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PRACTICE GUIDE FOR DECONTAMINATING AIRCRAFT

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SUBJECT: PRACTICE GUIDE FOR DECONTAMINATING AIRCRAFT

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1. PURPOSE.

This publication is a guide to be used by groups or emergency readiness teams in the civil aviation industry for organizing and conducting practice exercises in aircraft decontamination.

2. REFERENCE.

It is recommended that this guide be used in conjunction with the FAA publication, "Radiological Protection and Decontamination of Civil Aircraft," Flight Standards Service (November 1962), for sale by Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402 (price $.65). This publication offers additional information to be used under actual conditions.

3. HOW TO OBTAIN ADDITIONAL COPIES.

Additional copies of this guide can be obtained free of charge by requesting AC 20-48 from:

Federal Aviation Agency
Printing Branch, HQ-438
Washington, D.C. 20553

4. BACKGROUND.

The information in this publication is the result of extensive testing in actual aircraft decontamination exercise operations to determine practical methods and procedures. During the tests, inadequate techniques were eliminated and only the effective and practical exercise procedures were selected for inclusion. The contents of this guide originated in the FAA Central Region Defense Readiness Office and were reviewed by the Atomic Energy Commission for technical and procedural accuracy.

5. USE OF PUBLICATION.

While it is impossible to write a set of procedures that will suit all emergency conditions, this guide includes the fundamental processes for the decontamination of aircraft exposed to radiation (fallout). It is recommended that the basic principles be mastered before attempting advanced and complex situations. Every effort was made to keep the procedures simple, yet practical and effective. The procedures contained in this publication may require modification in the case of actual fallout, since specific procedures would not be suited to all situations. An active and interested recovery team should be able to complete a successful exercise by following the steps outlined in Chapters 1 and 2. These chapters are to be used by the team group leaders as a checklist to avoid omissions or inappropriate sequence of operations. Chapter 3 offers suggestions for guiding the team in evaluating a completed practice exercise. Test exercises revealed that working practice groups who conducted three or four of these exercises became adept in detecting their errors and were capable of making the necessary corrections to improve their methods or techniques for future actions. Appendix I provides information on the working equipment required and suggests methods for substitutions if necessary.

6. EXPERIENCE.

While it is desirable for all participants in one of these exercises to have some prior basic training in radiation, this cannot be expected in all cases. However, since the more technical aspects of the work involve a knowledge of radiation, the use of radiation instruments, calculating dosages, stay times, etc., it will be necessary to have at least one person in the group qualified to direct the monitoring operations. If such a person is not available within the group, he may be recruited elsewhere. There are qualified people in each agency listed in Appendix I as sources where radiation detection instruments may be borrowed. Your local Civil Defense Director will be able to recommend a qualified person, either to act as your monitoring team leader, or to instruct your own team leader sufficiently to qualify him for the job.

7. PARTICIPANTS.

This manual is prepared primarily for general aviation personnel; however, it may be of use to other groups, such as the civil air carriers, in developing their own techniques and methods for decontamination of large aircraft. Both men and women are encouraged to participate — pilots, mechanics, clerks, airport employees, etc., organized groups such as CAP Squadrons, local flying clubs, flying farmer units, fixed-base operators, and maintenance and repair stations. In fact, any group or organization operating an aircraft should complete this training.

8. PROFICIENCY

Decontamination work is comparatively new at this time and very few people have acquired proficiency; however, it can be self-taught. It is assumed that you will make mistakes during the initial exercises, but this is normal. You will learn by doing. A lively, serious "critique" period after each exercise is the key to improvement in each successive exercise. SPEED IS NOT IMPORTANT during training exercises in learning decontamination work. Your PRIMARY concern is (a) to learn how to do the job with a MINIMUM EXPOSURE of personnel to radiation, and (b) to remove as much of the contamination matter as possible from the aircraft. In fact, most errors are the result of trying to hurry through these procedures. The instructions in the following chapters will be most helpful in performing your practice exercise if taken in the order or sequence given.

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Director
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ACKNOWLEDGEMENT

We wish to thank the many people who so willingly gave their time and energy to the work of field testing the procedures necessary for the development of this guide. We are also grateful to numerous individuals whose advice and suggestions were most helpful.

Although space will not permit a complete list of the individuals involved, the following is a list of organizations which either participated as an entire unit or were represented by some of their members:

9502nd Air Force Reserve Recovery Squadron at Rockford, Illinois.
Rockford, Illinois, C.A.P.
Evanston, Illinois, Civil Defense Office.
Fort Sheridan, Illinois, Defense Readiness Staff.
9536th AFRR Squadron at Des Moines, Iowa.
9547th AFRR Squadron at St. Louis, Missouri.
Rockford, Illinois, Civil Defense Office.
Greater Rockford Airport Management and Staff.
Illinois Wing Headquarters, C.A.P.
Missouri Wing Headquarters, C.A.P.
Headquarters 8581st AFRR Group at Kansas City, Missouri.
9544th AFRR Squadron at Kansas City, Missouri.
9543rd AFRR Squadron at Kansas City, Missouri.
FAA Tower and FSS Personnel at Rockford, Illinois.

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Chapter i. HOW TO PLAN AND PREPARE AN EXERCISE

1. STARTING POINT. Enlist a group of 6 to 20 or more interested persons and have all participants read this guide. This can be done prior to or at the first meeting of the group.

2. MINIMUM ORGANIZATION.

a. The Group Leader (one) will direct the overall planning, preparation, execution, and final critique of the exercise. During the actual exercise, the group leader should locate his C.P. or command post (see area map on page 5) in a position where he can observe all of the activities. He will direct the team leaders to perform each step of the exercise at the appropriate time. The group leader will make the decisions for the group that cannot be determined by team leaders. He will work closely with his monitoring team leader, who will keep him advised of the radiation situation, enabling him to make command decisions involving the safety of personnel and the extent or degree of decontamination required. The group leader should have a positive knowledge of the basic problems created by the radiation hazard. If not, he must rely on his monitoring team leader for technical advice in all decision making.

b. The Monitoring Team Leader (one) will be responsible for obtaining and evaluating the radiation levels in the working area:

(1) He will instruct his team members in the techniques of their specific duties and keep the group leader and team leaders supplied with pertinent radiological information throughout the exercise;

(2) he will determine average levels of radiation for the working area and for aircraft to be decontaminated;

(3) he will also calculate the "stay times" for various crewmembers to avoid exposure beyond the allowable dose limits established for the exercise;

(4) he and his team members will act on orders from the group leader; and

(5) he will also be responsible for maintaining records of individual dosages for all members of the group.

c. The Decontamination Team Leader (one) will be responsible for decontamination operations on the aircraft, equipment, and personnel. He will instruct his team members in the techniques of their specific duties. He and his team will act on orders from the group leader and will be governed by information received from the monitoring team leader pertaining to "stay times" for his crewmembers.

d. The Security Team Leader (one) will be responsible for enforcing the use of the CONTROL POINT as the ONLY entrance and exit between the "hot" area and the "clean" area. His team will be on constant alert to prevent interference with the operations and to help enforce commands of the group and team leaders; he will also instruct his own team members in their specific duties.

e. Assign Remaining Members of the group to one of the three teams.

3. EQUIPMENT. Review the equipment list in Appendix I and make assignments of specific equipment items for individual members to obtain for the group prior to the exercise.

