federal agencies signatory to the IRAP. This Committee is responsible for obtaining Federal agency approval of IRAP policy, interpretation of the policy established by the Plan, changes in the Plan, and for assuring the respective agencies that the administration and implementation of the Plan are carried out in a manner consistent with applicable Federal Statutes and Executive Orders.
2. The Atomic Energy Commission is designated the agency responsible for administration, implementation, application and coordination of the provisions of the IRAP with the cooperation of the other participating Federal agencies. The AEC will carry out its responsibility (under IRAP) through a national coordinating office at AEC headquarters and coordinating offices at such of its operations offices as may be designated by the Commission. The AEC periodically shall inform the ICRA of the steps taken to implement its responsibilities under the plan.
3. IRAP signatory Federal agencies are responsible for:

   a. Making their resources available to the responsible national or regional coordinating office during radiological incident operations subject to essential operational requirements in the fulfillment of their primary responsibilities, and
   b. Providing an official representative to the ICRA and furnishing radiological incident capability data and other required information to the national and regional coordinating offices.

Concept of Operations. There will be established coordinating offices at the national, regional, State and local levels of the Federal agency organizations to the extent necessary to carry out the provisions of the IRAP. Offices and personnel normally available will be utilized to provide the necessary facilities, staff, and technical-operations personnel.

Operational details and responsibilities at the national, regional, State and local levels will be established as is required to accomplish the purpose, objectives and policy of this plan and enable the AEC and other signatory agencies to discharge their responsibilities under this Plan. Section on IRAP Operations, (page 10-16) outlines certain criteria, duties, activities and action to provide a basis for radiological assistance operations.

Training. For details see section entitled, "Radiological Incident Training Program for Public Safety and Public Health Personnel."

Definitions for the Purpose of This Document.

1. Radiological assistance is action taken after a radiological incident to:

a. Evaluate the radiological health hazard,
b. Minimize personnel exposure to radiation and/or radioactive materials,
c. Minimize the spread of radioactive contamination,
d. Minimize damaging effects on property,
e. Assist in carrying out emergency rescue and first aid procedures necessary to save life and minimize injury,
f. Provide technical information to appropriate authorities and medical advice on the treatment of injuries complicated by exposure to radioactive contamination,
g. Provide information to the public as quickly as possible to minimize undue public alarm and to assist in the orderly conduct of emergency activities, and
h. Carry out other general emergency measures.

2. A radiological incident is an occurrence which results in the loss of control of radioactive materials and which involves a hazard or possible hazard to life, health or property.
3. A coordinating office is an office responsible for coordinating the radiological assistance program within a specified geographical area.
4. A "major disaster" means any flood, fire, hurricane or other catastrophe which, in the determination of the President, is or threatens to be of sufficient severity and magnitude to warrant disaster assistance by the Federal government under Public Law 875 to supplement the efforts and available resources of State and local governments in alleviating the damage, hardship, or suffering caused thereby.

Implementation.

1. The provisions of this Plan are effective for a participating Federal agency and the agency becomes signatory to this Plan when an authorized official has signified in writing that the provisions of this Plan are acceptable to the agency he represents. (See page 10-19 for a list of signatory Federal agencies).
2. Signatory Federal agencies will promulgate intraagency instructions necessary for the implementation of their participation in this Plan.

FEDERAL STATUTES AND EXECUTIVE ORDERS APPLICABLE TO IRAP PARTICIPATING AGENCIES

The following is a list of Federal Statutes and Executive Orders which contain authority and responsibility applicable to emergency and disaster relief assistance of which radiological incident assistance is considered to be a part. There may be other applicable statutory authorities that should be added to this list. The list will need to be revised periodically to add presently effective applicable Federal Statutes and Executive Orders not listed below, to delete those that may no longer be effective, and to include those established by future legislation.

1. The Atomic Energy Act of 1954, as amended (42 USC 2011-2296)
2. The Federal Disaster Act of 1950, as amended (42USC 1855)
3. The Civil Defense Act of 1950, as amended
4. The Explosives and Combustibles Act of 1948 (18 USC 466)
5. The Public Health Service Act (42 USC 241)
6. The Federal Water Pollution Control Act (33 USC 466)
7. The Air Pollution Research and Technical Assistance Act (42 USC 1857)
8. The Federal Food, Drug, and Cosmetic Act, as amended (21 USC 301-392)
9. The Tea Importation Act, as amended (21 USC 41-50)
10. The Import Milk Act (21 USC 141-149)
11. The Federal Hazardous Substances Labeling Act (15 USC 141-149)
12. The Filled Milk Act, as amended (21 USC 61-64)
13. The Interstate Commerce Act, as amended
14. The National Security Act of 1947, as amended
15. The Clean Air Act of 1955, as amended (42 USC 1857-1857g)
16. The Agricultural Act of 1949, Section 407, as amended (7 USC 1427)
17. The Consolidated Farmers Home Administration Act of 1961 (see Public Law 87-128, Title III, August 8, 1961, section 321, Emergency Loans)
18. Public Law 875, 81st Congress, September 30, 1950, as amended. (Authorizes Federal assistance to States and local governments in major disasters and for other purposes.)
19. Executive Order No. 10014, November 3, 1948 (Cooperation in preventing pollution of surface and ground waters)
20. Executive Order No. 10173, October 18, 1950 (Safeguarding of U.S. vessels, harbors, ports and waterfront facilities), amended by E.O. No. 10352, May 19, 1952.
21. Executive Order No. 10346, April 17, 1952 (Federal agency preparation of Civil Defense plans), amended by E.O. No. 10438, March 13, 1953, and E.O. No. 10461, June 17, 1953
22. Executive Order No. 10427, January 16, 1953 (Administration of disaster relief), amended by E.O. 10737, October 29, 1957
23. Executive Order No. 10529, April 22, 1954 (State and local civil defense preemergency training programs)
24. Executive Order No. 10779, August 20, 1958 (Cooperation with State and local authorities in prevention of pollution of the atmosphere)
25. Executive Order No. 10831, August 14, 1959 (Establishing the Federal Radiation Council)
26. Executive Order No. 10952, July 20, 1961 (Assigning Civil Defense responsibilities to the Secretary of Defense and others), amended by E.O. No. 11051, September 27, 1962.
27. Executive Order No. 10958, August 14, 1961 (Delegating functions respecting civil defense stockpiles of medical supplies and equipment and food), amended by E.O. 11051, September 27, 1962
28. Executive Order No. 10998, February 16, 1962 (Secretary of Agriculture emergency preparedness functions)
29. Executive Order No. 11051, September 27, 1962, as amended (Responsibilities of OEP)

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30. Reorganization Plan No. 1 of 1958
31. Titles of the U.S. Code:
    14-Coast Guard
    18-Crimes and Criminal Procedure
    19-Customs Duties
    33-Navigation and Navigable Waters
    42-The Public Health and Welfare
    46-Shipping
    50-War and National Defense

IRAP OPERATIONS

<u>National Coordinating Office</u>.

1. Carries out within the policy and provisions of the IRAP the management functions requisite to the administration, implementation, application and coordination of the Federal agency radiological assistance capabilities made available under the Plan.
2. Specific activities include:

   a. Coordination of the Radiological Incident Training Program, to assure the development of training material suitable for use by the participating Federal agencies and adaptation to special groups such as the transportation industry.
   b. Establishment of a system and procedures to obtain information and radiological incident reports from regional coordinating offices and other Federal, civil and private sources.
   c. Development of a system for the coordination and dissemination of information to interested Federal, State and local organizations and the public.
   d. Establishment of basic operating rules and procedures for the integration and coordination of radiological assistance coordinating office operations.
   e. Issuance of instructions, directives, reports, bulletins, and such other documents as are necessary to put into effect the policy of the Plan and such policy interpretations, changes in the Plan, and other determinations as may be arrived at by the ICRA.
   f. Establishing a system of review and coordination for Regional Coordinating Office activities to assure continuity of regional actions with those of the participating Federal agencies.
   g. Reporting to the ICRA on the progress being made under the IRAP and other matters of interest to the Committee.

<u>Regional Coordinating Office</u>.

1. Requests assistance from, distributes information to, and coordinates as necessary with Federal, State and local agency offices located within the region to insure maximum implementation and continued success of this Plan.

2. Receives requests for assistance from local coordinating offices, State organizations or Federal agencies signatory to this Plan. In the case of DOD teams or resources, other than for purposes of immediate local response, requests for assistance will be made through the AEC/DOD Joint Nuclear Accident Coordinating Center.
3. Reports those radiological incidents of which it has knowledge and/or responsibility to the National Coordinating Office, and those incidents involving weapons shall also be reported to the AEC/DOD Joint Nuclear Accident Coordinating Center in accordance with AEC/DOD agreed procedures. Where appropriate, reports radiological incidents to interested Federal agency regional offices and to State or local coordinating offices.
4. Maintains current information on the location of participating Federal agency radiological assistance capabilities, their potential for providing assistance and such other resources available within the region.
5. Maintains current listing of State and local coordinating offices within the region and of the other Regional Coordinating Offices included under the IRAP.

Emergency Action and Control.

1. Immediate emergency action will be taken by authorities at the scene of an incident within the limits of available capability to:

   a. Minimize the immediate hazard to health and safety,
   b. Request radiological incident assistance of the local, State or Federal organization most appropriate,
   c. Report the radiological incident to local, State or regional Coordinating Offices, as is appropriate in accordance with standard procedures and implementing instructions, and
   d. Obtain all available information in regard to the identification and whereabouts of individuals who are or have been involved at the scene of the incident and others who may have observed the incident or events leading to the incident.

2. Radiological assistance operations at the scene of the incident will be carried out as follows:

   a. Those controlled by a Federal agency or local organization in accordance with the degree of authority available at the scene, will continue to be so controlled until controlling authority is transferred to transcendent authority where it exists.
   b. Those associated with radioactive materials physically under the control of a Federal agency will be controlled by that agency until controlling authority is transferred to transcendent authority where it exists.
   c. Those associated with weapons will be controlled in accordance with the provisions of AEC/DOD agreements.

d. Those in support of action taken to cope with the effects of major disasters will be coordinated under the provisions of applicable Federal Statutes and Executive Orders.
e. Those in support of nonmilitary radiological defense from enemy attack will be coordinated by the Office of Civil Defense, Office of the Secretary of the Army, as specified in applicable Federal Statutes and Executive Orders.
f. Those initiated in support of the National Search and Rescue Plan will be conducted in accordance with the provisions of that plan and supporting agreements.

RADIOLOGICAL INCIDENT TRAINING PROGRAM FOR PUBLIC SAFETY AND PUBLIC HEALTH PERSONNEL

Purpose. This Radiological Incident Training Program provides uniform instruction and a method of implementation for those personnel of Federal, State, and local organizations who might be expected to respond in the interests of public safety and health to cope with such hazards as might result from incidents involving radioactive materials.

Objectives.

1. The training of appropriate persons to insure that:

   a. Immediate emergency actions at the scene of a radiological incident will be taken to minimize personal injury, loss of life, property damage and radiological hazards, and
   b. Action to inform the public and to assist in restoring normalcy will be taken as soon as possible after the incident.

2. The formulation and dissemination of criteria, information and procedures to be utilized in preincident planning and indoctrination aimed at:

   a. Preventing irresponsible action at the scene of a radiological incident, and
   b. Mitigating adverse psychological reactions of individuals and members of the public who may become concerned with a radiological incident.

Scope.

1. Personnel to be provided training includes those:

   a. Likely to be at the scene of an incident when it occurs,
   b. Subject to being called for assistance in the immediate vicinity of an incident, and
   c. Local authorities who need to cooperate in obtaining emergency assistance (either locally or from organized radiological assistance capabilities).

2. Training material will be developed for:

   a. A short course designed for persons who would not be expected to come in contact with radiological problems in their normal activities, and
   b. A moderate length course designed for persons occupied in work concerned with health and safety who might have opportunity for contact with radiological problems.

Policy. The Radiological Incident Training Program of the Interagency Radiological Assistance Plan (IRAP) must utilize to a maximum and be integrated as fully as is practicable into existing training activities of the participating Federal agencies and of State and local training groups and organizations.

This training should not be considered to require the formulation of a special training organization.

Implementing Procedures.

1. The Interagency Committee on Radiological Assistance (ICRA) will form a Training Coordination Subcommittee consisting of not more than one representative of each agency signatory to the IRAP which shall have responsibility for assuring that training is made available to all appropriate communities and that duplication is prevented where more than one training capability exists.
2. Each agency signatory to the IRAP will provide, upon request, such assistance in the training of Federal, State, and local personnel, and in the dissemination of information as is available through its normal operating responsibilities and capabilities.
3. Each agency signatory to the IRAP will provide as is feasible such pertinent information regarding training activities as may be requested by the National Coordinating Office.
4. The National Coordinating Office, with the advice and assistance of the Training Coordination Subcommittee, will apprise appropriate Federal agencies of the magnitude and importance of the Radiological Incident Training Program and request them to assume specific responsibilities, subject to commitments of higher priority, for implementation of the personnel training program within the scope of their declared competencies and relationships.

FEDERAL AGENCIES SIGNATORY TO THE
INTERAGENCY RADIOLOGICAL ASSISTANCE PLAN

In accordance with the Implementation section plan, the following Federal agencies are signatory to the Plan:

Atomic Energy Commission
Department of Agriculture
Department of Commerce

Department of Defense
Department of Health, Education, and Welfare
Department of the Interior
Department of Labor
Federal Aviation Agency
Interstate Commerce Commission
National Aeronautics and Space Administration
Office of Civil Defense, Office of the Secretary of the Army
Post Office Department
Treasury Department

INTERAGENCY COMMITTEE ON RADIOLOGICAL ASSISTANCE

Organization and Plan for Interagency Operations

This Annex is a reprint of the document published by the U. S. Atomic Energy Commission.

Organization. The Interagency Radiological Assistance Plan (IRAP) of 1961, (revised October, 1964) provides that, "The AEC will carry out its responsibility (under IRAP) through a National Coordinating Office at AEC Headquarters and coordinating offices at such of its operations offices as may be designated by the Commission." The Plan also provides that, "There will be established coordinating offices at the National, regional, State and local levels of the Federal agency organizations to the extent necessary to carry out the provisions of the IRAP." The intent to use normally available personnel and facilities rather than to establish new offices was emphasized.

On page 10-16, Annex 1, the IRAP includes specific functions of the AEC national and regional coordinating offices. The other signatory Federal agencies may also establish national, regional or local IRAP coordinating offices to administratively and operationally discharge their respective IRAP responsibilities. However, the functions of non-AEC IRAP coordinating offices are not defined in Annex 1 and can vary according to the requirements of the respective agencies.

1. National Coordinating Offices

   a. The AEC Headquarters Division of Operational Safety is responsible for carrying out the IRAP National Coordinating Office functions.

   b. Federal agencies other than AEC will establish national coordinating offices in accordance with their respective intra-agency organizational requirements. The National Coordinating Office will be advised and provided with such information as is specified in IRAP Operations (see page 10-16).