4. CHOOSING AN AREA. Select a suitable area on the airport for decontamination work and consult with the airport manager to obtain his approval.

a. Good drainage is the most important factor to consider. Without satisfactory drainage, the contaminated runoff water must be collected, pumped into containers, and transported to an approved burial site, which is a tedious and difficult method of disposal. If the ground is unusually porous, a large amount of runoff water will seep down to lower levels where danger of harmful levels of radioactivity at the surface will be negligible. If sewer-type drains, built into a hard-surfaced area, will remove the contaminated water to a safe area (where persons will not be affected by the concentration of radioactive material), this method is ideal. If there is a collection or pool of contaminated water as a result of inefficient drainage, monitoring the pool will be necessary to determine if removal or a covering with several inches of earth is necessary.

b. The immediate area where the aircraft is to be decontaminated need be only slightly larger than the wing span or overall length of the aircraft. The IDEAL "washrack" area would be saucer-shaped, hard-surfaced, with a drain near the center, carrying all runoff water to a point some distance away, depositing the contamination three or more feet below the surface. (If you have any questions or doubts about your drainage area, it is suggested that you discuss this matter with your local Civil Defense Director.) A large tarpaulin can be laid on sloping ground in lieu of a hard-surfaced washrack. The runoff water can be directed from the lower edge of the tarpaulin into a drainage ditch or hole for burial purposes.

c. Criteria for a good decontamination site.

(1) Best possible drainage.

(2) Hard surface with drain or very porous soil.

(3) Close proximity to water supply.

(4) Isolated 500′ to 1,000′ from other airport activity.

(5) Sufficient space for all the working areas shown on the "Typical Area Sketch Map." (For practice purposes, the area might be located at any usable portion of the airport; however, the airport manager may prefer to start developing a permanent location for decontamination work and desire that the exercise be held at that preselected location.)

5. PLANNING AREA UTILIZATION. Draw a sketch map of the area selected showing the location of the washrack, hot and clean areas, etc. Using the sketch map on page 5 as a guide, prepare a sketch showing the general "layout" for your particular exercise area and reproduce it so that all members of the group will have a copy and become familiar with the plan before the exercise. The area plan should be oriented on the day of the exercise to accommodate the existing wind direction. The "clean" area should be upwind of the "hot" area so that any dust or contaminated water spray from the "hot" area will not be blown across the "clean" area.

6. SETTING UP A PROBLEM. Specific ground rules and limits must be established to perform the exercise both practically and effectively. Keep the practice problem simple. Use only one light aircraft. Assume the following conditions in your problem:

a. Assume the aircraft escaped blast and thermal damage but was covered with fallout where it was parked.

b. Assume the entire land area is contaminated; however, a few days after the fallout ceased, natural decay has reduced the level of radioactivity so that it is safe to begin recovery operations with limited "stay times."

c. Assume a decontaminated "clean" path has been prepared for personnel and vehicles extending from the shelter to, and including, the assembly area. Also assume that the entire "clean" area is decontaminated. This will provide working room. In a real situation, the decontamination process might have to begin at the exit of the shelter before any personnel or equipment proceeded to the decontamination site.

d. Assume a buffer zone is cleaned beyond the limits of the cleaned areas shown on your sketch map, making it safe to occupy all of the "clean" areas. For ALL exercises, use the following allowable limits:

(1) Maximum limit of dosage for any individual shall not exceed 14 mr. during one exercise, or in any one day, if more than one exercise is attempted the same day. (Normally only one exercise is held in any one day.) As an extra safety measure, this 14 mr. limitation is only 1/3 of the allowable dose for training purposes, Office of Civil Defense (OCD), Technical Bulletin 11-1. In actual emergencies, much higher exposures are likely to be required.

(2) After completing decontamination of an aircraft, at no point on the aircraft will a reading of more than 0.5 mr/hr. be acceptable. (Lower readings can be expected as a result of a thorough scrubdown.)

(3) Outer (protective) clothing should be decontaminated to a maximum permissible reading of 0.5 mr/hr.

(4) Parts of the body and any clothing worn under the protective clothing should not exceed 0.3 mr/hr. Respiratory protective devices should be cleaned to a maximum reading of 0.3 mr/hr. Remove the canister, before washing the respirator, to avoid damage to the filter element. (Do not let water enter the air intake end of the canister when washing, otherwise the full mask must be washed inside and out.)

(5) The monitoring team leader should prepare slips of paper on which the monitors will find figures representing four "assumed" levels of radiation — one for each of the four directions (North, South, East, and West) which they will face when taking area readings. The monitors will average these figures and enter the average for the quadrant on the monitoring report form used during the exercise. For example, the "hot" area can be roughly divided into four quadrants. The monitors will proceed to the center of each quadrant and enter the average of all four "assumed" levels of radioactivity in the appropriate place on the sketch map, thus simulating the taking of actual readings. (CAUTION: Monitoring of aircraft and all personnel returning from the "hot" area to the "clean" area must be done by instrument. Only the background levels should be simulated or assumed. If used, radioactive uranium-ore sand will register on the instruments when monitoring a contaminated aircraft or personnel who have been contaminated. DO NOT SIMULATE THE READINGS FOR EITHER THE AIRCRAFT OR PERSONNEL.[1]).

[1] In Chapter 2, Phase II, Paragraph 24, you are directed to multiply the actual aircraft readings by 200. This is an exercise procedure which is necessary in order to have a mathematical figure which is large enough so that you can subtract the assumed background radiation figure to obtain the aircraft level. It is suggested that the "hot" area background radiation level readings for the various quadrants be preset for the exercise somewhere in a 10–30 mr/hr. range.

7. SETTING EXERÇISE TIME AND DATE. Coordinate the selected exercise time and date with the airport manager, control tower, fire chief, and others as necessary.

8. PRE-EXERCISE TRAINING. The monitoring team leader, security team leader, and decontamination team leader should instruct their respective team members in their duties, and in the methods, techniques, and safety measures to be observed. Team leaders should meet with their team members (crews) before the exercise in a pre-exercise training session.

a. The Monitoring Team will be taught to read instruments, and the use of forms for recording their readings, and they should be given practice in wearing and adjusting protective clothing. The monitoring team leader should underscore all passages in this guide which apply to the monitors' specific duties and review this material with his crew.

b. The Decontamination Team leader will instruct his team in the techniques to be used, as described in this guide, the precautions to be taken to control the spread of contamination, and the proper use of protective clothing. He should underscore specific passages in the manual related to his team's duties and review the items with his crew.

c. The Security Team personnel must have a thorough understanding of the area sketch map and be aware of the seriousness of their responsibility for keeping all personnel from wandering aimlessly about the area or from using any crossing points other than the CONTROL POINT in traversing between the "hot" and "clean" areas. It should be stressed that security personnel may be of assistance to all participants by observing their movements and calling attention to actions which might either endanger the participants or create problems of cross-contamination.