2. Regional Coordinating Offices

   a. The AEC New York, Oak Ridge, Savannah River, Albuquerque, Chicago, Idaho, San Francisco, and Richland Operations Offices are designated to carry out the IRAP Regional Coordinating Office functions. The AEC geographical regions of responsibility assigned to these offices will be used as the basis for establishing the interagency field office network for IRAP administration and radiological incident operations.

b. Federal agencies other than AEC will assign regional coordinating office functions in accordance with their respective intra-agency organizational requirements. The National Coordinating Office will be advised and provided with such information as is specified in IRAP Operations.

3. State and Local Coordinating Offices

State and local government agencies may designate offices to coordinate activities concerned with incidents involving radioactive materials. The designation of such offices is not included in the IRAP as this Plan is applicable only to the signatory Federal agencies.

Plan for Operations. Interagency operations under the IRAP will be carried out through the organization described in the above section to achieve the purpose and objectives of the Plan in accordance with the policy and other provisions of the Plan.

1. Headquarters Operations

a. The headquarters of each agency signatory to the IRAP will issue instructions and guidelines to define and direct the participation of its subordinate offices in the IRAP. Instructions and guidelines will be in accordance with the policy and provisions of the IRAP. They must be consistent with the authority and responsibilities provided by currently effective Federal Statutes and Executive Order applicable to IRAP signatory agencies and not in conflict with any others. Each agency i esponsible for assuring this consistency with respect to its own instructions and guidelines.

b. The headquarters of each signatory agency serves as the coordinating office at the National level unless the agency determines otherwise and advises the ICRA accordingly.

c. The AEC National Coordinating Office will issue instructions, directives, reports, bulletins, and other documents to the IRAP coordinating offices in the field through the headquarters of the signatory agencies except when a different procedure is agreed on with a specific agency.

2. Field Operations

a. AEC Regional Coordinating Offices will:

(1) carry out National Coordinating Office instructions and directives.

(2) perform those functions of the Regional Coordinating

Office specified in IRAP Annex II, IRAP OPERATIONS.

(3) develop regional radiological assistance plans and establish operating procedures for the use of IRAP signatory agency resources in the event of incidents involving radioactive materials.

(4) establish with State and local government agencies liaison and arrangements as are needed to provide for mutual cooperation and assistance in: radiological incident planning, development of State and local emergency capabilities, and emergency operations.

(5) establish liaison and coordination with other IRAP coordinating offices responsible for activities within the respective AEC Regional Coordinating Office geographical areas of responsibility.

b. Other IRAP coordinating offices will:

(1) carry out their IRAP assignments in a manner consistent with IRAP policy and provisions and, whenever applicable, compatible with or supplemental to AEC Regional Coordinating Office plans, procedures, and other action documents implementing IRAP provisions.

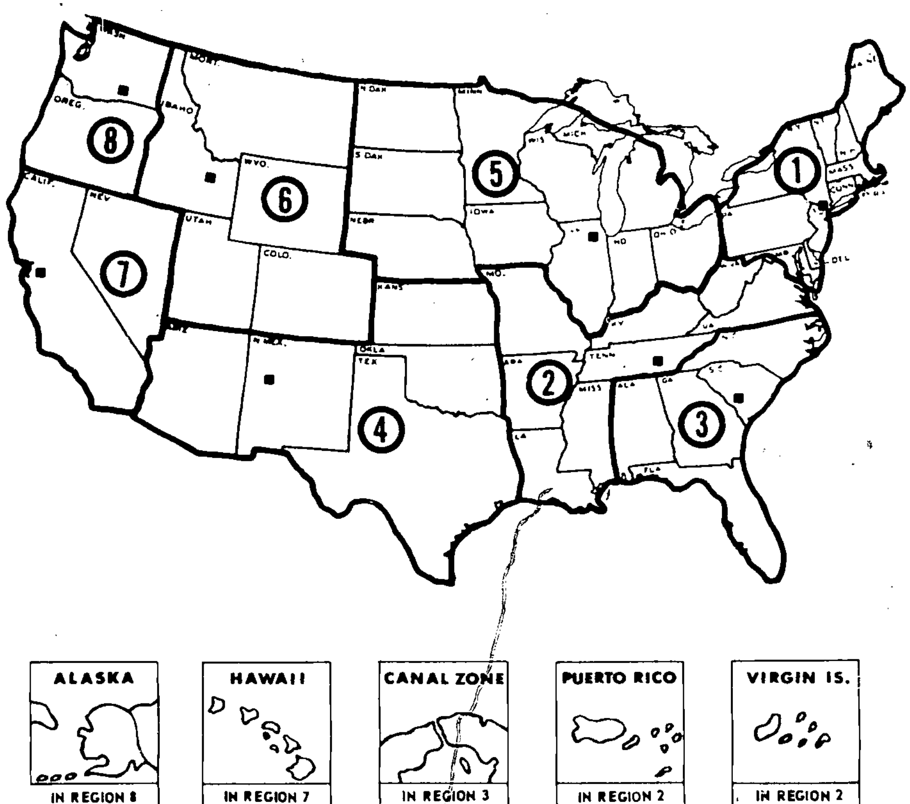
(2) provide radiological incident plans, procedures, and other documents to appropriate AEC Regional Coordinating Offices for review prior to the documents becoming effective.

(3) establish arrangements with appropriate AEC Regional Coordinating Offices to assure that IRAP matters of mutual interest to other agencies will be routinely brought to the attention of those agencies concerned.

<u>AEC Regional Coordinating Offices</u>. The following map lists the eight AEC Regional Office areas of responsibility for radiological assistance in incidents involving radioactive material, and includes their respective post office addresses, their business telephone number to call for requesting emergency assistance, and the geographical area for which each office has responsibility.

U.S. ATOMIC ENERGY COMMISSION

REGIONAL COORDINATING OFFICES
FOR
RADIOLOGICAL EMERGENCY ASSISTANCE
AND THEIR
GEOGRAPHICAL AREAS OF RESPONSIBILITY



REGION NO. and OPERATIONS OFFICE	POST OFFICE ADDRESS	TELEPHONE for ASSISTANCE	DDD AREA CODE
1 NEW YORK	376 HUDSON STREET NEW YORK, NEW YORK 10014	989-1000	212
2 OAK RIDGE	P. O. BOX E OAK RIDGE, TENNESSEE 37831	483-8611, Ext. 3-4510	615
3 SAVANNAH RIVER	P. O. BOX A AIKEN, S.C. 29802	N. AUGUSTA, S.C. 824-6331, Ext. 3333	803
4 ALBUQUERQUE	P. O. BOX 5400 ALBUQUERQUE, NEW MEXICO 87115	264-4667	505
5 CHICAGO	9800 S. CASS AVE. ARGONNE, ILLINOIS 60439	739-7711 Ext. 2111 duty hrs. Ext. 4011 off hrs.	312
6 IDAHO	P. O. BOX 2108 IDAHO FALLS, IDAHO 83401	526-4400 Ext. 1515	208
7 SAN FRANCISCO	2111 BANCROFT WAY BERKELEY, CALIFORNIA 94704	841-5620	415
8 RICHLAND	P. O. BOX 550 RICHLAND, WASHINGTON 99352	942-1111 Ext. 6-5441	509

Revised: January 1966

RADIOLOGICAL EMERGENCY PROCEDURES FOR THE NONSPECIALIST

This Annex is a reprint of Radiological Emergency Procedures for the Nonspecialist, prepared for the Interagency Committee on Radiological Assistance by Karl F. Oerlein, PhD., Training Division Headquarters, Defense Atomic Support Agency; and published by the United States Atomic Energy Commission. The format has been modified slightly and the illustrations have been deleted.

Early man, in his long struggle for survival, was constantly faced with many hazards. Although overwhelmed, at times, by the destruction of life and property around him resulting from nature's unleashing of forces beyond his comprehension and control, he learned, nevertheless, to live with these hazards and occasional disasters. As his understanding of these events increased he also grew more accustomed to accepting the results of such destruction as something to be expected.

Today, man faces many more hazards in his daily life. Some are still beyond his control - others are the result of his own making. But, if he understands them or just thinks he understands them, he grows accustomed to accepting the results of such hazards.

To furnish the basis for later comparison with radiological hazards, a few examples are cited of the rather heavy losses of life and property caused by the more common daily hazards faced by man. They include those which man thinks he understands and, therefore, accepts. Note that some of these hazards are manmade while others are natural.

1. Hazard - Explosives. On August 7, 1959, in the little community of Roseburg, Oregon, 13 people were killed, more than one hundred were injured, buildings on about 12 blocks were almost totally destroyed with material damage to properties on 40 others. In all, more than 6,000 properties were damaged with physical loss over $9,000,000. The cause, a truck plainly identified as a vehicle for transportation of explosives was parked next to a building which caught fire during the night and ignited the truck containing more than 6 tons of explosives.
2. Turning to another hazard - Fire. About 6,000 people die annually in fires in dwellings in the United States. It is estimated that a fire breaks out in the United States every 15 seconds. It is interesting to note that there are about 20,160 fire departments and more than 1,000,000 firefighters in this country.
3. And still another hazard - Vehicular Traffic. In 1963 about 43,400 deaths resulted from accidents involving motor vehicles. That is about one fatality every 12 minutes.

4. Turning now to natural hazards - Floods. In August 1955 Hurricane "Diane" caused the worst floods in New England's history. There were 184 deaths and 832 million dollars damage.
5. Hazard - Hurricanes. In August and September 1960 Hurricane "Donna" stormed up the Atlantic seaboard producing winds estimated near 140 miles an hour with gusts in the 175-180 miles an hour range. In the United States alone over fifty persons were killed, with property losses at 500 million dollars.
6. The 1962 edition of the World Almanac furnishes our final examples of casualties due to daily hazards. Under the heading Disasters reported for each month of 1961, in this case for August 1961, the following is quoted: "Sixteen Americans drowned August 2 when a bus carrying 35 tourists and 3 crewmen plunged into Lake Lucerne near Hergeswill, Switzerland, after colliding with a truck... Hungarian Airlines Dakota crashed in Budapest August 6, killing all 14 aboard... Cunard Eagle Airways Viking crashed into North Sea off Sola, Norway, August 9, killing all 39 aboard, including 34 English school boys... 17 drowned August 10 when bus was swept away in flooded stream near Poonch Kashmir... Fire set August 14 in escape attempt at prison in Taubate, Brazil, killing 40 prisoners... Bus plunged into canal near Trichur, India, August 27, drowning 50... French Air Force jet cut cable of lift in French Alps near Chamonix August 29, plunging 6 to death in sightseeing cable cars: 81 rescued from cars that did not fall... Train derailed at Le Theil, France, August 29, 8 killed, 62 injured." This adds up to 200 deaths! And remember, this included only the more noteworthy accidents for just one month.

The annual number of deaths due to accidents involving explosions, fires, motor vehicles and nature's fury is certainly impressive, if not staggering, as these few selected examples show. The general public appears to accept this destruction of life with little more than a casual "too bad" attitude. Yet, by contrast, there is consternation and protest reaction to the mere mention of nuclear radiation. Why is this? The public's almost passive acceptance of accidental deaths due to, shall we say, "conventional accidents" is in sharp contrast to its very adverse attitude toward hazards associated with nuclear radiation. It is as if one were to say, "It's just too bad if death results from an explosion of conventional dynamite. But it is an entirely different story if death were due to exposure to nuclear radiation." This is a normal reaction because, as we have already said, we tend to accept losses resulting from accidents involving circumstances we understand or even think we understand. But, losses caused by circumstances we do not understand are not so acceptable to us.

The time has come, we believe, when all of us should have some understanding about nuclear radiation, - what it is and how it has affected us. It is not necessary nor desirable that anything more than the most basic concepts be included in this familiarization. In this respect this presentation bears the same relationship to the arrival of the radiological safety expert at the scene of an emergency involving radioactive materials as a first aid course bears to the arrival of the physician at the scene of an accident involving personnel. This comparison is much more than casual. For in the case of first aid, it is an established principle that when in doubt as to the degree of injury it is best not to move the patient until the medical expert arrives. Do the obvious of making the patient comfortable, see that there is no obstruction to his breathing and keep nonessential personnel at a distance. That may very well be all that can and should be done until the doctor arrives. In much the same way with an emergency involving radioactive material, it may very well be the best and only course of action to establish a perimeter around the accident and restrain nonessential personnel from touching or moving anything until the radiological experts arrive. Do the very obvious of insuring that the proper information is dispatched to obtain the experts as quickly as the circumstances require. Above all remain calm, and resist temptations to spread unwarranted rumors which could lead to confusion or even panic.

The purpose, then, of this presentation is twofold:

1. To put the hazards of nuclear radiation in proper perspective in relation to the hazards of modern daily living.
2. To develop a familiarization with the most essential steps to take in an accident involving radioactive materials.

UNDERSTANDING NUCLEAR RADIATION

To some, it may come as a distinct surprise to learn that our planet Earth has been subject to penetrating nuclear radiation just as routinely as it has received light from the sun. In fact, only since about the turn of this century have scientists discovered what nuclear radiation is and recognized its potentiality. Our ancestors, in fact, were born, lived and died in a background of natural radiation unknown to them. As a matter of fact, according to one highly regarded theory on the origin of life, it was a timely burst of nuclear radiation during a favorable set of circumstances that triggered off the initial conversion of inert substances into living matter. It therefore appears that nuclear radiation is something to be understood and need not be always feared.

Is it possible to obtain an understanding of radioactivity and its effects without a technical background? We certainly believe so and we intend to accomplish just that during this session.

To begin with remember that we are already familiar with some kinds of radiation. Take for example, the radiant energy received from our sun. Obviously, light is a part of this radiant energy. It affects our sense of sight. It isn't hard to recognize also a sense of warmth when exposed to direct rays of the sun. This is the same type of radiation received directly from an open fire. This radiant energy stimulates our sense of touch. Not quite so familiar, however, is the radiation that is directed upon us when, for example, our chests are X-rayed. We can't feel the X-rays or see them, in fact they don't stimulate any of our five senses. Unless a competent person, knowledgeable in X-ray techniques, is in control we could very easily be overexposed. In a similar way, we can easily become sunburned by overexposure to the ultraviolet rays from the sun. Just because we can't respond through one or more of our senses does not mean that some effect may not be taking place in our bodies. Fortunately, the nuclear radiation background from natural sources, which have been with us all along, are very low and we are not "overexposed" by living in it.

Since its discovery, much has been learned about penetrating nuclear radiation. During the early days when the effects of radiation on human tissue were not at all understood, many who were associated with its development received injuries. However, by the time our Nation was involved in World War II much had been learned about the control of nuclear radiation. In fact, so much was known about it that although the amount of radioactive material produced during the five-year period 1940-1945 was many times greater than that during the period 1895-1940 and the total number of persons involved was so much greater, there were fewer radiation injuries than during the preceding forty-five years. This is positive evidence that protection against and control of nuclear radiation is now better understood.