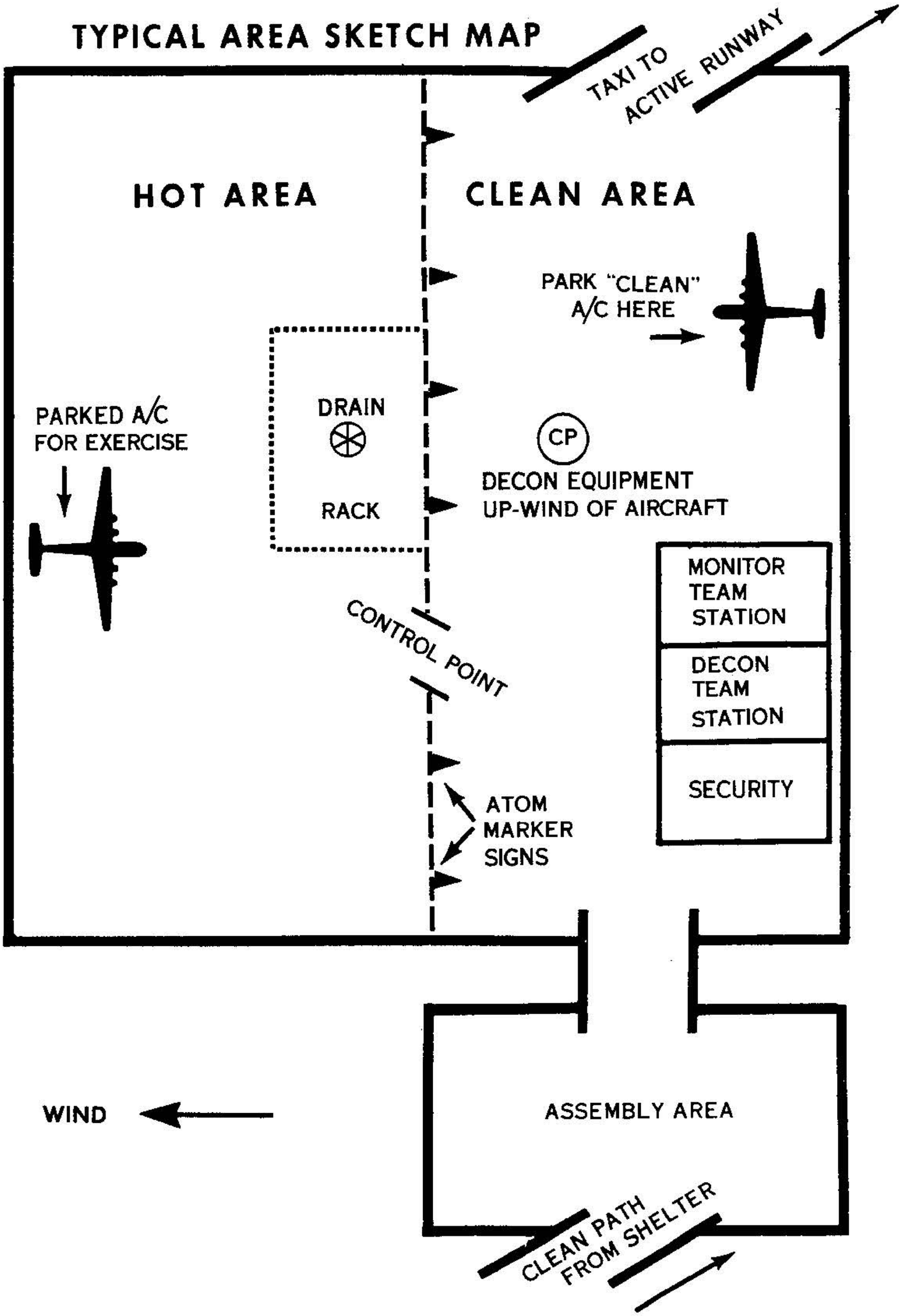
d. Members of ALL teams are to be taught radiological safety procedures. External radiation originates from a radioactive source outside the body. For example, gamma radiation from a piece of radioactive material outside the body is external radiation, since radiation passes from the material through the body. On the other hand, alpha particles do not penetrate the skin and, therefore, are not an external hazard. The danger from alpha particles occurs when they are ingested by breathing, eating, drinking, or if they enter through an open wound. External radiation can come from radioactive fallout or other radioactive materials. Protection against external radiation consists of one or a combination of three factors — TIME, DISTANCE, and SHIELDING.

(a) Time as a factor is easily understood. The dose received equals rate multiplied by time. Therefore, it is important that the time spent in a radiation area be kept to the minimum necessary to do the job. If the rate of radiation is 50 mr/hr., an exposure for one hour would give a person a dose of 50 mr. An exposure for ½ hour would give only a 25 mr. dose.

(b) Distance is often the best protection available. For example the radiation received 10 feet from a radioactive point source would be approximately 1/100th of the radiation received at a distance of one foot. This is one reason for recommending the use of a long-handled brush during scrubdown, so that the operator can stand as far as possible from the source of radioactivity.

(c) Shielding material must be dense to be effective for most external radiation. Concrete and heavy metals are very effective shields. If it is possible for the participant to carry on his work in a position where concrete, iron, steel, etc., are between his body and the source of radiation, this should be practiced. However, it may not be possible for the participant to remain completely shielded and also accomplish his objective. During rest periods, crewmembers should take advantage of the shielding afforded by a vehicle, such as a water-tank truck, as well as the protection of distance. Normally, the most readily available protection is a combination of time and distance. Personnel should stand as far from the source of radiation as possible and remain in the area the shortest time possible. All decontamination and monitoring personnel must enter and leave the contaminated area through a single CONTROL POINT in order to control the monitoring and to reduce cross-contamination. This point must be stressed.

TYPICAL AREA SKETCH MAP



Chapter II. HOW TO CONDUCT THE EXERCISE

Phase I

9. ASSEMBLY. All personnel and equipment should move into the "clean" assembly area via the previously decontaminated path leading from the shelter. Be certain that the group understands the problem and all assumed conditions of the exercise. Emphasize the locations of the stations, washrack, and outer limits of the area, etc. (It is advisable to place temporary stakes at the four corners of the area, and at station locations. If possible, the area should be roped-off to indicate boundaries.)

10. SECURITY PERSONNEL. Post security personnel around the assembly area to keep people inside the "clean" area.

11. EQUIPMENT. Check the equipment for adequacy and completeness.

12. CLOTHING. Issue personal protective clothing and equipment to monitors and decontamination team members; issue arm bands and dosimeters (if available) to all personnel.

13. FINAL BRIEFING. The entire group should be briefed by the group leader to explain, in sequence, the order of procedure for the exercise. This is an oral "dry run" of the exercise to let everyone visualize the process. It will help reduce possible confusion and error. Do not actually use any equipment during the dry run. The final briefing may also be used to clear up a variety of last minute items.

a. If the teams or any of their members have not practiced "dressing out" in their protective clothing, this practice should be part of the final briefing.

b. If any last minute changes in the orientation of the area are required due to wind shift, this is the time to do so.

c. Last minute individual assignments can be made or changed at this time.

d. Questions from the group should be encouraged, to be certain that every team member understands his assignment.

14. DRESS OUT. When decontaminating aircraft, team members must wear protective clothing, which they should now put on under supervision of their team leader. The object is to keep the contaminated water from soaking through to, or touching, the skin. Gamma rays cannot be prevented from penetrating the clothing (one reason for limiting "stay" or "exposure" times), but beta particles, which will cause severe burns, can be kept from reaching the skin by wearing the proper clothing. The inhalation of dust or contaminated water spray can be prevented by wearing a face mask. Water-repellent clothing permits washing off the particles which emit gamma rays, thus reducing the exposure of the person wearing the protective clothing. When "dressing out," observe these simple procedures:

a. Make all joints of two-piece protective clothing overlap from top to bottom.

b. Keep the head covering outside the jacket; the sleeves outside the glove cuff; and the trouser-leg bottom outside the boot top, so that water will run off rather than run down inside the clothing at the neck, wrists, or ankles.

c. The clothing should be closely taped at the juncture of the sleeves and rubber gloves, at the edges of the face mask, and at any points where water might splash or run inside.

d. Cover all buttons, seams, side vents, or small holes in clothing with masking tape.

e. Seal all locations with tape at points where dust or water spray could enter.

f. Leave a one-inch fold-over tab on the ends of the tape. (This makes it easier to remove the tape with the bulky protective gloves, which are the final items of protective clothing to be removed.)

15. TAKE STATIONS. All three teams should now move from the assembly area to their respective team stations. At the same time, move all decontamination equipment to the team stations. Team stations are located in the "clean" area because:

a. It provides team members with a protected area to which they can retreat when they are not working. (This gives them the added protection of the distance between the station and the source of radiation.)

b. All personnel should be exposed to radiation as little as possible and for the shortest possible period of time.

c. Once the exercise has started, strict enforcement of NO SMOKING, EATING, or DRINKING rules must be observed in the working areas, as well as in the team stations. (The ban can be lifted when personnel have been cleared AFTER their final monitoring.)

16. MONITOR "HOT" AREA. Two or more monitors will now make a survey of the "hot" area and record their "average" readings on their copies of the sketch map, indicating where the readings were taken. Monitors will return to the CONTROL POINT and give the maps to their team leaders.

a. The method for "area monitoring" differs somewhat from "equipment" and "personnel" monitoring. In area monitoring, readings are taken at a level 3 feet from the ground.

(1) The instrument or—if so equipped—the probe is held parellel to the ground with the shield open.

(2) The monitor proceeds to the center of a particular quadrant and takes four readings, facing the North, South, East, and West to take the separate readings, after which he averages them and records the average figure on the sketch map for that particular quadrant reading.

(3) Although monitoring is done as quickly as possible to avoid excessive exposure; in a real situation, much depends on the ACCURACY of these readings. Therefore, the monitors should take sufficient time to assure a steady needle reading or, if the needle refuses to stop oscillating, decide on the average needle reading and use that figure.

(4) Monitors should visually spot the approximate centers of the quadrants before leaving the CONTROL POINT so that they can walk unerringly to their check point. Aimless wandering in a radiation field should be avoided. This part of the exercise should emphasize practice in monitoring an area with minimum exposure of personnel.

b. After the "hot" area is monitored, the monitors return to the CONTROL POINT rather than to their respective stations. Because no decontamination equipment has yet been moved into the "hot" area, there is no way to wash down the monitors in the event their clothing has become heavily contaminated. If the "hot" area radiation level during an actual situation were high enough to necessitate the return of these men to their stations, all procedures would be delayed until a unit of decontamination equipment had been moved into the "hot" area so that these monitors could be rinsed off. In this type of situation, it is ideal to have a portable shower unit. However, the exercise can be accomplished without these facilities. If you are equipped to include personnel showering as part of your exercise, the following information will be helpful:

(1) A special area should be provided for personnel to remove contaminated clothing before entering the showers. (Ordinary metal trash cans with covers may be provided as clothing receptacles. Personnel without protective clothing should not be permitted within this contaminated area). The showers should be located in a buffer or transit zone between the contaminated and uncontaminated areas.

(2) Normally, the same procedures that remove ordinary dirt from the body will also remove radioactive contamination.

(3) Personnel should use an abundance of soap and water, thoroughly scrubbing the body, hair, hands, and fingernails.

(4) After the shower, personnel should be monitored and any residual contamination removed by spot-cleaning or further showering. (If a person has an injury or a wound, he should

make this fact known to medical personnel so that special medical precautions may be taken to prevent contamination of the wound during recovery operations.)

(5) Following the shower procedure, a "clean" area for dressing purposes should be specified. At no time should contaminated personnel or equipment be permitted in this area.

17. CALCULATE AREA RADIATION. The monitoring team leader calculates the average level-of-radiation for the entire "hot" area and dispatches monitors to install the atom-marker signs.

a. Calculate the Area Average by adding all the quadrant readings and dividing by the number of readings used. The result will give the average area level figure. This will be used as the background level for the "hot" area, including the washrack.

b. The Monitor Team Leader now calculates the "stay times" for the security team personnel and gives the stay-time figure to the security team leader. (Plan on posting security guards 3 feet inside the atom-marker line on the "clean" side.) The monitoring team leader must constantly be thinking of exposure time for all personnel. If in doubt, he should call for a reading of the dosimeters on the individuals in question and, if necessary, take time to recheck his "stay-time" figures. This is one reason for not rushing through the procedure. THE SAFETY OF ALL PERSONNEL DEPENDS TO A LARGE EXTENT ON THE CARE AND ACCURACY WITH WHICH BOTH EXPOSURE AND DOSAGE ARE KEPT UNDER CONTROL.

c. "Stay times" are calculated to determine the period that a person may remain in a given area at a given level-of-radiation without exceeding his allowable dose limit. The problem sets the dose limit at 14 mr. per person. To calculate the area "stay time" for the monitoring and security teams, divide the figure 14 by the area-average level. This will give the number of hours or fraction of an hour for "stay time." Usually, the area level figure will be greater than the dose limit figure 14. For example, if the average area level is 56 mr/hr. and dose limit is 14 mr., then 14 divided by 56 gives 0.25 hours. Thus the stay time would be ¼ hour or 15 minutes. By using the same figure and checking with dosimeter readings, it can be determined if those monitors who were used in monitoring the "hot" area in item 16 have consumed their allowable "stay time." If they have, other members of the monitoring team will be used to conduct further monitoring operations required in the steps to follow.

18. POST SECURITY. The security team leader now posts his personnel at the CONTROL POINT and along the atom-marker line. (It would be possible to operate a decontamination area without security personnel but this would require the gamble of self-discipline on the part of all concerned.) Security personnel should stay within the bounds of the "clean" area at all times and control traffic through the CONTROL POINT making sure that no person or equipment is permitted to leave the "hot" area without first being monitored. The posting of security personnel is done with the minimum number of guards possible. The reason for this is to conserve manpower and reduce the total exposure of security personnel. One or two security guards should be sufficient to handle the CONTROL POINT, and two or three security guards can be assigned to patrol the remainder of the atom-marker line. The functions of the security team leader are to provide maximum safety at all times by:

a. Using SECURITY PERSONNEL to prevent cross-contamination

b. Using an ALERT SECURITY TEAM to provide an additional check on all safety measures being used by monitors and decontamination team members; and

c. Using CAUTION in exposing oneself or others to unnecessary dosage.

19. MONITORS — CONTROL POINT. The monitors are sent to the CONTROL POINT to monitor all personnel and equipment returning to the "clean" area from the "hot" area. (When not needed at the CONTROL POINT, the monitoring team leader and his crew may withdraw to the team station to reduce their exposure.)

a. The monitors must know the techniques of monitoring both personnel and equipment:

(1) The monitors, with the backup of the security guard, must insist on monitoring anything or anybody moving through the CONTROL POINT from the "hot" area to the "clean" area.

(2) The monitoring team leader, not the monitors, are to make the decisions in the requirement for the decontamination of equipment and personnel before they are cleared into the "clean" area.