Just what, then, is nuclear radiation and in what way does it affect us? Scientists have found that in nature a few basic substances, called chemical elements, are not stable. That is, they undergo a spontaneous nuclear change. Radium is one such substance. Early research on radium revealed that there were three distinct kinds of radiation coming from it which were caused by this spontaneous nuclear change. Before these were identified by later research they were named "alpha," "beta," and "gamma," the first three letters of the Greek alphabet. Further study revealed that the alpha and beta radiations were exceedingly minute atomic particles while the gamma radiation was a "ray" of energy. It turns out that the beta particle is identical to the electron, the basic unit of electrical charge. Gamma rays are very similar to X-rays, except that gamma rays are usually more penetrating. The alpha particle is more complicated than the beta particle and is less known, although it is the "heart" of the atom of the very familiar element, helium. Streams of these particles are commonly called "rays." Technical descriptions of the radiations are available in physics textbooks.

Those elements which emit nuclear radiation spontaneously are said to be <u>naturally</u> radioactive. However, scientists discovered early that they can make stable elements radioactive also. These are said to be <u>artificially</u> radioactive elements and are referred to as radioisotopes. Radium, as we have seen, is a naturally radioactive element while Cobalt is not radioactive until it has been bombarded by neutrons in a nuclear reactor, and is thus made <u>artificially</u> radioactive.

There are over 40 forms of so-called radioelements occurring in nature. Each atom of such an element emits one or more of the radiations just discussed in accordance with a fixed pattern uniquely characteristic of that particular radioactive element. Some of these radioactive elements are more active than others. The length of time it takes for one-half of a given amount of a radioactive element to change (scientists call it transmutation) into the next element is called its half-life. The half-life of known radioactive elements ranges from very short times, expressed in fractions of a second, to others that are very long, expressed in billions of years. For example, the half-life of radium is about 1600 years. In other words, if, say, 1 ounce of radium had been set aside 1600 years ago, today it would be one-half an ounce of radium and one-half an ounce of stable lead. It would take another 1600 years before the remaining one-half ounce of radium will be reduced to one-fourth ounce of the original one ounce.

An important characteristic to remember about all radioactive elements is that the rate of spontaneous release of nuclear radiation from the atom occurs naturally and cannot be increased or decreased by any known means. Hence, we cannot artificially remove radioactivity from a radioactive substance. If the radiation released is high enough to be a health hazard, we can protect ourselves from radiation exposure in several ways. First, the radioactive material can be removed to a place where it can be tolerated until its radioactivity decreases (through an appropriate number of half-lives) to a point at which the remaining radioactivity is so weak as to be a negligible hazard.

Another form of radiation protection is called shielding. Shielding is a method by which some material is placed between the radiation source and people. The radiation is absorbed in the shielding material and the radiation hazard is reduced or completely removed. Alpha and beta particles are comparatively easy to stop. Even a piece of letter paper is enough material to absorb alpha particles. Beta particles are more penetrating, however, and about a 1/8th inch thickness of aluminum is required to stop them. Shielding against gamma radiation is much more complex and involves factors such as the energy of the gamma radiation and the stopping power of different materials for various gamma energies. It is found that, theoretically, some gamma radiation will get through any thickness of shielding material. However, this is like taking half of a half of a half, and so on into infinity, since it is possible to reduce gamma radiation by half each time the shielding is increased by a given thickness of material. Calculations have been made determining the so-called half-value-layers of various shielding materials for gamma radiations of different energies. For example, it has been shown that for certain gamma energies the following thickness of materials will reduce the gamma radiation by one-half.

Steel	1-1/2"
Concrete	4-1/2"
Earth	7-1/2"
Water	10

Only a few fundamental facts about radioactivity and nuclear radiation have been given here. There are many excellent references on these subjects available to serve a wide range of reader interest. For those who wish to pursue the subject further, your local library will assist you in making a selection.

From a practical standpoint we are much more concerned with the effects nuclear radiation produces on the human body rather than on its precise definition and technical characteristics. Bear in mind, however, that volumes have been written about these things, but for the sake of brevity we are omitting details here. Our immediate concern is to understand something about how these radiations affect us and how to protect ourselves against being accidently exposed to more than the natural background amounts.

Much study and research has been completed on the effects of nuclear radiation on the human body. Again, however, it is neither essential nor desirable to burden you with these technical aspects. How these radiations produce damage to body tissue will now be briefly described.

All of these radiations are capable of affecting the chemical composition of the living cells which compose our body tissues. If, for example, an alpha particle penetrates the walls of a particular cell, the rather complex chemical processes and delicate electrical balance of this cell might be upset to such an extent as to create a deteriorating situation that may eventually result in the death of the cell. When a cell is thus penetrated and the radiation gives up its energy within the cell we say the radiation has been absorbed. How dangerous would the death of a particular body cell be to the body's functions? Answering this question will lead us to an understanding of the overall effect of the absorption of radiation by the body.

We know that our body is made up of millions upon millions of cells. Secondly, all cells are not of equal importance to our bodily functions. Muscle cells are not as important from a functional basis as, say, nerve cells controlling reflexes. Thirdly, the body has recuperative capabilities depending much on the health of the person affected. From this it is obvious that the answer to the question above must be a qualifying one. If there are enough cells destroyed of the important kind, and/or fast enough so that the body does not have time to replace them, then a deteriorating situation prevails. This could result in the death of the person. On the other hand, if the death rate of individual cells is very slow, or takes place over a long period of time, or the exposure is over only such parts of the body as arms or legs, the recuperative ability of the body would have a chance to replace dead cells. Under these conditions permanent damage might not result. It is as simple as that.

Let's consider the effectiveness of each type of radiation to destroy living cells. Beta particles are much lighter than alpha particles and usually have less energy. Principally for this reason, the beta

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particle is less able to cause cell destruction than the alpha particle. Gamma rays, as we have said, are very penetrating and are best described as a beam of energy. Therefore, the gamma ray must hit an atom directly or it will pass through the cell with no effect. Although this is a somewhat simplified explanation, it will serve our purpose here.

There is to some extent protection gained from the fact that these radiations are not all equally able to penetrate the body when the exposure is from an external radioactive source. Actually, alpha and beta particles are so easily stopped that the normal unbroken skin of our bodies will keep them from entering the body, although large quantities of beta radiation can produce serious damage to the skin and tissue directly beneath the skin. Alpha and beta particles are the most hazardous if the radioactive material gets into the body. This can occur through openings in the skin, through the mouth, the digestive system, or into the lungs by inhalation. Gamma rays being akin to X-rays can penetrate the body without any need to find a special point of entry, but may go harmlessly through. Alpha particles are, therefore, treated as internal hazards; beta particles may be either internal or external hazards, while gamma rays are classed as an external hazard.

Up to this point we have discussed some of the more essential facts about radioactivity qualitatively. To be able to discuss it quantitatively requires the use of some unit of measurement. One such unit that is widely used is the roentgen (r).

Technically speaking, the roentgen expresses a quantity of radiation from a gamma or X-ray emitting source. Because we are primarily concerned with the effect of radiation on the human body, another unit, the roentgen-equivalent-man or mammal, the rem, is used. However, for our purpose here, it is sufficiently accurate to consider a rem equal to one roentgen. When dealing with low levels of radiation, a smaller unit is used. This is the milliroentgen (mr). One thousand mr equal one roentgen.

Again it is not necessary to burden you with precise technical definitions. Instead, a study of the following table will help you appreciate the size of the roentgen.

Single dose over whole body		Effect
In Roentgens	In Milliroentgens	
Less than 25	Less than 25,000	Clinically not detectable
25 - 100	25,000 - 100,000	Blood changes but no illness expected
100 - 300	100,000 - 300,000	Slight to severe illness
300 - 500	300,000 - 500,000	Illness and possible death
500 - 1000	500,000 - 1,000,000	Survival possible
Over 1000	Over 1,000,000	Survival improbable

The table also furnishes a basis upon which to compare the radiation exposures permitted to people employed in the atomic energy industry, a maximum of 5 roentgen (5,000 milliroentgen) of gamma or X-radiation per year, to the much greater exposures required before we can detect an effect on the human body.

Much discussion has been generated on the subject of radioactivity introduced into the atmosphere by detonation of nuclear devices in the air during tests. However, in the past, the relative importance of the radiological hazard resulting from fallout from tests has very often been exaggerated. When fallout radiation was compared with the radiation from sources both natural and manmade, the fallout radiation was estimated to contribute less than three percent of the total average radiation exposure that the general population might receive.

The average yearly radiation exposure to the population (if everyone was exposed the same) has been estimated. Radiation from cosmic rays at sea level exposes us to about 37 milliroentgens a year. Minute traces of radium exist in practically all our water supplies and from this source we get about 40 milliroentgens a year. The luminous dial of a watch may contribute another 30 milliroentgens a year. Gamma rays from radioactive substances in the Earth contribute about 60 milliroentgens a year. Occurring naturally in our bodies is a kind of potassium that is radioactive. This source, from which we cannot escape, contributes about 20 milliroentgen of radiation a year. One routine chest X-ray may contribute as much as 100 milliroentgens. The building material in an average home may contribute another 40 milliroentgens a year, all of which adds up to about 327 milliroentgens a year.

We see, therefore, that we are all inescapably exposed to nuclear radiation in the form of measurable amounts of natural background radioactivity. Additional radiation exposure is received when our teeth are X-rayed by a dentist, or a doctor uses an X-ray to help him treat injuries or disease, or in the annual chest X-ray campaign and from other uses of radiation. We have been accepting manmade radiation with little or no concern because we believe that we benefit from them. We do, however, recognize the need to control manmade radiation and keep radiation exposures as low as possible.

CONVENTIONAL AND NUCLEAR WEAPONS

America's arsenal for national defense is not only formidable but potentially very destructive. It is meant to be. In fact, any weapon is meant to be destructive. The problem is to make it safe until it is deliberately used against the enemy. By its very mission the Department of Defense deals with weapons, all kinds of weapons; conventional as well as nuclear. But of all the Nation's formidable weapons, rightly or wrongly, nuclear weapons have created the most public concern over the possibility of their accidental detonation.

Upon detonation, the energy of a conventional bomb appears as blast and heat. These are familiar effects and are generally understood. When a nuclear bomb detonates, about 85% of its energy appears as blast and heat. However, the remaining portion, about 15%, appears as nuclear radiation which is a new effect not so generally understood. If, to this general unfamiliarity with nuclear radiation is added the tremendously increased destructive capability of nuclear bombs, the public's apprehension is understandable. A generally held belief is that the greater a weapon's destructive power, the less safe it is to handle. In the case of nuclear weapons, this belief is entirely erroneous. As we shall presently see, the nuclear bomb is actually more safe to handle than most other military explosives.

Conventional bombs obtain their destructive power by detonation of certain chemical compounds, known as High Explosives, or simply as HE. The reaction is purely chemical in nature, involving only outer portions of the atoms. Nuclear bombs, on the other hand, obtain their tremendous destructive power by a physical reaction involving the central portions (or nuclei) of the atoms.

To help understand why nuclear bombs are inherently more safe to handle than conventional bombs, a brief description of the operation of an atomic bomb is presented. First, a nuclear detonation cannot take place unless a certain amount of nuclear material is compressed into a small mass so as to produce what is called a multiplying or self-sustaining chain reaction. Such an explosive reaction cannot take place in anything except a nuclear explosive device designed to achieve a nuclear detonation.

No matter how much active material may be in the bomb, or how severely the bomb may be abused in an accident, unless this nuclear material is brought to supercriticality no nuclear detonation can take place. This supercriticality is achieved by compressing the active nuclear material by means of an implosion wave of tremendous force.

The implosion wave is created at the desired instant as follows: The active material in a subcritical configuration is surrounded by a sphere of conventional high explosives (HE). On the outer surface of the sphere are a number of detonators. The configurations of the HE and detonators is such that, when at the desired instant all detonators are simultaneously fired, a compression wave is generated which moves inward - implodes - to squeeze the active material into a small volume. This squeezing action brings the subcritical active material to supercriticality. The multiplying nuclear chain reaction results in a nuclear detonation.

Note from the preceding that a nuclear bomb contains conventional HE as well as the active material. The hazards associated with HE are, therefore, present in connection with a nuclear weapon. In an accident involving severe impact, or high octane fuel fires, the HE portions of the bomb may catch fire and some or all of the HE may detonate. Unless all the HE in the bomb is made to detonate at the same time--a highly unlikely occurrence in such an accident--the chance of a significant nuclear yield is extremely remote. The HE detonation could, however, scatter nuclear material in a number of directions from the point of detonation. Even if that were to occur, the radioactive contamination would not be as great a hazard to people as are many of the hazards we find in our daily living.

Nuclear weapons are made with many built-in safety features. The design of these bombs is such that if only part of the HE is accidently exploded it cannot trigger a nuclear detonation of the bomb. Tests have been made which prove that it is practically impossible to obtain any significant amount of nuclear yield except when the bomb is intentionally detonated to produce a nuclear explosion.

To verify the safety built into our nuclear weapons, a comprehensive testing program is conducted. This program includes field testing during which components of nuclear weapons are subjected to such abuse as dropping from an aircraft, impacting against a concrete wall and even enveloping the components in the intense flames of an aviation fuel fire. In no case has there been a nuclear detonation. As a matter of fact, in more than 19 years of storing, transporting, flying, overhauling, modifying, inspecting and otherwise working on and with nuclear weapons, our safety record in this major area is perfect. The nuclear part of the weapons has never contributed to an accident or injury or resulting damage.

ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

It should now become abundantly clear that the hazards due to radioactive materials, particularly as they affect our daily lives, have been emphasized out of all proportion in comparison to many more familiar daily hazards. As shown earlier, other daily hazards contribute far more to the loss of life and property than the hazards involving radioactive substances. For example, even though employing upwards of 300,000 people at its peak, the atomic energy field had over the period 1943-1955 (the first for which careful records are available) an excellent safety record in the nuclear radiation field. For example, of the 184 fatalities during this period only <u>two were attributed to radiation</u>: the balance of 182 were due to typical industrial accident causes: falls, 43; electrocutions, 31; mobile equipment (cranes and bulldozers) 25; motor vehicles, 20; miscellaneous, 63.

Records of all accidents involving nuclear weapons and radioactive materials have been carefully kept. Review of these official records reveals information of substantial value in helping to avoid accidents in the future.

The wide spread increase in the industrial use of radioactive materials has greatly increased the number of shipments of these substances. The chances, therefore, of more people becoming involved in accidents in the transportation of radioactive material is much more probable now than in the past. It is the transportation accidents to which we will give the most attention.

From official reports several types of accidents involving radioactive materials including atomic bombs have been selected for review. Familiarization with past emergencies should furnish some idea of what might be expected in future incidents.