(3) The monitors call out their readings to their team leader when monitoring at the CONTROL POINT.

(4) Other readings, such as the area readings and those taken on the aircraft, will be entered on the proper form and brought to the team leader.

(5) When taking readings on personnel, use a type CD V-700 meter; open the beta shield on the probe.

(6) DO NOT TOUCH THE PERSON BEING MONITORED

(7) Direct him to raise his arms to a horizontal position and stand with feet apart so that all parts of his clothing and body can be monitored.

(8) Hold the probe approximately one inch from the clothing or body being monitored.

(9) DO NOT ALLOW THE PROBE TO TOUCH THE BODY OR CLOTHING. Monitor the face, neck, scalp, palms, and backs of hands, wrists, sleeves, chest, back, trouser seat, trouser leg, ankles, and shoes.

(10) Detect the radiation by means of the headset. (You will not be able to observe the meter needle while you are watching the probe position in an effort to keep it from touching the body or clothing.)

(11) When the "clicks" in the headset signal the presence of radioactive material, hold the probe at that point and observe the reading from the instrument dial before proceeding.

b. Equipment monitoring is essentially the same as personnel monitoring:

(1) Localized or heavy contamination, indicated by high readings, will be noted by the monitoring team leader.

(2) The monitoring team leader will advise the decontamination team leader when further washdown is required, and will specify the particular parts of the equipment requiring additional attention. This will save water and cut down the exposure time of the personnel performing the work.

20. CONTAMINATION OF AIRCRAFT. Two or more decontamination team members should now proceed to the parked aircraft, apply the uranium-ore sand, and return to their station. Contamination of the aircraft is accomplished by sprinkling the contaminated sand on the aircraft surface where fallout would most naturally be deposited on a parked aircraft. Since fallout settles by gravity, most of it may be found on the topside of the horizontal surfaces. Some fallout may be windblown into areas where it becomes trapped by an oily or greasy film or in the heavy carbon area on the backside of the exhaust stacks. It will also collect in surface irregularities such as screwheads, latches, edges of access plates, joints, seams, hinges, rough areas such as abrasive walkways, and around the window and door frames. Painted and unpainted aluminum surfaces have similar affinity for contaminants. If the aircraft is clean to begin with, an oily rag may be used to prepare special spots on the surfaces where you may desire to make the sand adhere. Do not waste the sand by trying to hide it in out-of-the-way places. There are plenty of areas in the open which will give sufficient practice in decontamination for the first few exercises:

a. It will take 10 pounds of uranium-ore sand for one exercise on one aircraft. Because this sand has such a low level of radioactivity, much more sand (by volume) is used in an exercise than normally would be deposited by fallout to give off an equal radiation intensity.

b. Dampen the sand before handling. In the dry form, it will stir up clouds of dust which might be inhaled by unprotected personnel. It might also blow off the aircraft while taxiing to the washrack. For this reason, and also to prevent the sand from shaking off if it is necessary to taxi over rough ground, you may prefer to move the aircraft onto the washrack (see paragraph 21) before applying the sand to the aircraft.

c. It is recommended that the 10 pounds of sand be divided into several portions and applied to 8 or 10 different locations on the aircraft. Apply approximately one pound of sand over a 6- or 8-inch square area—about 1/4 of an inch deep. This should give readings between 0.15 and 0.3 mr/hr.

d. If, when monitored at the CONTROL POINT, these team members are contaminated above the acceptable limits (0.5 mr/hr.) for outer protective clothing, they cannot be cleared back to their station in the "clean" area. The men will either have to remain there until the decontamination equipment is brought for the aircraft scrubdown or a special unit of equipment will have to be brought in. It is very possible that only their gloves will be contaminated and a bucket of water will be sufficient to wash off the contamination.

21. MOVE AIRCRAFT INTO POSITION. The pilot taxis the aircraft onto the washrack (facing the wind) and stops the engine.

22. POSITION MONITOR. A monitor takes position about 50 feet from the exit door of the aircraft, prepared to monitor the pilot.

23. MONITOR PILOT. The pilot leaves the aircraft as soon as it is parked on the rack and approaches the monitor for personal monitoring. Readings are to be reported to the monitoring team leader who would, in a real situation, determine if the pilot required a change of clothing, shower, etc. If the pilot is contaminated, he should be processed in the same manner as the decontamination team members who contaminated the aircraft. (See paragraph 20d).

24. MONITOR AIRCRAFT. Monitors are now dispatched to take readings on the aircraft and return to their station via the CONTROL POINT. A report form should be designed for the monitors to use, similar to the sample Aircraft Monitoring Report form on this page. A list of suggested entries for monitoring are shown in the sample. You may desire to change or to add other entries due to the model of aircraft being used.

a. The meters should show about 0.15 to 0.3 mr/hr. Multiply this by 200 (for exercise purposes) and subtract the background figure. Enter the difference on the Aircraft Monitoring Report form.

> **Example:** Meter reading of 0.2 mr/hr. × 200 = 40, subtract the assumed background level of 20 and enter 20 mr/hr. on the Aircraft Monitoring Report form.

b. When monitoring the aircraft, keep the probe a constant distance (1 to 2 inches) from the surface. By maintaining this same distance when remonitoring the aircraft, a valid comparison of first and second readings may be made for any area of the aircraft. Never allow the probe to touch a contaminated surface as some of the contamination could adhere to the probe. Thereafter, this contamination would result in false readings. If the instrument does become contaminated, it should be wiped off and monitored with another instrument before being used again.

AIRCRAFT MONITORING REPORT

AIRCRAFT IDENTIFICATION

LOCATION ON A/C	1st Reading	2nd Reading	3rd Reading
PROPELLER			
TOP ENGINE COWLING			
TOP RIGHT WING			
TOP LEFT WING			
TOP FUSELAGE			
LANDING GEAR RIGHT			
LANDING GEAR LEFT			
TAIL SURFACES RIGHT			
TAIL SURFACES LEFT			
DOORS			
WINDOWS			
WIND SHIELD			

DATE TIME MONITOR

SAMPLE

c. After completing their work, the monitors return to their station via the CONTROL POINT. If personal monitoring at the CONTROL POINT indicates their protective clothing has a reading of less than 0.5 mr/hr., they can proceed to their station. Otherwise, they will have to wait at the CONTROL POINT to be washed down before they return to their station. (See paragraph 16.)

25. CALCULATE THE STAY TIME. The Monitoring Team Leader now calculates the stay times for the decontamination crew members and gives a copy of the Aircraft Monitoring Report to the decontamination team leader. In order to figure decontamination crew member "stay time," divide the average of the aircraft readings (multiplied by 200) plus background level into 14.

Example: Instrument XI scale reading of 0.2 mr/hr. $\times$ 200 = 40.0 mr/hr. plus background of 30.0 mr/hr. gives 70.0 mr/hr. which divided into 14 gives 0.2 hours or 12 minutes stay time.

Phase III

26. FIRST SCRUBDOWN. The decontamination team now moves its equipment into the "hot" area to a position on the upwind side of the washrack and proceeds with its decontamination work, keeping in mind the following principles and procedures:

a. General Principles

(1) Radioactive material cannot be destroyed; most decontamination processes are designed for removal of contaminants from a surface or the removal of the surface itself. Radioactive material, at best, is merely moved from one place to another.

(2) It is advisable to learn the basic methods and techniques of exterior decontamination work first and attempt interior decontamination later.

(3) Clean water is a precious commodity in an emergency; therefore, learn to conserve it.

(4) Remove contamination with a minimum amount of water and with a minimum exposure of personnel to the radiation. (This includes spraying or splashing of contaminated water on personnel.)

(5) When removing the aircraft contaminant, use great care to control the runoff water (which contains a concentration of radioactive material) from the aircraft. The need for care in this cannot be overemphasized.

(6) When washing down aircraft remove the pressure hose nozzle, using a flow-on application of the water, since direct pressure will damage light aircraft coverings. (This also reduces the amount of water splashed and sprayed around the area, and will help to reduce the spread of the contaminated material as it is loosened and washed from the surfaces of the aircraft.)

(7) Cover any accumulated contaminant with earth to provide a greater protective factor. This lessens danger to personnel in the vicinity. Burning or other common means of destruction are futile with radioactive materials. Burial beneath the earth's surface provides the best known method of disposing of such material.

b. External Decontamination

(1) Position the decontamination equipment upwind from the aircraft to reduce the amount of spray or splashing of contaminated water on the equipment. On windy days, spray from a careless application could be wind-blown several hundred feet.

(2) The monitors' report will most likely show a concentration of radioactivity in greasy or oily locations which will necessitate scrubbing with brushes and the use of rinse water.

(3) Use long-handled brushes for scrubbing operations to permit decontamination personnel to stand as far as possible from the aircraft, giving them the added protection which distance provides.

(4) Mix soap or detergent into one or more buckets of water and carefully dip the brushes into this soapy water and apply to the aircraft.

(5) Scrub the surface and make certain that the oil or greasy film is loosened and prepared for rinsing off by hose. On smooth clean surfaces, fallout is easily removed by a flow-on application of water.

(6) Apply water to the surface of the aircraft, working from top to bottom and front to rear (assuming the aircraft is parked facing the wind.) Decontamination crew members

should stand windward of all scrubbing and hosing operations.

(7) Play the water directly on the contaminated surface so that contamination is removed with a minimum of wasted water and a minimum of splash.

(8) Apply hose water at an angle of approximately 30-40 degrees, pointing down-wind. A sharp angle, such as 80-90 degrees, will splash and spray contaminated water back onto areas previously cleaned.

c. Interior Decontamination

(1) Interior decontamination is more difficult to accomplish than exterior decontamination. Decontamination of the interior of aircraft can be started by using a vacuum cleaner to remove loose radioactive debris and dust, principally in corners and in locations that are difficult to clean. The monitors can poinpoint the locations of radioactive dust concentration. Great care must be taken in handling the vacuum cleaner after usage. Contents of the disposal bag containing the radioactive material should be disposed of as solid waste material, preferably by burial. Although special filters might not be required for the vacuum cleaner as used in the exercise, such filters would probably be essential for actual emergency conditions.

(2) After the interior of the aircraft has been vacuumed, part of it, depending upon the construction materials, may be scrubbed with a solvent, using soft fiber brushes or wiping rags. A detergent and water wipedown may be used in the cabins of the aircraft. The direct application of a water hose in aircraft interiors is undesirable for obvious reasons.

27. CLEAN PERSONNEL AND WASHRACK. Before leaving the washrack, the decontamination team should hose down or rinse off each other and then hose or wash the runoff water (which usually collects under the aircraft) down the drain. It may be necessary to wait a few minutes until the runoff water has stopped (or nearly stopped) dripping from the aircraft. Personnel will then return to their station via the CONTROL POINT where a monitoring check will determine if they require further rinsing off before being permitted to proceed to the clean area.

28. REMONITOR AIRCRAFT. Monitors will now remonitor the aircraft, entering their readings in Column 2 of the report form, and then return to their station and give the readings to their team leader. The instrument readings taken by monitors are to be multiplied by 200, as before, with the washrack background figure subtracted. (See paragraph 24.)

29. DETERMINE IF SECOND SCRUBDOWN NEEDED. The team leader determines if the aircraft is now above or below the established limits of permissible radiation. The team leader advises the group leader of the results, and the group leader will determine if a second scrubdown is necessary. (Do not forget that the aircraft readings have been multiplied by 200. Thus, they must be corrected before comparing the final decontaminated aircraft reading with the .05 mr. allowable limit. This limit is set only for purposes of the drill. Under emergency conditions, much higher limits may be appropriate as discussed in the FAA Publication "Radiological Protection and Decontamination of Civil Aircraft.")

30. SECOND SCRUBDOWN. If required a second scrubdown will be limited to those areas requiring special attention. The monitoring team leader will advise the decontamination team leader of the location of these areas of remaining radiation activity. Care will be taken not to spread contamination (by water smear) to other parts of the aircraft previously cleaned. Clean the washrack and personnel as previously described and withdraw to the assigned stations.

31. RECHECK BY MONITORS. Same as paragraph 28 except that the readings will be entered in Column 3. The monitoring team leader reports the results to the group leader.

32. REMOVAL OF AIRCRAFT. When the aircraft is affirmed as clean by the group leader, the pilot will taxi the aircraft from the washrack to the "clean" area and park it.

Phase IV

33. MONITOR EACH VEHICLE AND UNIT OF EQUIPMENT. Monitor each vehicle and unit of equipment used in the decontamination work. The monitoring team leader then advises the decontamination team leader of the units of equipment that require a washdown:

a. Decontaminate the equipment as required.

b. Remonitor the equipment.

c. When all equipment readings are reduced to a level within allowable limits, decontamination and monitoring personnel will then hose and rinse off each other and proceed to the CONTROL POINT with their equipment.

34. MONITOR PERSONNEL. The decontamination and monitoring personnel are monitored at the CONTROL POINT, while still in protective clothing to determine if further cleaning is necessary before removing the protective clothing.

35. REMOVAL OF PROTECTIVE CLOTHING. Protective clothing can now be removed by all personnel. Appropriate procedures for the removal of protective clothing may depend upon the clothing used and the nature of the hazard. It is good practice to remove first those items most likely to be contaminated. Assistance by other persons can be very helpful.

a. It is important to keep from touching any protective clothing with bare hands, or allowing the protective clothing to rub against exposed skin or underclothing. The inside of each piece of protective clothing should be free of contamination.

b. Carefully remove head coverings with as little jarring as possible, as contamination could fall or drip onto the head, hair, neck, etc.

c. Remove other pieces of clothing with equal care, working generally from the top and proceeding downward.

d. Place all removed protective clothing in a pile.

e. REMOVE GLOVES LAST.

36. FINAL MONITORING CHECK. Make a final monitoring check of the personal clothing worn under the protective clothing and a thorough check of the body, head, neck, hands, feet, etc. If readings are above allowable limits, the monitoring team leader will determine the extent of further decontamination necessary such as a change of clothing, showering, etc.

37. READ INDIVIDUAL DOSIMETERS. Individual dosimeter readings should now be taken from each member of the group.

a. The readings of the dosage received during the exercise will be recorded by the individual on his PERSONAL RECORD OF RADIATION DOSAGES RECEIVED form. (See sample form below.) This form should remain in the possession of the individual.

b. Organized groups should keep a permanent record copy of the individual doses for everyone in the organization. Because of the extremely low-level activity of the uranium-ore sand being used and the short periods of exposure, some dosimeters may not give satisfactory indication of dosage received. In this case, the monitoring leader may prepare a calculated dosage figure which the individual will enter on his personal dosage record form.

c. This calculated figure, if used, can be based on the length of time the individual remained in the "hot" area and the average rate of radiation to which he was exposed. This will not eliminate the requirement for monitoring all personnel when leaving the "hot" area.