1. An illustration of what can happen when an uninformed person picks up a "souvenir:" In Connecticut, a workman picked up an encapsulated radioactive source. It was attached to a string and used in the construction job to radiograph welds. The workman recovered the capsule hanging by a string and put it into his shirt pocket. A few minutes later he placed it in the glove compartment of his car. The workman received an estimated whole body gamma dose of 22-26 roentgens and an estimated dose to two small skin areas of about 3600 roentgens each. There were no observed biological effects from this exposure. Three others riding in his car pool were possibly exposed to as much as 7 roentgens each. While no permanent injury resulted in this documented case, it points up the possible hazards involved in picking up and carrying away unfamiliar objects before having them identified as possible radiological hazards.
2. In another case, four employees in Nevada exceeded the maximum permissible nuclear radiation dosage (3.9 roentgens per 13 weeks) because they did not wait for a monitor to accompany them in entering a nuclear test site to retrieve some test items. These exposures were as follows: 4, 14, 18, and 28 roentgens of gamma radiation respectively. These men showed no signs of ill effects as a result.
3. Another example of what can happen is illustrated by the following incident in Idaho. Fortunately, in this case no radiation exposure to personnel occurred. A boxcar, while transporting scrap uranium between plants, became derailed by a rock and a snowslide and was demolished, spilling the contents on the right-of-way. Radiation detection instruments were used to locate the material so that it could be recovered.
4. In Montana, a freight train was transporting drums of a compound containing uranium. Twenty-six cars were derailed as a result of a broken rail. The car containing the uranium compound was immersed in a river. All material was recovered and no health hazard resulted.
5. In Oregon a semi-tractor-trailer truck loaded with two casks containing radioactive slugs went over an embankment. No one was seriously injured and again, fortunately, all the slugs remained safely in the casks. An instrument survey made after the accident of the equipment, area and personnel indicated that there had been no leakage of radioactivity.
6. Another incident took place in Missouri when a loaded truck was transporting solid pieces of uranium metal between plants. The truck was involved in a vehicular accident and fire resulted from the rupture of the truck's gasoline tank. A local fire

department responded but was instructed to use no water by the guards with the truck, who had received such instructions. Although the instructions had been changed, the two guards had not as yet attended the training class. As a result the fire spread through most of the cargo prior to the arrival of an AEC contractor fire department which extinguished the fire with water.

7. An example of an accident involving nuclear weapons: A USAF C-124 transport aircraft carrying three unarmed atomic bombs took off on a routine logistical mission. Moments after takeoff the aircraft crashed in a nearby field and fire broke out immediately, enveloping the aircraft and its atomic cargo. The entire fuselage and two starboard engines were destroyed by the fire. Wing sections from the fuselage to the engines also sustained fire damage and were damaged by the impact. Once again, however, the conventional high explosive in the atomic weapons did not explode, there was insignificant radioactive contamination and there was no nuclear explosion.

Uranium in finely divided form or in small pieces is combustible. Just what the size of the pieces need to be to become noncombustible is presently under study. However, the radiation hazard from normal uranium contamination is negligible.

In nearly all cases where such accidents have occurred, there has not been too much that could or should have been done by a layman who might find himself at the scene of such an accident. In this respect the standard instruction in First Aid is to make the patient comfortable and when in doubt do not move the patient unless absolutely necessary to make him comfortable until professional personnel arrive. In much the same way in a radiological accident, at which a layman may find himself, the first actions to be taken would not be much different from those taken at the scene of a similar non-radiological accident. What these differences are will be discussed in the next section.

EMERGENCY MEASURES

To begin with, all Federal agencies involved in any way with the production, use and distribution of radioactive materials, enforce very specific regulations designed to ensure the safe handling of such substances under normal as well as emergency situations. Extensive radiological safety programs including training in safety are conducted by Federal agencies such as the Atomic Energy Commission, Department of Defense, United States Public Health Service, and the Federal Aviation Agency. In the Armed Services and the Atomic Energy Commission, to augment the engineering and scientific work done in designing our nuclear weapons so that they can be handled with safety, great emphasis is placed on atomic weapons safety training. Training in the safe handling of weapons is practiced on a continuing daily basis. In the more than 19 years of the atomic weapons program, the nuclear portion of a nuclear bomb has not contributed to the cause of an accident involving these weapons.

As pointed out in the section entitled, "Accidents Involving Radioactive Materials," the chances of the average layman becoming an active participant in an accident involving radioactive materials is most likely to be in connection with an accident in the transportation of the radioactive materials. It is quite possible, therefore, that such an accident could happen many miles away from the agency responsible for the custody of the radioactive material involved.

In order to be prepared to bring to bear the maximum available radiological emergency capability in the event of an accident of major concern to the public health and safety, Federal agencies associated in any way with the protection of the public health and safety from accidents resulting during the development, manufacture, use or the transportation of radioactive materials, have developed an emergency assistance plan called the Interagency Radiological Assistance Plan (IRAP). This plan provides for the development of definite procedures whereby the agencies will furnish all available assistance in case of accidents involving radioactive materials. Inasmuch as the Atomic Energy Commission and the Department of Defense have been involved with radioactive materials for a much longer time than other Federal agencies, both agencies have well developed emergency plans and teams with the capabilities to cope with accidents involving radioactive materials, including nuclear weapons. These teams are located throughout the United States at AEC and military installations. Other Federal agencies that may be contacted include the Office of Civil Defense, Public Health Service, and the Food and Drug Administration. Detailed information concerning the policies and capabilities of these agencies should be obtained from them. However, through mutual assistance these and other agencies' capabilities are often utilized. A few States have organized radiological emergency monitoring teams that can be dispatched to the scene of accidents involving radiation or radioactive materials within their respective State boundaries. Information about such teams is usually available from the State Atomic Energy Directors or Coordinators, Departments of Labor and Health, or the State Police.

An example will help to show how this plan might function: Suppose a truck transporting some radioactive material belonging to an AEC facility is involved in a vehicular accident. The truck is, say, 50 miles from the plant having custody of the radioactive material. However, just a mile away is an Army Post. The local police arrive on the scene of the accident and immediately call the local Army Post explaining the situation. They (or the Army) also notify the AEC facility of what has happened and that radiological assistance is being furnished by the Army Post. A radiological assistance team from the Army Post, properly equipped to handle situations like this, arrives in short order and with the assistance of the local police assumes command of the situation. This team remains in charge until the arrival of an authorized team from the custodian agency, in this case AEC. The AEC team takes over, performing such actions as are required to retrieve the material, control the radiation hazard and take any other action necessary. The military team will continue to help control the situation if they are needed.

Note in this example that the accident takes place outside the physical areas where trained and competent personnel would be immediately available to handle the situation. It points up the most likely situation in which a layman might, by chance, be at the scene of an accident involving radioactive materials. What specific steps, if any, should such a layman take? Or, in the absence of specific steps are there any general guidelines to follow?

The one very specific step to be taken is to NOTIFY PROPER AUTHORITIES. This is the most important contribution that a layman can make at the scene of such an accident. To help accomplish this each individual should have the specific information on the official agencies he should notify in case of a radiological emergency. Among these should be the telephone numbers of the local police and fire departments, the nearest Atomic Energy Commission and military installations and any other appropriate agency. This is so important that space is provided on the cover of the AEC publication to record this information for any particular locality. Also, on the back cover of the publication are some wallet size cards on which this information may be recorded. These cards may be cut out and placed in wallet or purse, the remainder may be distributed among family and friends.

One must be prepared at the time of contacting the proper authority to supply sufficient information upon which the authority can take proper action. Give the location of the accident in sufficient detail so that it may be easily located. Briefly describe the kind of accident it is, if there are any personnel casualties, and if it is suspected that radioactive materials are involved. In passing on information to authorities be careful to distinguish between information based on what you actually observed and on information based on what you guessed or suspected. Great harm may result if these two get confused. If you are not absolutely sure, it is perfectly correct to mention that you have reason to believe that radioactive materials may be involved in the reported accident. Be sure that you fully identify yourself and how you can be contacted, and give the authority who can be contacted at or near the accident scene.

It might be very difficult to decide what to do first if there was an injured or trapped person involved in the accident and you are the one who arrives at the scene first. The decision to act must then be made with the knowledge that help will be needed as soon as possible and the sooner the authorities are notified the sooner help will arrive. Nevertheless, the saving of human life and care of injured is the first consideration and reporting will usually be second. Therefore, in any accident situation, whether or not it is clear what chemical or radiological hazards may be present, there are several emergency actions the "Nonspecialist" should follow:

Sequence of Emergency Procedures

1. Keep away from the wreckage, material, container or other material involved, except to rescue people.

2. Report the accident as quickly as possible to the nearest local authority (police, fire, health, etc.) and (if radiological material is suspected) notify the nearest AEC or military installation.
3. Warn sightseers to stay well away, 500 yards or more if possible.
4. Stay out of smoke, mist, dust, or other visible substances that are airborne.
5. People who have been in the area affected by the accident may have become contaminated and should be held in some nearby place for examination by emergency or rescue personnel before they are released to go their way. If they will not stay, obtain their names, addresses, telephone numbers and occupations to give to the emergency personnel or local authorities when they arrive.
6. Leave firefighting to the firefighters - especially if explosives are involved - except under the direction of firefighting personnel.
7. Do not permit people to handle debris or take souvenirs from the accident scene.
8. Turn over control at the accident scene only to properly identified authorities.

There are, as we have already discussed, some special problems to consider in the event a nuclear weapon is involved in an accident. We need, therefore, to know what immediate steps can be taken by the first observers on the scene or by the emergency personnel who may very likely arrive before the military or AEC weapons accident emergency experts. For the "Nonspecialist" the following actions should be taken when it is believed that a nuclear weapon (or military explosive such as ammunition) is involved:

1. Give immediate assistance to rescue personnel where possible. Otherwise, keep away from the accident. Even though there has been one or more explosions there is always the danger of detonation of unexploded pieces of any conventional high explosives.
2. Report the accident as soon as possible to the nearest military authority or AEC office and local fire and police departments.
3. Keep sightseers away from the accident area. Get other witnesses to help in doing this. In the open, an exclusion distance of at least 500 yards should be established to minimize the chance of fatal injuries from the direct blast effects of conventional HE. But, even at this range there is a danger of injury from secondary missiles that might be flung into the air by an explosion. If there has been no explosion and it is suspected that a bomb (or HE) is involved, there may still be an explosion.
4. If there is a fire stay out of the smoke except for the purpose of rescuing people. Always approach the accident scene from upwind and from uphill, if possible. If the smoke cannot be avoided, use any immediately available method to prevent smoke

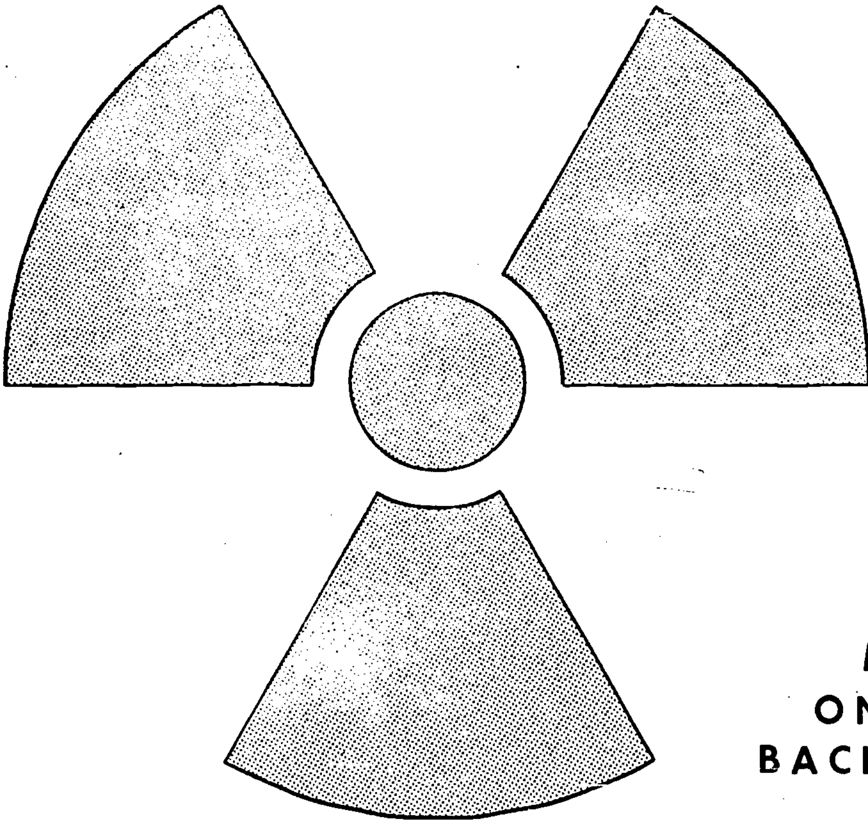
from affecting your eyes and throat. Although there may be a toxic, caustic, or radioactive material in the smoke, tests have shown that short incursions are not likely to have serious effects on the person exposed. If it has proved necessary to enter the smoke from a fire, report subsequently to the AEC or military emergency team for radiological monitoring and possible decontamination.

5. Do not try to fight a fire, especially if it is believed that explosives may be present.
6. Do not permit anyone to touch anything unnecessarily or retain as souvenirs any objects found in the accident area.

These actions are based on Part II, "Emergency Procedures" of the "Technical Information Bulletin on Atomic Weapon Accident Hazards, Precautions and Procedures," (revised January 1, 1963) which is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for 10 cents a copy. (This publication is reprinted as Annex 4 to this chapter.) Similar suggested actions to be taken by fire, police and local emergency services, pending arrival of AEC or military special emergency teams, are also included in this Bulletin. Because the capability of these local agencies to carry out emergency operations is much better than that of a citizen who comes on the accident scene purely by chance, the importance of notifying these local authorities and emergency personnel as soon as possible cannot be overemphasized.

We have talked about accidents involving radioactive materials without discussing how such an accident might be distinguished from an accident in which the presence of active materials is not a factor to be considered. As was pointed out previously, none of our five senses can detect the presence of the radiations from radioactive materials. We cannot, for example, identify the presence of such a substance by smelling it, even if we could come close to it. Without proper instruments the layman must rely on other means to identify radioactive materials. What are some of these means?

The American Standard Radiation Symbol that is used in the United States and some other countries to signify the actual or potential presence of nuclear radiations and to identify sources of these radiations is depicted on the following page. This symbol can be found on radioactive source containers used for storage and in-plant transportation, painted on doors or walls, applied on tags, labels, or items of equipment or products containing radioactive material and in many other places. Most applications of signs, tags, labels, or items of equipment or products containing radioactive material and in many other places. Most applications of signs, tags, labels or the radiation symbol alone are for the dual purpose of identification and warning of the presence of a radiation source.



MAGENTA
ON YELLOW
BACKGROUND

From what has been said the mere presence of radioactive substances should no longer automatically evoke fear. We have learned that the transmission of nuclear radiations from radioactive materials can be greatly reduced or stopped entirely by means of shielding. Hence, radioactive materials are shipped in containers that are apt to be rather bulky and heavy. Radioactive materials to be shipped by land, air or water transport are packaged, identified and marked in accordance with definitely prescribed regulations for the protection of the public health and safety. Shipments of radioactive material to hospitals and schools are often in small enough quantities to be shipped in containers weighing only a few pounds and may travel by land or air transport. On the other end of the scale, shipments of nuclear reactor fuel may be made in large casks weighing up to 125 tons. Safety precautions are taken in accordance with the degree of potential hazard.

When being shipped from one place to another all containers, regardless of size, are marked with the appropriate warning label or placard as specified by Interstate Commerce Commission, Federal Aviation Agency, U.S. Postal and U.S. Coast Guard Regulations. Look, then for one or more of these identifying labels or placards. In the event that no label is observable, it is good practice to suspect any small but unusually heavy shipping container as one that might contain radioactive material.

Finally, above all, if you ever become involved in an accident with radioactive material, remain calm and don't panic. Once again it must be emphasized - that there is no substitute for good judgment and common sense.

ATOMIC WEAPON ACCIDENT HAZARDS, PRECAUTIONS AND PROCEDURES

This Annex is a reprint of Technical Information Bulletin on Atomic Weapon Accident Hazards, Precautions and Procedures, Department of Defense and United States Atomic Energy Commission, Revised January 1, 1963. The format has been modified slightly.

Purpose. The purpose of this annex is to present unclassified information on Safety Precautions, Potential Health Hazards, and Procedures applicable at the scene of an accident involving atomic weapons.

Background. The extreme care devoted to the design of equipment and procedures for transporting atomic weapons has been repaid with a record of no inadvertent or unintentional nuclear detonations. Present procedures and transport equipment are based on both scientific knowledge and principles of safety engineering, as well as results of field experiments. In the United States, atomic weapons may be transported by aircraft, truck, train, and naval vessel. In each case, weapons and components are installed in special containers which are securely fastened to the transport vehicle by carefully designed tie-downs and mountings. Stringent safety measures have also been incorporated in the design of all atomic weapons. The latter measures, combined with existing handling and transportation procedures and equipment, are designed to preclude a nuclear explosion in the event of any accident, even of a military aircraft in operational exercises. It is emphasized that for all atomic weapons in combat aircraft, a specific sequence of positive actions is required to ready them for a nuclear detonation.

Possible Hazards. Even though nuclear weapons are so designed as to prevent a nuclear yield in the event of accidental detonation, there is still a probable hazard commensurate with conventional weapons and materials. The two components of a nuclear weapon that constitute the most probable hazard in the case of an accident are (1) the high explosives, and (2) the plutonium. Other components may produce hazards, but they are of such a nature that precautions taken against explosives and plutonium are more than sufficient for their control. It should be kept in mind that accidents involving nuclear weapons or components will usually involve other materials in more widespread use, such as gasoline or other volatile and explosive fuels. If fire occurs, acrid, suffocating, and toxic fumes and smoke will probably be generated by the combustion of surrounding materials. In that event, normal procedures and precautions applicable to the type of fire should be taken.

1. HIGH EXPLOSIVES. Most atomic weapons will contain conventional high explosives in varying amounts up to many hundreds of pounds. These high explosives comprise the major hazard associated with accidents involving atomic weapons. Due to the probable presence of high explosives in any atomic weapons shipment, accidents or fires involving such shipments must be treated as would accidents or fires involving conventional high explosives. The following is a summary of knowledge concerning high explosives and their danger and should be applied to atomic weapons where appropriate.

a. Detonation. In any accident involving a high explosive there is some possibility of a detonation occurring. The detonation may range from a very small one to one of considerable magnitude or it may be a series of small explosions. The breakup of the weapon due to impact or a small explosion will probably result in the local scattering of small pieces of high explosive. Rough handling as well as accidents may produce powdered explosives. Most explosives are more unstable in these conditions and are more apt to detonate due to changes in temperature and/or shock. Exposure to sunlight likewise increases the sensitivity of the explosive and changes it coloring, usually making small pieces and powder difficult to distinguish from their surroundings. Thus, it is unwise for any one other than trained demolition personnel to attempt clearing an area of broken high explosives.

b. Fire. If a nuclear weapon is enveloped in the flame of a gasoline fire, the high explosive may ignite, burn, and in some cases, detonate. These detonations may also range from one large to several small ones. It is extremely difficult to extinguish large quantities of burning high explosives. Whenever burning high explosives are confined, as in an intact weapon, detonation may occur at any time. When high explosives burn, "torching" (jets of white flame coming out of the weapon) may be observed, but torching is not always evident before detonation. High explosives may melt at comparatively low temperatures, flow out of the weapon and resolidify. In this state, they are extremely sensitive to shock. If unconfined, high explosives may burn with the production of toxic gases and leave a poisonous residue. Ignition or detonation of the high explosives in a nuclear weapon involved in a fire can be prevented if the temperature of the explosives is kept below 300°F.

c. Disposal. Only personnel specially trained in high explosives disposal should attempt to clean up, recover or dispose of high explosives.

d. Nuclear Yield. While it is not feasible to predict the exact effect of an accident involving high explosives, it is considered that the possibility of the accidential nuclear explosion of a nuclear weapon is so remote as to be negligible.

2. PLUTONIUM. Plutonium may become dispersed as small particles as the result of impact or detonation of the high explosives, or as fumes if a fire occurs.

a. Body Effects. When small particles of plutonium are suspended in the air, it is possible to inhale them and thus deposit plutonium in the lungs. It may also get into the body through swallowing, but in such cases only a small percentage is retained by the body, since the plutonium is in a highly insoluble form. Cuts in the skin provide a third source of entry through which plutonium may enter the blood stream. Plutonium is not a hazard if it remains outside the body, because it is an alpha emitter. The alpha particles have a very short range and lack the ability to penetrate the skin. This characteristic of plutonium radiation makes its behavior markedly different from that of fallout from an atomic explosion in that it does not emit the more penetrating beta and gamma radiation. It is noted that conventional survey meters are of little use in detecting alpha radiation, and only special teams trained for handling nuclear accidents are capable of evaluating the radiological situation at the scene of an accident.

b. Amount Available. Field experiments indicate that the principal potential source of intake of plutonium into the body is inhalation during the passage of the cloud resulting from the detonation of the explosive, or a fire. Safety restrictions have been placed on the number of atomic weapons per shipment, so that the plutonium inhaled from an accident would not result in serious injury. Once the fine particles have been deposited on the ground, the hazard is markedly reduced. Whereas, it is always desirable to reduce to a minimum the intake of plutonium, where necessary one may enter or remain in a highly contaminated open area for short periods of time (up to several hours) after passage of the cloud.

c. How to Avoid. When fighting a fire involving plutonium, contamination of rescue personnel can be markedly reduced if they remain upwind and uphill from the accident. Conventional mechanical breathing apparatus or dust filter masks, goggles, and protective clothing will reduce contamination for those who must enter the smoke. Members of the special radiological team wear full protective clothing, since they usually remain in the area for considerable lengths of time; however, the nonavailability of any or all of these items should not hold up rescue operations. Potential hazards in buildings can be reduced by shutting doors and windows and turning off ventilation equipment. The potential danger from plutonium to those engaged in rescue work is no more serious than the danger from the other products of combustion.

EMERGENCY PROCEDURES

The Department of Defense and the U.S. Atomic Energy Commission have specially trained and equipped Radiological Assistance Teams prepared to deal with all aspects of accidents involving atomic weapons. These teams include ordnance disposal personnel and decontamination facilities. Their assistance may be obtained by contacting the nearest military or AEC installation.

In the event of an accident involving atomic weapons or military vehicles suspected of carrying atomic weapons, report the incident immediately to fire and police departments, and in addition, to the nearest military installation or AEC office. Give brief details of the accident, and if an aircraft is involved, its type, i.e., transport, bomber, or fighter. In the event of an accident occurring on a military base, all concerned should follow the accident procedures of the base.

Action. Action by first observer pending arrival of authorities:

1. Give immediate assistance to personnel where possible. However, except for the saving of lives, keep away from the accident. There is always the danger of a detonation of the conventional high explosives.
2. Report accident immediately, with brief description as above, to the nearest military installation or AEC office, local fire and police departments.
3. Organize other witnesses to keep sightseers away from the accident. In the open, an exclusion distance of 1,500 feet should be established because of the potential hazards from the direct blast effects of a detonation of conventional high explosives, but cover must be taken even at this range from secondary missiles flung into the air by the explosion. If there has been no explosion and it is suspected that a bomb is involved, there may still be an explosion. Except for the purpose of saving lives, keep away from the crash.
4. Stay out of the smoke. If there is a fire, do not enter smoke except for the purpose of actually saving lives. Always approach from upwind and from uphill, if possible. In saving lives, use any immediately available method to prevent smoke from affecting your eyes and throat. Although there may be a toxic, caustic, or minor radioactive hazard in the smoke, short incursions are not likely to be serious and will not be lethal. If it has proved necessary to enter the vicinity of the smoke around the fire, report subsequently to the special team after their arrival for monitoring and possible decontamination.
5. Do not try to fight a fire if it is believed ammunition may be present. After rendering appropriate assistance, clear the area to at least 1,500 feet or more.
6. Do not touch anything unnecessarily and do not pocket or retain as souvenirs any object found in the accident area.

Action by fire, police and emergency services pending arrival of special teams:

1. Rescue and assist injured personnel as practicable.
2. Notify nearest military installation or AEC office of the accident (and of the type of vehicle involved) and give them any information available as to whether nuclear weapons could be or are involved. They will in turn dispatch their own men to the scene of the accident and notify the Joint Nuclear Accident Coordinating Center as appropriate. In addition, pending arrival of the special team, the activity called will provide advice regarding the incident.
3. Clear area of all nonessential personnel to a distance of at least 1,500 feet or more. Maintain exclusion of the area until arrival of Radiological Assistance Team.
4. When there is a fire and weapon cannot be seen burning or torching in the flames, go about the extinguishing and/or rescuing procedures normally used. Try to secure early control of liquid as the weapon is located, cool it over its entire surface with available fire extinguishing agents. If weapon components are exposed and the extinguishing agents cause accelerated burning, stop their application. In some cases where the weapon is not in the fire, the foam used for extinguishing the fuel fires can be spread over the weapon to protect it from radiated heat from flames. Avoid breaking down a foam blanket on fuel with water streams.
5. If weapon is engulfed in flames, or if the high explosive is burning (torching), clear area out to at least 1,500 feet of all personnel; do not attempt to fight fires.
6. Avoid smoke and clear downwind area, but if dense smoke must be encountered for long periods of time, dust filtering masks, goggles, or breathing apparatus should be used. These are not needed for short stays in the smoke and their nonavailability should never hold up rescue efforts. Personnel who have entered smoke in the crash area must report to the special team for monitoring, and, if necessary, decontamination after initial action is over.
7. After the burning has subsided, and if the special team has not yet arrived,

   a. Do not attempt to clean up the scene of the accident.
   b. Do not permit reentry into scene of accident by anyone. Rope off scene in a semipermanent manner.
   c. Organize all personnel that may have been contaminated to preclude the spreading of plutonium about the environs and so that they can be monitored by the special team on arrival.
   d. Follow advice of the special radiological team upon their arrival.

RESPONSIBILITIES

General Humane Responsibilities. Major consideration, commensurate with personal safety, at the scene of an accident shall be the saving of any personnel involved in the accident. These personnel may be aircraft pilot and crew, truck drivers, couriers, etc.

Couriers. Atomic weapons are classified items of material, and, as such, must be safeguarded at all times. Couriers are personnel physically accompanying shipments of atomic weapons material for security purposes. In effect, the courier "owns" the material; that is, he is the direct custodian of the material. While physically able, it is the courier's responsibility to protect the material from loss or security compromise (i.e., view and handling by unauthorized personnel).

The AEC/DOD Division of Responsibilities. The AEC and DOD have agreed on the following general division of responsibility between them in all cases of accidents involving nuclear weapons:

1. "Immediate responsibility" for providing technical direction at scene of accident will be assumed by Service or agency receiving first notification of the incident.
2. Primary and continuing responsibility for providing technical direction at the scene of the accident will be assumed by the Service or AEC agency having physical possession at the time of the accident (when their personnel arrive).

The AEC and the DOD have a Joint Nuclear Accident Coordinating Center which can dispatch additional special teams as appropriate upon the request of the responsible agency.

SUMMARY

In the event of a nuclear weapon accident, the high explosives in a weapon will constitute the main danger. The nuclear material that would be spread about an accident area by a high explosives detonation will not cause any radiation damage to personnel if kept outside the body. Toxic or caustic gases may be produced in the burning or vaporization of weapons. Radioactive fumes from any plutonium that may be burning will accompany the toxic and caustic gases to form a smoke cloud that should be avoided.

Instructions for Personnel. Personnel approaching an accident in which it is believed an atomic weapon is involved should:

1. Attempt to save lives where possible; otherwise, keep away from accident area.
2. Notify the fire and police department and in addition, the nearest military installation headquarters or AEC office.
3. Secure area. Clear it of all nonessential personnel out to 1,500 feet or more.

4. Refrain from touching, removing, or examining any items in the vicinity of an explosion.

s/ Paul F. Foster	s/ Edward N. Parker
PAUL F. FOSTER	EDWARD N. PARKER
General Manager	Rear Admiral, USN
Atomic Energy Commission	Chief, AFSWP

CHAPTER XI

FEDERAL RADIOLOGICAL FALLOUT MONITORING STATION DIRECTORY

OCD has published a directory, titled "Federal Radiological Fallout Monitoring Station Directory," of the locations of Federal agency facilities having radiological monitoring capability. It is being given only limited distribution, primarily to those Federal agencies having assigned radiological defense responsibilities, and to the States through the OCD Regions. The Directory will be used chiefly to assist Federal agencies and States in providing for the most effective utilization of their radiological fallout monitoring and reporting capabilities.

A small number of copies is being stocked to meet other essential needs. A copy may be obtained by request addressed to:

U.S. Army, AG Publication Center
Civil Defense Branch
2800 Eastern Boulevard, Middle River
Baltimore, Maryland 21220

247-884 O - 67 - 26

CHAPTER XII

DECONTAMINATION AND RELATED COUNTERMEASURES

This chapter is directed to those persons who are responsible for planning and establishing a radiological decontamination capability. It contains guidance on the various methods of decontamination and related countermeasures. Although decontamination is emphasized, other countermeasures such as protective measures against the immediate effects of nuclear weapons, protective measures against fallout, and remedial movement are provided.

The effects of a nuclear explosion may be divided into two broad categories; namely, immediate and delayed. The immediate effects are those which occur within a few minutes of the actual explosion. These include air blast and ground shock, thermal radiation (light and heat), and initial nuclear radiation. The delayed effects are associated with the radioactivity present in fallout and neutron-induced radioactivity. In general, there are three basic countermeasures against weapon effects; they may be summed up as "shielding," "distance," and "time." In other words, it is necessary to provide either protection by the use of material or by obstructions to protect personnel and materials in order to get beyond the reach of the effects of the nuclear explosion until the radioactivity has decreased as a result of natural decay.