PERSONAL RECORD OF RADIATION DOSAGES RECEIVED

NAME John Doe

ADDRESS 717 Oak St. Mobile City

Date radiation received	RADIATION DOSAGE	
	Received this date	Accumulated to date
	Roentgens	Roentgens
7/10/62	.001	.001
7/17/62	.003	.004
7/18/62	.001	.005
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.
	.	.

SAMPLE

Chapter III. CRITIQUE OF THE EXERCISE

38. CRITIQUE SESSION. Assemble all personnel and conduct the "critique" session immediately after the exercise while all events and actions are still fresh in the minds of the participants.

a. The group leader should discuss his written comments and notations made during the planning and execution of the exercise.

b. After discussing his comments and notes for each operation, the group leader should permit ample time for suggestions, observations, and criticisms from team members.

c. Particular attention should be given to:

(1) The effectiveness of the protective clothing used.

(2) The adequacy of the water supply, amount used per aircraft, and methods to conserve water.

(3) Was the drainage satisfactory? If not, how can it be improved?

(4) What techniques used were well executed? What techniques were used that were not satisfactory? Reasons?

(5) Were there any problems encountered in trying to prevent cross-contamination? Solution?

(6) Were any difficulties encountered in the monitoring and decontamination of personnel? Solutions?

(7) Did the security team have any situation that could not be controlled?

(8) How could facilities for decontamination of personnel be improved, such as providing a field shower, etc.?

(9) Was the marking of the danger area ("hot" area) satisfactory?

(10) Were any soaps, detergents, or solvents used that were unsatisfactory? What appeared to work best?

(11) Were there any problems involving communication among group leaders, team leaders, and team members?

(12) Were all personnel impressed with the primary importance of accomplishing the decontamination work in a manner to provide the maximum protection for everyone concerned?

d. Summarize and indicate how the next exercise can improve on this one.

e. Schedule the next exercise.

Appendix I. EQUIPMENT

Equipment List	*Quantity*
Radiation detection meters	1 to 6
Personal dosimeters	1 per person
Water	100 gals. (Minimum)
Scrub brushes (long handles)	1 to 6
Detergent, solvent, or soap	2 to 4 lbs.
Protective clothing	1 complete outfit for each member of monitoring and decontamination teams.
Atom-marker signs	10 to 12
Arm bands	1 per person
Vacuum cleaner	1 (required only for advanced classes)
Aircraft	1
Contaminant (simulating fallout)	10 lbs.
Water pails	1 to 4

1. RADIATION DETECTION METERS (GEIGER COUNTERS). For a practice exercise, the Civil Defense low-range model CD–V–700 (0-50 mr/hr.) is recommended. The military equipment is model AN/PDR 27 or 27A. It is necessary to have a minimum of one Geiger counter. If possible, borrow several counters, so that more people can be given the opportunity to learn how to use them. Arrangements should be made to borrow these instruments from one of the following sources:

a. Federal Aviation Agency station or tower.

b. Department of Defense Installation (Army, Navy, Marines or Air Force).

c. Weather Bureau.

d. Civil Defense Unit (county or local).

e. High School or College Science Department.

2. PERSONAL DOSIMETERS. Low-range picket-type dosimeters may be borrowed (from the same sources) for each person in the group. The Civil Defense model DC-V-138 is the equivalent to military model No. IM-9. These dosimeters are preferable to the film-badge type only because they are self-reading. A dosimeter charger, Civil Defense model CV–V–750, is necessary in order to reset the dosimeter hairline to zero or to bring the line onto the scale so that a starting and ending reading can be taken.

3. WATER. As far as possible, water used for decontamination purposes should be clean or free of contamination. If, at your airport, it is necessary to use water pumped from an open body supply, place the intake end of the hose 1 or 2 feet below the surface, but not on the bottom. Fallout which descends on open water will either sink to the bottom (heaviest particles) or float on the surface (lighter dust). If water is obtained from a tank or covered well, it will probably be free of contamination. Local fire trucks equipped with tanks may be available, which would greatly simplify the water problem for this exercise.

4. SCRUB BRUSHES. Any fiber brush will be satisfactory, provided it has a long handle. Fairly soft bristles and a good size brush-head, 2½ or 3 inches by 8 or 10 inches, are preferable.

5. DETERGENTS, SOLVENTS, OR SOAPS. Ordinary soaps and detergents found in any grocery store are satisfactory. Where fallout has been embedded in or adheres to an oily or greasy spot, the addition of soap to the water will greatly increase the efficiency of decontamination work. Although it is unlikely that heated water or a steam jet will be available, they are both very effective in removing grease and oil.

6. PROTECTIVE CLOTHING. This is the most important of all the equipment needed for your exercise. IF YOU CANNOT PROTECT YOUR PERSONNEL WITH WATERPROOF CLOTHING, DO NOT ATTEMPT THE EXERCISE. However, it is neither difficult nor expensive to obtain the clothing required for adequate protection.

The following items must be included:

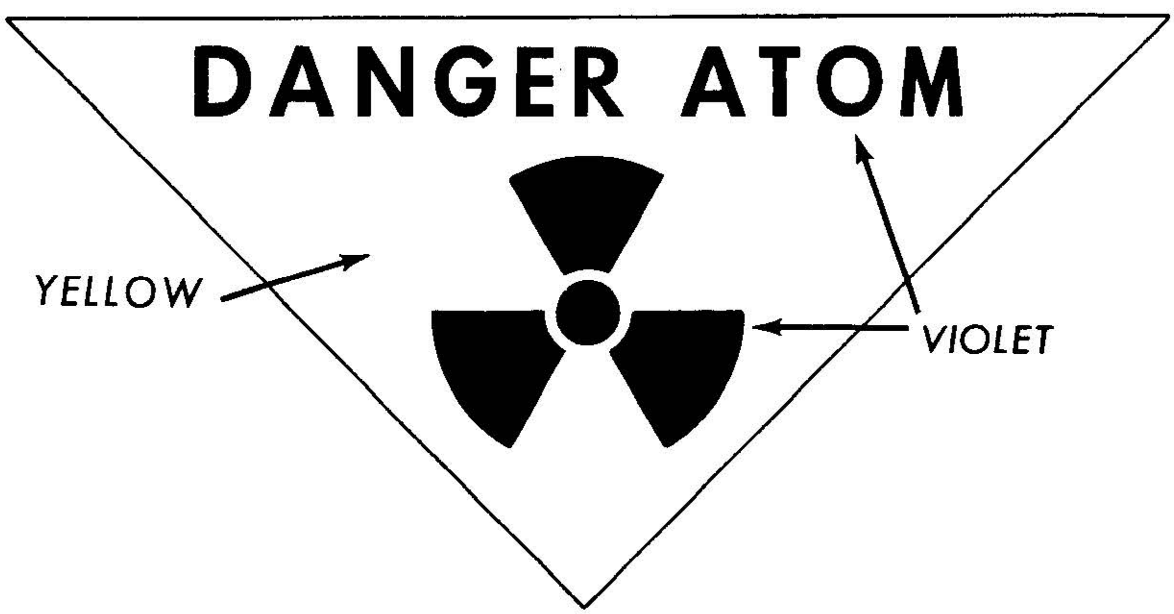
- waterproof boots
- waterproof suit with hood (hip boots and a slicker type raincoat and a separate hood can be substituted)
- rubber gloves (waterproof fabric gloves can be substituted, but do not take chances on contamination soaking through to your skin)
- protective face mask

Use 2-inch wide masking tape or waterproof adhesive tape to seal clothing joints at ankles, wrists, waist, neck, and to cover zippers and close any other openings where moisture might possibly penetrate the protective clothing.