The first principle, that of shielding, is utilized in protection from both the immediate and delayed effects from nuclear weapons. Although the major means of shielding is shelter or protective construction, there are other means that can be employed for protection from both the immediate and delayed effects. Guidance for evaluating the effectiveness of existing and proposed shelters is provided in other chapters.

The second principle, that of distance, is utilized in (1) remedial movement, i.e., movement of personnel from highly contaminated areas to areas of less contamination, and (2) decontamination, i.e., the removal of contaminating radioactive material from a structure, area, object, or person, and safely disposing of the material in an isolated area. Decontamination also utilizes the principle of shielding by covering the contaminated surface with sufficient mass material to significantly reduce the radiation hazard.

The third principle, time, is utilized in time-phased application of countermeasures against the delayed effects.

All of the above countermeasures can be utilized to prevent or limit casualties. The decision as to the countermeasures to be used would be a complex one based on many variables, and is the responsibility of the local civil defense director, assisted by the Radiological Defense Officer and other members of his staff.

PROTECTIVE MEASURES AGAINST IMMEDIATE EFFECTS

The objective of protective measures against the immediate effects are to decrease the direct harmful effects of blast, thermal radiation, and initial nuclear radiation, which occurs within the first few minutes after a nuclear explosion. This section deals with countermeasures that may be employed directly by the individual, although it is provided for the guidance of radiological defense personnel who do not have adequate shelter, whether engaged in personal pursuits or on assigned emergency missions.

Blast. Where a blast resistant shelter is not available, protection should be sought in the strongest building that is accessible. Protection against flying debris can be obtained by taking refuge in the location, preferably selected in advance, that is least likely to be entered by blast debris. Individuals should stay away from windows and easily breakable materials, such as plaster walls or ceilings. In the collapse of buildings as a result of blast, heavy structural members, pieces of the building materials and contents of the structure will fall or be hurled about. There is a dual hazard of being hit and trapped; therefore, positions next to walls in basements offer the best protection. Above ground, the safest locations are generally near, but not against, walls and away from doors and windows.

Even if there is no prior warning of a nuclear attack and the first indication is the flash of light, there may still be the opportunity to take some protective action against the effects of blast. If prompt action is taken, a person in a building could reach a position of the type indicated above. In the open, some protection against the blast may be obtained by falling prone, and remaining in that position until the blast wave has passed. In the prone position, with the head directly toward or directly away from the explosion, the body presents the smallest target for flying debris. The area of the body exposed to the onrushing blast wave is also relatively small and the danger of displacement is thereby decreased.

Thermal Radiation. In an air or surface burst of large weapons, the thermal radiation is received in two pulses, in each of which there is a maximum of intensity followed by a decrease. If an individual is caught in the open or is near a window in a building at the time of a nuclear explosion, evasive action to minimize flash burn injury should be taken, if possible, before the maximum in the second pulse. At this time, only 20 percent of the thermal energy will have been received. Consequently, a large proportion can be avoided if shielding is obtained before or soon after the second thermal maximum.

The major part of the thermal radiation travels in straight lines, and any opaque object interposed between the fireball and the skin will give some protection. This is true even if the object is subsequently destroyed by the blast, since the main thermal radiation pulse is over before the arrival of the blast wave.

At the first indication of a nuclear explosion, by a sudden increase in the general illumination, a person inside a building should immediately fall prone and, if possible, crawl behind or beneath a table or desk or to a planned protected location. Even if this action is not taken soon enough to greatly reduce the thermal radiation exposure, it will minimize the displacement effect of the blast wave and provide a partial shield against splintered glass and other flying debris. An individual caught in the open should fall prone to the ground in the same way, while making an effort to shade exposed parts of the body. Getting behind a tree, building, fence, ditch, bank, or any structure which prevents a direct line of sight between the person and the fireball, will give a major degree of protection. If no substantial object is at hand, the clothed parts of the body should be used to shield parts which are exposed. Individuals should make every effort to avoid looking toward the fireball to protect against eye injury.

Extensive fires may result from thermal radiation and from secondary blast effects, i.e., overturning of stoves, short circuiting of electrical wires, etc. Appropriate fire control action may be directed along two lines, (1) elimination or reduction of potential ignition points, and (2) provision for isolation or rapid extinction of ignitions to prevent formation of large fires.

Potential ignition points can be decreased by continuous upkeep of existing wood structures and by taking steps to keep yards free from all combustible trash. The second aspect of fire control action is to plan and train for the elimination of small fires before they can grow into serious ones. By extinguishing small fires soon enough, the number of serious fires may be sufficiently small to be dealt with by professional firefighters. Consideration should be given to the provision of adequate fire breaks using reflective surfaces, and to the zoning and planning of urban areas. Dispersal and protection of utilities and emergency services should also be included in such planning.

Initial Nuclear Radiation. The regions in which large doses of initial nuclear radiation could be received are those of high blast pressure and intense thermal radiation. Major protection against all three effects would be provided by a massive reinforced, fire-resistant building. The immediate evasive action suggested earlier for limiting the effects of thermal radiation and blast to a person in the open may assist, to a lesser extent, in reducing the dose of initial nuclear radiation. From large yield weapons, in particular, a second or two elapses before much of the nuclear radiation is delivered at distances where survival is possible.

PROTECTIVE MEASURES AGAINST FALLOUT

The objectives of protective measures against fallout are: (1) Decrease the direct harmful effects of radioactive fallout on personnel, (2) Prevent contamination and minimize the deposition and retention of fallout on personnel, vehicles and buildings, and (3) Facilitate the removal of fallout material from people and their possessions. This section deals with (a) fallout protective measures that may be employed directly by the individual for his personal protection either at home or while engaged in postattack emergency work, and (b) community preattack protective measures. In general, these measures are applicable to rural as well as to urban situations. However, the U.S. Department of Agriculture has prepared specific guidance (Protection of Food and Agriculture Against Nuclear Attack, Agriculture Handbook No. 234) for protection of livestock and agriculture.

Personnel. Upon warning of attack, all personnel should seek the best shelter available. If the presence of fallout is indicated before adequate shelter can be reached, actions should be taken which tend to minimize the effects of radioactive fallout. Some of these are:

1. Continue to destination as fast as existing circumstances permit unless otherwise directed.
2. Keep under cover as much as possible using trees, overhangs, etc.
3. Cover the hair or head to prevent contamination. Any cap or hat is satisfactory. A piece of heavy cloth or newspaper used to cover the head would be just as good, but might be difficult to keep in place.
4. Keep all outer clothing buttoned or zipped to prevent inner clothing from becoming contaminated. Adjust clothing to cover as much of your skin as possible.
5. Avoid ingestion and inhalation of the fallout material by covering the mouth and nose with a handkerchief or other cloth material.

Upon arriving at a sheltered location, all persons should decontaminate themselves. (See section on Decontamination of Personnel and Clothing.)

When, for any reason, personnel might need to leave shelter after fallout has arrived, such as for decontamination operations or remedial movement, protective measures should be taken to prevent contamination of their bodies. Clothing will not protect personnel from gamma radiation, but it keeps the radioactive material away from the skin and reduces the need for extensive washing or scrubbing of the body for prevention of beta radiation burns. The following measures will help reduce contamination of personnel:

1. Time outside shelter should be kept to a minimum especially during the first two days after attack if the radiation dose rates are high.
2. Under extremely dusty conditions, or while fallout is still being deposited, wear adequate clothing to cover as much of the body as practicable. This includes covering the head and wearing gloves. Also, wear boots or rubber golashes that cover the shoes, and tuck the pant cuffs in them to reduce contamination of feet and ankles. A piece of tight knit cloth could be wrapped and tied around the shoes and pant cuffs serving in lieu of boots or golashes.

3. Avoid highly contaminated areas, if possible. Puddles and very dusty areas where contamination is easily spread should also be avoided.
4. The amount of radioactive material absorbed from fallout by inhalation appears to be relatively small because the nose is capable of filtering out almost all particles over 10 microns in diameter, and about 95 percent of those exceeding 5 microns. However, under dry and dusty conditions a man's folded handkerchief or a piece of tight knit cloth, folded several times, should be held or worn over nose and mouth to prevent inhalation of particles.
5. Avoid unnecessary contact with contaminated surface (buildings, shrubbery, etc.). Do not stir up dust unnecessarily.

Under extremely dusty conditions, or while fallout is being deposited, personnel in vehicles should remain in the vehicle, leaving it only when necessary or when better protection is immediately available. To prevent contamination of the interior of the vehicle, all windows and outside vents should be closed. Although vehicles provide only slight protection from gamma radiation, they provide excellent protection from beta radiation, and can prevent personnel from being contaminated.

Food and Water. Availability of uncontaminated food and water will be of some concern to personnel during the shelter and recovery periods. It is not likely that consumption of contaminated food or water will constitute a serious survival hazard for a large fraction of the populace. However, in some areas, ingestion of contaminated food and water would become a long term postattack recovery problem. Protective measures to prevent contamination of stored food and water are not difficult. The principle is to prevent the fallout material from becoming incorporated into the food and water. Food exposed to fallout radiation would not be dangerous if the radioactive particles did not become incorporated in the food, or if the fallout particles could be washed off or otherwise completely removed.

Most foods in houses will be safe for use. Foods in cans, or sealed packages will be safe for consumption. Even in open containers food stored in refrigerators or cupboards will also be safe for consumption. Foods in open containers covered with plastic films will also be safe. All foods that are open and exposed to dusty conditions should be washed or decontaminated, if practicable, before they are consumed.

Most stored foods in closed stores or warehouses will be safe for consumption. Foods stored in large refrigerators and closed warehouses, preventing contamination from dust will be safe. Simple protective measures that should be applied to warehouses upon warning of fallout would be to close all windows, doors and vents to prevent entry of fallout material. Similar protective measures should be taken with trucks carrying food from warehouses to stores. Food in closed refrigerated trucks and tank cars would not be contaminated.

All water in closed containers, such as hot water tanks, tins and bottles will be safe for consumption. If windows and doors of the house were closed to prevent fallout from entering, tubs, sinks and pans filled with water would probably be safe for drinking. To insure this water purity, simple protective measures such as covering the container with a plastic wrap, or any material that would keep out dust particles would suffice. Normally, water in covered cisterns will be safe from fallout. Rain could sweep fallout particles from the air and the roof or catchment area and contaminate the cistern water. Protective measures must be taken to prevent rain water from entering the cistern after the beginning of fallout and until the drainage area and subsequent rains are relatively free of radioactive material.

All water stored in covered reservoirs, either ground or elevated type, will be safe for consumption. To prevent the contamination of this water after the arrival of fallout, additional water should not be pumped into these reservoirs until the source is found to be free of radioactive matter. If covered prior to the beginning of fallout with any nonporous material, such as plastic to keep out dust particles, small, uncovered reservoirs would assure a safe supply.

Because soil has the ability to absorb and retain certain elements from the water seeping through it, underground sources of water will generally be free from radioactive contamination. For the same reason, wells, even under ground covered with fallout, would be considered safe sources of drinking water. Where there is not adequate capability in water treatment plants for decontamination of radiologically contaminated water, there should be individual and community effort to identify existing wells of good quality.

Vehicles and Equipment. Vehicles and equipment, which will be required after attack for necessary individual use, for operational recovery, for movement of personnel, firefighting, police operations and other purposes, should be protected from radiological fallout contamination. If preventive measures are not taken, unnecessary time and manpower plus personnel exposure, would be required after attack to decontaminate such vehicles and equipment.

A major part of the vehicles and equipment used for firefighting, police operations, and road maintenance, are normally stored in large buildings or garages. Upon warning of attack or fallout, unprotected vehicles and equipment should be stored in available garages and warehouses, if possible. The windows and doors of both vehicles and buildings should be closed.

There are many vehicles and pieces of equipment, such as bulldozers, cranes and large trucks, that cannot be conveniently stored. Protective measures to keep the radioactive dust particles off the equipment should be implemented. Among such measures are covering vehicles or equipment with tarpaulins, thin plastic material, or any other type of protective covering. It is especially important that the area where the operator sits be covered With equipment having closed cabs, close the openings or cover the cab to prevent contamination of the interior. Shovels, picks, power tools and other small pieces of equipment should be stored in covered tool boxes, or covered with tarpaulins of plastic to prevent contamination. In large vehicles such as busses and trains, all openings should be closed to prevent contamination of the interior. These simple protective measures to prevent contamination of the vehicles and equipment will aid tremendously in restoring them to operable condition.

Structures. It is important to prevent or minimize the contamination of the interior, as well as the exterior of structures. To prevent contamination of the interior of homes or other structures during the fallout periods, windows, doors, vents or openings to the outside should be closed. Radioactive fallout particles can be carried by the wind and could enter into the structure and spread if these openings are not closed. All personnel, before entering homes, shelters, or any structure, should undergo self-decontamination. (See section on Decontamination of Personnel and Clothing.)

There are certain essential areas and structures in communities which people will be dependent upon during the recovery period. These essential or critical structures and areas, such as electrical power facilities, water supply plants, food processing plants, pharmaceutical plants, oil refineries, communications facilities and emergency operation centers (control centers), might require certain protective measures that will minimize the deposition and retention of fallout and facilitate its removal.

Under many conditions, the provisions of removable covers for the work area or facility that are capable of being removed automatically or rapidly by decontamination personnel when fallout is complete may constitute an effective system. The system might consist of an awning or tent-like structure of fabric or flexible plastic that could be drawn over the facility before the arrival of fallout and retracted after fallout is complete. In vital areas, a similar cover in rolls located at the edge of the area could be drawn over the area before the arrival of fallout and retracted afterwards. Facilities in the work area should be flush with the surface to prevent obstructing the system. Many variables of this concept may be considered in the design of essential facilities.

The washdown system is a reclamation system developed by the Navy for use on ships. The washdown system is supplied by the fire main and consists of nozzles that spray water over all exposed surfaces during the fallout period. This washdown of exposed surfaces results in the suspension and removal of radioactive particles similar to that resulting from firehosing the area continuously during fallout. If an essential facility were provided with a properly sloped, smooth roof surface, with the area surrounding the facility being paved and well drained away from the facility, a washdown system might prove effective. Limitations of this system when applied to land facilities are the requirements for adequate water supplies and pumping facilities. To be feasible, the area to be washed down must be as small as possible. The amount of fallout material removed will depend on the flow rates, slope of the roof and type of roof surface. It has been determined that nonwettable surfaces, even though smooth, are to be avoided and that very rough surfaces such as tar and gravel roofs are unsatisfactory. Smooth, hard, wettable surfaces with a minimum slope of one-half inch per foot are best suited for washdown systems. It is recommended that the water flow rate for initial coverage of a dry roof should be six gallons per minute per foot of roof width.

It should be remembered that the washdown system has no effect on radiation from material in the air above the structure. Also, some exposure will occur from removal material while it is in the process of being washed from the roof. However, a properly designed washdown system may be expected to remove at least 95 percent of the radioactive material that would otherwise have been deposited on the roof or surface. For critical facilities that do not have a sufficient water supply, provision should be made to drain the water into large tanks from which, after filtering, it can be reused.

REMEDIAL MOVEMENT OF PERSONNEL

The objective of remedial movement is to decrease, or keep to a minimum the direct harmful effects of radioactive fallout. This section provides general guidance for the remedial movement which may be required for various reasons. Potential radiation exposures might be reduced through movement (1) to an area that is not so highly contaminated and has equivalent shelter protection, (2) to another shelter affording greater protection, (3) to an area having no significant contamination, and (4) to another shelter because of an emergency situation such as fire, flooding of shelter, etc. The decision as to the use of remedial movement versus employment of other countermeasures is the responsibility of the local civil defense director, advised by his Radiological Defense Officer and other staff members, including the Medical Officer, welfare and transportation officials.

Remedial movement will generally involve transport through contaminated areas in vehicles providing little protection. Therefore, the resulting radiation exposure may be greater than would result from remaining in the existing shelter and taking other countermeasures. Detailed calculations must be made by the radiological defense staff to see which is more feasible.

Remedial movement to another area not only will take people from their homes or community shelters in which they have a relative degree of comfort and sense of security, but it will require mass transportation across fallout areas, the establishment of reception and care centers, and the subsequent transportation of food and other required survival items.

Various types of shelter regimentation should be considered as alternatives to remedial movement. However, (1) remedial movement may be the only solution if relatively poor fallout protection (such as the first floor of a home) is all that is available in much of a community, or (2) in heavily contaminated areas where radiation exposures following the maximum practical shelter occupancy could not be tolerated.

DECONTAMINATION

The objective of radiological decontamination is to reduce the contamination to an acceptable level with the least possible expenditure of labor and materials, and with radiation exposure to decontamination personnel held to a minimum commensurate with the urgency of the task. In general, the principles of radiological decontamination are: (1) radioactivity cannot be destroyed, (2) the surface dictates the method to be used, (3) proceed from the easy to the most difficult method, and (4) monitor frequently for effectiveness. Decontamination is one of the countermeasures which are available for reducing the radiation dose that would be received from fallout.

This section is directed to those persons who are responsible for planning and establishing radiological decontamination operations in State and localities. It contains guidance on the various types of decontamination procedures and the relative effectiveness of each.

DECONTAMINATION OF PERSONNEL AND CLOTHING

State and local public welfare departments and agencies, as the welfare arms of their respective governments, have primary responsibility for planning and preparing the facilities and developing capabilities essential to provide emergency welfare at the local level. Voluntary social welfare agencies will assist. Welfare personnel, assisted by radiological defense personnel, would be responsible for decontamination of personnel and their clothing in case of remedial movement of shelterees.

Decontamination of personnel (engaged in recovery operations) and their clothing would be the responsibility of the various operational services, such as fire departments, police departments, and decontamination teams. Many persons would be responsible for decontamination of themselves and their families in accordance with instructions of the local government.

Personnel.-- It is important that all people, and particularly those directing emergency operations, understand that the total radiation injury from fallout is a composite due to several causes, including contamination of the surrounding areas, contamination of skin areas, and ingestion and inhalation of fallout materials. To keep the total radiation injury low, the effect of each potential source of radiation on the total radiation exposure must be kept in mind, and each contributing element should be kept as low as operationally feasible. Normally, ordinary personal cleanliness procedures will suffice for personnel decontamination in the postattack period.

All personnel entering shelter after fallout starts should be monitored to determine if they are contaminated. Personnel monitoring may be impracticable in some shelters because (1) radiation levels or contamination levels inside the shelter may be too high, or (2) the influx of persons into the shelter may be too large to permit the monitoring of each person. In the event of high radiation or contamination levels, delay monitoring until it can be performed in accordance with procedures outlined in Chapter IX. In the event of a large influx of persons into the shelter, periodically monitor a person selected at random to determine the extent of personal contamination. If practical, segregate groups suspected of heavy contamination until each individual can be monitored.

Upon arriving at the shelter location after fallout starts the personnel should decontaminate themselves as follows:

1. When clothing is dry, personnel contaminated should remove hats and outer garments, shake or brush them vigorously, stamp feet to dislodge loose materials from the shoes, and then put on the outer garments again. This procedure should be carried out away from the monitoring location. Ordinarily, brushing will remove most of the contaminated material from the shoes and clothing, and often may reduce the contamination to, or below the permissible level. It is important to brush or shake from the upwind side of the contaminated item. Under rainy conditions the outer clothing should be removed before entering the sheltered area.
2. After monitoring within the shelter, if it is determined contamination levels of the outer clothing require additional decontamination, the outer clothing should be removed and stored in an isolated location within the structure, but outside the shelter area. Contaminated wet clothing should be stored similarly.
3. Wash, brush, or wipe thoroughly, exposed portions of the body, such as the skin and hair, being careful not to injure the skin. If sufficient quantities of water are available persons should bathe, giving particular attention to skin areas that had not been covered by clothing.

<u>The Injured</u>. It is desirable that contamination of medical facilities and personnel be kept at a minimum. Medical personnel, whose skills would be needed for the saving of lives, should be protected from radiation to the extent feasible. Persons entering a medical treatment station or hospital should be monitored, decontaminated if necessary, and tagged to show that they are not contaminated. To do this, a checkpoint could be established at a shielded location at each medical treatment station and hospital. Although decontamination procedures for the injured are the same as those previously described for personnel decontamination (i.e., the removal of outer clothing, and other clothing if necessary, and finally the washing of contaminated body areas, if required) special factors also must be considered. In the face of extreme urgency for rapid decontamination, there will be many casualties who are unable to decontaminate themselves and whose condition will not permit movement. For some cases a medical examination will determine that first aid must take priority over decontamination. Also, it may not be possible to decontaminate some casualties without seriously aggravating their injuries. These will have to be segregated in a controlled area of the treatment facility.

Clothing. Thorough decontamination of clothing can be deferred until after the emergency shelter period when supplies of water and equipment are available. Equipment for decontamination of clothing includes whisk brooms, or similar types of brushes, vacuum cleaners (if available), and laundry equipment. For more effective decontamination of clothing, washer and dryer equipment should be available since there is normally little accumulation of "dirt" in a washing machine, and virtually all of the contaminant would be flushed down the drain. The chance of significant residual contamination of the washing machine appears to be quite small. Although there is little serious danger involved in washing, direct contact with the contamination should be kept to a minimum.

The procedures for decontamination of clothing should be as follows: First, brush or shake the clothing outdoors; second, vacuum clean; third, wash; and fourth, if the previous procedures are not effective, allow natural radiation decay. Monitoring of the clothing upon completion of each step will indicate the effectiveness of the decontamination procedure and indicate any need for further decontamination. In many cases, depending upon the amount and kind of radioactive contaminant, brushing or simply shaking the clothing to remove the dust particles may reduce the contamination to a negligible amount. If two thorough brushings do not reduce the contamination to an acceptable level, vacuum cleaning should be attempted. Care should be taken in disposing of the contaminated material from the dust bag of the vacuum cleaner. If the clothing is still contaminated after dry methods of decontamination are completed, it should be laundered. Clothing usually can be decontaminated satisfactorily by washing with soap or detergent.

Any clothing that still remains highly contaminated should then be stored to allow the radioactivity to decay. Storage should be in an isolated location so that the contaminated clothing will not endanger personnel.

DECONTAMINATION OF FOOD, AGRICULTURAL LAND, AND WATER

State and local public agencies, assisted by radiological defense personnel, will be responsible for the decontamination of food and water. Stored foods in warehouses, markets, etc., will be the responsibility of the agency controlling the distribution of the food items. Water supply personnel of the local government or private organizations will be responsible for monitoring, and if required, decontamination of the water supplies they operate. Each person or family not expecting to be protected in a public shelter, is responsible for providing, before attack, sufficient food and water to supply its needs for at least two weeks, since outside assistance may not be available during this period.

Food. The following guidance is provided for individuals and groups who need to use food which may have been contaminated with fallout. Before opening a food package, the package should be wiped or washed if contamination is suspected. Caution should be taken when wiping or washing outer containers to avoid contaminating the food itself. When possible, the package surface should be monitored with a radiation detection instrument before removing the food as a check on the effectiveness of the decontamination procedure.

Meats and dairy products that are wrapped or are kept within closed showcases or refrigerators should be free from contamination. Fallout on unpackaged meat and other food items could present a difficult salvage problem. Fresh meat could be decontaminated by trimming the outer layers with a sharp knife. The knife should be wiped or washed frequently to prevent contaminating the incised surfaces.

Fruits and vegetables, harvested from fallout zones in the first month postattack, may require decontamination before they can be used for food. Decontaminate fruits and vegetables by washing the exposed parts thoroughly to remove fallout particles, and if necessary, peeling, paring or removing the outer layer in such a way as to avoid contamination of the inner parts. It should be possible to decontaminate some fruits, such as apples, peaches, and pears; and vegetables, such as carrots, squash, and potatoes, by washing and/or paring. This type of decontamination can be applied to many food items.

Animals should be put under cover before fallout arrives and should not be fed contaminated food and water if uncontaminated food and water are available. If the animals are suspected of being externally contaminated they should be washed thoroughly before being processed into food.

Even when animals have received sufficient radiation to cause later sickness or death, there will be a short period (one to ten days following exposure, depending on the dose) when the animals may not show any symptoms of injury or other effects of radiation. If the animals are needed for food, if they can be slaughtered during this time without undue radiation exposure to the worker, and if no other disease or abnormality would cause unwholesomeness, the meat would be safe for use as food. In the butchering process, care should be taken to avoid contamination of the meat, and to protect personnel. The contaminated parts should be disposed of in a posted location and in such a manner as to present a negligible radiological or sanitation hazard. If any animal shows signs of radiation sickness, it should not be slaughtered for food purposes until it is fully recovered. This may take several weeks or months. Animals, showing signs of radiation sickness (loss of appetite, lack of vitality, watery eyes, staggering or poor balance) should be separated from the herd because they are subject to bacterial infection and may not have the recuperative powers necessary to repel diseases. They could infect other animals of the herd.

Agricultural Land. The uptake of radioactive fallout material would be a relatively long term process and the migration of fission products through the soil would be relatively slow. Therefore, crops about to be harvested at the time fallout occurs would not have absorbed great amounts of radioactive material from the soil. However, if crops are in the early stages of growth in an intense fallout area, they will absorb radioactive materials through their leaves or roots and become contaminated. Thus, if eaten by livestock or man, it may cause some internal hazard. Before use, the degree of contamination should be evaluated by a qualified person. Foods so contaminated could not be decontaminated easily because the contaminants would be incorporated into their cellular structure. These contaminated foods should not be destroyed, however, since they may later be needed for human or animal consumption.

Liming of acid soil will reduce the uptake of strontium since the plant system has a preference for calcium over strontium and has some ability to discriminate. The plant's need for calcium leads to the absorption of the similar element, strontium. In soils low in exchangeable calcium, more strontium will be taken up by the plant. By liming acid soils, more calcium is made available to the plant and less strontium will be absorbed.

Another method to limit the uptake of strontium is to grow crops with low calcium content, such as potatoes, cereal, apples, tomatoes, peppers, sweet corn, squash, cucumbers, etc., on areas of heavy fallout. Other foods with high calcium content, such as lettuce, cabbage, kale, broccoli, spinach, celery, collards, etc., should be grown in areas of relatively light fallout.

Water. Following a nuclear attack, water in streams, lakes and uncovered reservoirs might be contaminated by radioactive fallout. However, about 90 percent of the fallout activity is insoluble and will settle to the bed of the stream, lake, etc. Fallout contamination in running streams would pose only a temporary problem since the streams tend to cleanse themselves. Fallout in large bodies of water, such as the Great Lakes, would be diluted to virtually trace amounts by the tremendous volumes of water involved and the settling of the fallout material.

Decontamination of Water by Municipal Water Treatment Plants. Normal community water treatment processes may be employed to decontaminate water contaminated with radioactive fallout. The degree of removal will depend upon the nature of the contaminant (suspended or dissolved) and upon the specific kind of atomic or radionuclide content of the fallout. The range of expected removals by municipal water treatment processes is presented in Table 1. These values, in Table 1, are based on reactor produced fission products, but are given for general guidance on expected removals of mixed fission products from fallout.

Radioactive materials absorbed in precipitates or sludges from water treatment plants must be disposed of in a safe manner. Storage in low areas or pits, or burial in areas where there is little likelihood of contaminating underground water supplies, is recommended.

TABLE 1.—*Expected removals of fallout by municipal water treatment processes*

Treatment Process	Amount of Contaminant Removed (Percent)	Remarks
1. Settling	10–90	Over 24-hour period dependent on particle size.
2. Coagulation and Settling	50–95	Higher coagulant doses will increase the percentage of removal. Also dependent on particle size.
3. Coagulation, Settling and Filtration	Up to 98	Depending on chemical characteristics. Will remove insoluble particles and some dissolved contaminants.
4. Clay Slurry plus Coagulation, Settling and Filtration	80–98	1000 ppm of clay (effective for cesium removal.)
5. Lime-Soda Ash Softening	85–98	High doses of chemical effective for strontium removal. (Some limitations.)
6. Clay Slurry plus Settling	80–90+	Dosage of 1000 ppm and settling.

Other Water Treatment Facilities. Other water treatment facilities might be available for the treatment of the long-term water requirements. Water treatment processes may be available at local industries, particularly beverage and milk bottling plants, or from private supplies such as country clubs and large hotels or motels. Expected removals of other treatment facilities are presented in Table 2.

TABLE 2.—*Expected removals of fallout contaminants by other treatment methods*

Treatment Process	Amount of Contaminant Removed (Percent)	Remarks
1. Slurrying with Ion Exchange Resins (Cationic)	Up to 99	Function of resin dosage. Very effective on ionic (dissolved) contaminants.
2. Coagulation, Settling	99+	Mixed bed ion exchange resins.
3. Distillation	99+	

Small Scale Emergency-Type Water Treatment Units. Several devices for treating relatively small quantities of water under emergency conditions have been tested. Most of them use ion exchange or absorption for removal of radioactive contaminants.

1. Small commercial ion exchange units containing either single or mixed-bed resins, designed to produce softened or demineralized water, could be used to remove radioactive particles from water. Many of them have an indicator which changes the color of the resins to indicate the depletion of the resins' capacity. Tests of these units have indicated removals of over 97 percent of all radioactive materials.
2. Emergency water treatment units, consisting of a column or flower pot, containing (1) a screen to cover the bottom of the pot or column with two or three sheets of paper tissue or cloth over the screen, (2) two or three inches of subsoil, humus, and clay, and (3) an additional two to three inches of small rocks on top have been tested for removal of radioactive materials from water. This type of emergency water treatment unit will remove over 90 percent of all radioactive materials.
3. Although tank-type home water softeners are usually found in areas supplied by well water which would not require decontamination, they are capable of removing up to 99 percent of all radioactive materials, and are especially effective in the removal of Strontium 90 and Cesium 137.

DECONTAMINATION OF VEHICLES AND EQUIPMENT

Decontamination of vehicles and equipment of the various operational services, such as fire departments, police departments, and decontamination teams, will be the responsibility of the various services, aided by radiological defense services. Individuals will be responsible for decontamination of their own vehicles and equipment in accordance with instructions of local government.

Vehicles and Equipment. Vehicles leaving contaminated areas might carry contamination to other areas. If survey instruments indicate heavy contamination on vehicles or equipment they should be decontaminated. However, in some operational situations, detailed monitoring and organized decontamination of all contaminated vehicles and equipment may be virtually impossible.

Inquiry as to routes traveled by the vehicles, with spot check monitoring (1 vehicle in 25, for example) will determine the relative need for decontamination. Vehicles needing decontamination should be distinctly marked and allowed to proceed to the nearest decontamination point, be sent to an isolated area for decontamination at a later time, or be left in an isolated area to take advantage of natural radioactive decay.

The simplest and most obvious method for partial decontamination of vehicles and equipment is by water hosing. Quick car washing facilities are excellent for more thorough decontamination. Special precautions should be used when vehicles and equipment are brought in for maintenance. The malfunctioning part of the vehicle or equipment should be thoroughly decontaminated to protect maintenance personnel from radiation burns.

Hosing should not be used on upholstery or other porous surfaces on the interior of vehicles, as the water would penetrate and carry the contamination deeper into the material. The interior of vehicles can be decontaminated by brushing or vacuum cleaning. Procedures for decontaminating interiors of vehicles by vacuum cleaning are similar to those used on the interior of structures.

Vehicles and Equipment Used by Decontamination Personnel. Upon completion of missions in a contaminated area, vehicles and equipment used by decontamination personnel should be monitored and decontaminated, if necessary. Complete decontamination may not be necessary, but attempts should be made to reduce the hazard to tolerable levels.

A decontamination station setup at a control point adjacent to the staging area would be the best place for decontaminating vehicles and equipment. A paved area would be desirable so that it could be hosed off after the equipment is decontaminated. Monitoring should follow the application of each decontamination method.

DECONTAMINATION OF VITAL AREAS AND STRUCTURES

The operational planning aspects of decontamination of vital areas and structures are very complex and require trained decontamination teams from government services, industry, and private and public utilities under the direction of a specialist in decontamination. All methods described in this section are common techniques with which personnel of the emergency services are generally familiar. Operational details associated with use of the equipment are not discussed. However, operational aspects peculiar to radiological recovery are emphasized. Monitoring of areas and structures should be carried out in accordance with the instructions in Chapter IX. The method of decontamination selected will depend upon the type and extent of contamination, type of surface contaminated, the weather, and the availability of personnel, material, and equipment. Each type of surface presents an individual problem and may require a different method of decontamination. The type of equipment and skills required for radiological decontamination are not new. Ordinary equipment now available, such as water hoses, street sweepers, and bulldozers, and the skills normally used in operating the equipment are the basic requirements for radiological decontamination.

Paved Areas and Exterior of Structures. Decontamination of paved areas and the exterior surface of structures requires two principal actions: (1) loosening the fallout material from the surface, and (2) removing the material from the surface to a place of disposal. Some decontamination methods for paved areas are street sweeping and motorized flushing. Firehosing may be used for both paved areas and the exterior of structures.

Street sweeping is termed a dry decontamination method because water is not used. There are many advantages of this method over wet methods. In the absence of adequate water supplies for large scale decontamination procedures, dry street sweeping would be the preferred procedure. Also, during cold weather, wet decontamination procedures may not be practicable.

Most commercial street sweepers have similar operating characteristics. A powered rotary broom is used to dislodge the debris from streets into a conveyor system which transports it to a hopper. Thus, a removal and bulk transport system is inherent in the design. Some sweepers utilize a fine water spray to dampen the surface ahead of the pickup broom to limit dust generation. This use of a spray would reduce the effectiveness of the procedure for decontamination because the combination would tend to produce a slurry which would make complete removal of surface contamination more difficult.

A recent development in equipment of this type is the sweeper in which the broom system is enclosed in a vacuum equipped housing. The material picked up by the broom and the dust trapped by the filters are collected in a hopper.

Normally, a single operator is required per street sweeper. However, because fallout material would be concentrated in the hopper, the operator may be subjected to a high radiation dose. This may make it necessary to rotate personnel for street sweeping operations. As precautions to keep his accumulated radiation dosage low, the operator should be instructed to keep a close check on his dosimeter, and dump the hopper often at the predesignated disposal area. In decontaminating paved areas by street sweeping, decontamination factors better than 0.1 can be realized, depending upon the rate of operation and the amount of fallout material. For decontamination of vital areas and structures, the term decontamination factor (DF) is used. This represents the decimal fraction remaining after decontamination is accomplished. This is used for ease of computations.

The flushing or sweeping action of water is employed in decontaminating paved areas by motorized flushing. Conventional street flushers using two forward nozzles and one side nozzle under a pressure of 55 pounds per square inch (psi) are satisfactory for this purpose. In flushing paved areas it is important that fallout material be moved toward drainage facilities. Decontamination factors of 0.06 to 0.01 can be realized by motorized flushing, depending upon the rate of operation and the type and roughness of the surface.

The flushing or sweeping action of water also is used in decontaminating paved areas and the exterior of structures by firehosing. Equipment and personnel are commonly available for this method. Employment of the method is dependent upon an adequate postattack water supply. When decontaminating paved areas and structures it is important that fallout material be swept towards predesignated drainage facilities and, where possible, downwind from operational personnel.

Standard firefighting equipment and trucks equipped with pumping apparatus may be used in this decontamination method. The most satisfactory operating distance from nozzle to the point of impact of the water stream with open pavements is 15 to 20 feet. On vertical surfaces, the water should be directed to strike the surface at an angle of 30° to 45°. As many as three men per nozzle may be required for firehosing.

When decontaminating rough and porous surfaces, or when fallout material is wet due to a detonation on or under water, the use of both firehosing and scrubbing are recommended for effective reduction of the radiation hazard.

Initial firehosing should be done rapidly to remove the bulk of fallout material. Hosing followed by scrubbing would remove most of the remaining contamination. Two additional men per hose may be required for the scrubbing operation. Decontamination factors between 0.6 and 0.01 can be realized by firehosing tar and gravel roofs with very little slope, and 0.09 to 0.04 in decontaminating composition shingle roofs that slope 1 foot in every 2-1/2 feet. Decontamination factors of 0.06 can be realized in firehosing of pavements.

Unpaved Land Areas. Decontamination of unpaved land areas can be accomplished by removing the top layer of soil, covering the area with uncontaminated soil, or by turning the contaminated surface into the soil by plowing. The two latter methods employ soil as a shielding material.

The effectiveness of any of the methods is dependent on the thoroughness with which they are carried out. Spills or misses and failure to overlap adjoining passes should be avoided. Reliance should be placed on radiation detection instruments to find such areas, although in heavily contaminated areas the fallout material may be visible. Large spills or misses should be decontaminated with the use of shovels, front-end loaders and dump trucks.

Large scale scraping operations require heavy motorized equipment to scrape off the top layer (several inches) of contaminated soil, and carrying the soil to suitable predesignated dumping grounds. The contaminated soil should be deposited 100 or more feet beyond the scraped area, if possible; if not, at least to the outer edge of the scraped area. Scraping can be done with a motorized scraper, motor grader, or bulldozer. Effectiveness of the procedure depends upon the surface conditions. In decontaminating unpaved areas by scraping, decontamination factors over 0.04 can be realized if all spills and misses are cleaned up.

The motor grader is designed for grading operations, such as for spreading soil or for light stripping. This grader can be used effectively on any long narrow area where contaminated soil can be dumped along the edge of the cleared area. The blade should be set at an angle sufficient for removing several inches of the contaminated soil. The scraped up earth should be piled along the ground in a windrow parallel to the line of motion. The windrow can be either pushed to the side of the contaminated field and buried by the grader or removed by other pieces of earthmoving equipment.

The bulldozer can be useful in scraping small contaminated areas, burying material, digging sumps for contaminated drainage, and in backfilling sumps. It would be particularly suitable in rough terrain where it could be used to clear obstructions and as a prime mover to assist in motorized scraping. The contaminated soil stripped off by a bulldozer should be deposited at the outer edge of the scraped area, or beyond, if practicable.

Filling may offer no advantage over scraping, either in effectiveness or speed. Its principle use would be where scraping procedures could not be used, either because of rocky ground or because of permanent obstructions. Filling can be used in combination with other methods to achieve a low decontamination factor. The object of filling is to cover the contaminated area with uncontaminated soil or fill material to provide shielding. For these operations a motorized scraper, bulldozer, mechanical shovel, or dump truck and grader may be used. The effectiveness of filling relatively flat surfaces will vary with the depth of fill. A 6-inch fill of earth can reduce the radiological hazard directly above to a decontamination factor of 0.15, and a 12-inch fill can reduce the hazard to a decontamination factor of 0.02.

Plowing provides earth shielding from radiation by turning the contaminated soil under. It is a rapid means of decontamination, but may not be suitable in areas in which personnel must operate or travel over the plowed surface. The depth of plowing should be from 8 to 10 inches. In decontaminating unpaved land areas by plowing, decontamination factors of 0.2 can be realized if the depth of plowing is from 8 to 10 inches.

Two or more methods can be applied in succession, achieving a reduction in the radiation field not possible, practical, or economical with one method alone. Any of three combinations of methods--scraping and filling, scraping and plowing, or plowing, leveling and filling--could be effective in unpaved areas. In some cases, any of the three might be more rapid than individual removal of spillage. The equipment used would be the same as in component methods previously discussed.

Because large earthmoving equipment could not be used in small areas, such as those around a building, other methods of decontamination must be used. If the area is large enough for a small garden type tractor, or front-end loader, these can be used for plowing and scraping the soil. Improvised methods of scraping small areas, such as using a jeep to tow a manually operated bucket scoop, could be used. There would remain some areas requiring hand labor with shovels to dig up or remove the top layer of soil or sod. Equipment and manpower requirements for loading and hauling the soil to a disposal area should be included in estimates of decontamination "costs." The rates of operation of these methods would vary with the type of terrain and its vegetative cover. The various procedures can result in decontamination factors of 0.15 to 0.1.

Interior of Structures. The two principal methods for decontaminating interiors of structures are vacuum cleaning and scrubbing with soap and water. Vacuum cleaning is useful for the decontamination of furniture, rugs, and floors. Floors, tables, walls, and other surfaces can be decontaminated by scrubbing them with soap and water. Mild detergents can be substituted for soap. Rags, hand brushes (or power driven rotary brushes, if available), mops, and brooms are suitable for scrubbing.

Cold Weather Decontamination Procedures. Cold weather decontamination methods will depend upon the weather conditions prior to and after the arrival of fallout. Various problems, such as fallout on various depths of snow, on frozen ground mixed with snow or freezing rain on pavements and under various depths of snow could occur. The presence of snow or ice would complicate the situation since large quantities of these materials would have to be moved along with the fallout material. In addition, snow and ice could cause loss of mobility to men and to equipment. Fallout may be clearly visible as a dark film or layer of soil or powder on or within snow unless it precipitates with the snow.

The principal cold weather decontamination methods are: (1) snow loading, (2) sweeping, (3) snowplowing, and (4) firehosing.

Snow loading is accomplished with a front-end loader and is applicable for snow covers. When fallout is on snow, the front-end loader bucket is used to scoop up the contaminant and top layer of snow, which are forced into the bucket by the forward motion of the vehicle. The snow cover should be observed closely for pieces of contaminated debris which may have penetrated to some depth. The loader carries the contaminated material to a dump truck which removes it to a dumping area. The remaining clean snow is removed by normal snow-removal procedures and can be used for shielding purposes. Decontamination factors of approximately 0.10 can be realized by this process, depending mainly on the amount of spillage.

Pavement sweepers can remove fallout from dry pavement, traffic-packed snow, or reasonably level frozen soil or ice. Pavement sweepers are more effective than firehosing where there is a drainage problem, or when temperatures are below -10°F. Sweepers will not effectively pick up contaminants on wet pavement above the freezing or slush point on ice or packed snow. Decontamination factors are approximately 0.10.

Snowplowing is applicable for all depths of contaminated snow. When fallout is precipitated with snow, all of the snow must be removed to the dumping area. Blade snowplows, road graders, or bulldozers in echelon, windrow the contaminated snow to one side until the blades are stalled by the snow mass. A snow loader can be used to put the contaminated snow in dump trucks, which move it to the dumping area. Decontamination factors of 0.15 can be realized by this method.

Firehosing is possible and can be used on paved areas and exteriors of structures slightly below freezing temperatures. Firehosing is not recommended where slush from snow will clog drains. Problems associated with firehosing below 32°F are freezing of the water, thereby sealing the contaminant in ice and causing slippery conditions for the operating personnel. The principle of operation, and equipment used in temperate weather will be the same under cold weather conditions. The effectiveness of firehosing will depend on surface and dose rates, and the decontamination factors will vary from 0.5 to 0.1.

In small areas, such as roofs of buildings, and around buildings, where large snow removal equipment could not be used, other methods of decontamination must be used. With small amounts of dry snow on roofs or paved areas, sweeping the area with brooms is satisfactory. With larger amounts of snow, with the fallout material on top of the snow, or mixed with the snow, shoveling the snow and removing it to an area where large snow removal equipment can be used is practicable. The rates of operation of these methods would vary with the amount of snow to be removed and the type of surface to be decontaminated. These various procedures can result in decontamination factors of 0.15 to 0.1.

In order to locate needed services and to guide the movement of decontamination equipment through heavy snow covers, colored poles should mark street corners, drains, hydrants, and hidden obstacles. Open ground areas planned for postattack use should be cleared of rocks stumps, etc., prior to the arrival of snow.

Small Scale Decontamination Methods. Table 3 lists other decontamination methods that may be used on a small scale for specific areas of high contamination. These methods probably would not be used until the final recovery phase.

Table 3—*Small scale decontamination methods*

Agent	Type of Surface	Situations
Steam.	Painted or oiled, non-porous.	Equipment.
Detergents.	Non-porous (metal, paint, plastics, etc.). Industrial films, oils and greases.	Surface covered with grease. Fixed or movable items.
Complexing agents.	Metal or painted.	Surfaces where corrosion is not desired.
Organic solvents.*	Painted or greased.	Final cleaning. Where complete immersion dipping operations are possible. Movable items.
Inorganic acid.*	Metal or painted, especially those exhibiting porous deposits, such as rust, marine growth.	Dipping of movable items.
Caustics.*	Painted.	Dipping of painted objects.

* Unusual hazards are associated with these methods, and special precautions or protective equipment are required.

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