7. ATOM-MARKER SIGNS. The control of contamination, which is a major problem, can be materially assisted by "fencing off" specific areas. Remember that contamination can be spread by tracking on shoes. Vehicles can also track contamination from one area to another. Valuable and much needed equipment could be out of service for long periods if carelessly or unnecessarily driven into contaminated areas.

a. The purpose of the atom-marker signs is to assist in controlling the spread of contamination. The signs should constitute sufficient warning to stop people from wandering into a "hot" area and returning to "clean" areas, which would result in cross-contamination.

b. The signs may be handmade, but they should follow the approved Department of Defense design and dimensions as closely as possible.



The prescribed shape is a right-angle isosceles triangle with a base having a minimum length of 6 inches. The quantity of signs required will depend on the size of the area you wish to designate as a "hot" area. Signs should be placed 20 to 30 feet apart, to minimize the possibility of people walking into the area without observing at least one of the markers. Signs should be mounted on stakes, standards, or may be suspended from a rope barrier if used. The surface on each marker should face away from the contaminated area. Signs are of little or no value if placed flat on the ground.

8. ARM BANDS. If you have a large group, it it advisable to provide identifying colored arm bands for each team. Otherwise it is almost impossible to identify people when they are "suited out" in full protective clothing. The team leaders should be given a distinctive identification such as a double arm band. Reflective tape can be used for night operations.

9. VACUUM CLEANER. This is not a required piece of equipment, at least for the first few exercises. However, when you are prepared to practice interior decontamination, the vacuum cleaner will be a very handy tool. A portable source of electrical power will be necessary if a vacuum cleaner is used.

10. AIRCRAFT. It is suggested that a small aircraft be used for the exercise until the basic lessons have been learned. The contaminated sand will not damage the aircraft and all traces of radioactive material should be removed during the exercise so there will be no danger to personnel operating or working on the aircraft at a later date. Radiation will not interfere with the functioning of the engine or any other mechanical or electrical equipment aboard.

11. CONTAMINANT — RADIOACTIVE SAND. If possible, use a material which will simulate fallout in order to gain practical experience in the decontamination processes. Smearing mud on the aircraft has been tried, but without radioactive material in the mud, DECON crews cannot be sure of complete removal. Therefore, obtain a contaminant which will provide a few milliroentgens of gamma and beta radiation. Such a material is available in the form of uranium-ore sandstone, which is finely ground and ready to use. It will take about 10 pounds of this to conduct one exercise on a light aircraft. Arrangements can be made with the Homestake-Sapin Partners, P.O. Box 98, Grants, New Mexico, to organize one central distribution point in each state so that you can place your order with that distributor. Your State Department of Aeronautics or the Federal Aviation Agency General Aviation District Offices will be able to advise where this distribution point is in your state. The cost of this radioactive sand, plus shipping charges (motor freight), will be approximately $1 to $1.50 for 10 pounds.

12. CERTIFICATE OF ACHIEVEMENT. Some organizations may wish to give an award to their members in recognition of completion of preparatory training and successful execution of this exercise. A suggested format for such a certificate is shown on page 20.

Certificate of Achievement

AWARDED TO

____

for ______________________________

at ______________________

Awarded this ______________ *day of* __________ *19*____

______________________ ORGANIZATION

______________________ AUTHORIZED SIGNATURE

Appendix II. GLOSSARY

Alpha Particle—A particle emitted spontaneously from the nuclei of some radioactive elements. It is identical with a helium nucleus, having a mass of four units and an electric charge of two positive units. It travels only a few inches, even in air, but can be very harmful if ingested by breathing or taken into the blood stream through an open wound.

Attenuation—The absorption or stopping of some of the radiation as it passes into or through solid materials.

Beta Particle—A charged particle of very small mass emitted spontaneously from the nuclei of certain radioactive elements. Most, if not all, of the direct fission products emit (negative) beta particles. Physically, the beta particle is identical with an electron moving at high velocity. The beta particle is the cause of beta burns to the skin, which may be very serious.

Buffer Zone—An area that has been decontaminated immediately beyond and in addition to the intended working area.

Clean Area—One in which decontaminating measures have been taken to reduce the amount of residual radioactivity.

Contamination—Deposit of radioactive material on the surface of structures, areas, objects, or personnel following a nuclear (or atomic) explosion. This material generally consists of fallout in which fission products and other weapon debris become incorporated with particles of dirt, etc. Contamination can also arise from the radioactivity induced in certain substances by the action of neutrons from a nuclear explosion.

Cross-contamination—The contamination of a previously "clean" area by radioactive material which is windblown, or tracked on shoes or vehicle tires, etc.

Decay—Sometimes referred to as "natural decay," is the decrease of any radioactive material with the passage of time.

Decontamination—The reduction or removal of contaminating radioactive material 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;

(3) covering the contamination to attenuate the radiation emitted.

Radioactive material removed must be disposed of by burial on land or at sea, or by other suitable methods.

Dosage (dose)—A total or accumulated quantity of ionizing (or nuclear) radiation. A dosage can be measured by reading a pocket dosimeter or it can be calculated by multiplying the hours of exposure times the rate of radiation, which is expressed in terms of roentgens or milliroentgens per hour.

Dose Rate—As a general rule, the amount of ionizing (or nuclear) radiation to which an individual would be exposed or which he would receive per unit of time. It is usually expressed as roentgens or milliroentgens per hour. The dose rate is commonly used to indicate the level of radioactivity in a contaminated area.

Dosimeter—An instrument for measuring and registering total accumulated exposure to ionizing radiation (pronounced — dosímeter).

Gamma Rays (or Radiations)—Electromagnetic radiations of high energy originating in atomic nuclei and accompanying many nuclear reactions, e.g., fission, radioactivity, and neutron capture. Physically, gamma rays are identical with x-rays of high energy, the only essential difference being that the X-rays do not originate from the atomic nuclei, but are produced in other ways. Gamma rays probably constitute the greatest threat in radioactivity and are the main reason for decontaminating—to remove the source of this type of radiation.

Milliroentgen (mr)—A one-thousandth part of a roentgen.

Monitoring—Procedure of locating and measuring radioactive contamination by means of survey instruments which can detect and measure (as dose rates) ionizing radiations. (The individual performing the operation is known as a monitor.)

Radiation Levels—Measure of ionizing radiation at specified periods, usually read from survey meters as—mr/hr. or r/hr.

Radioactivity—The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nuclei of an unstable isotope. As a result of this emission, the radioactive isotope is converted (or decays) into the isotope of a different (daughter) element which may or may not also be radioactive. Ultimately, as a result of one or more stages of radioactive decay, a stable non-radioactive end product is formed.

Roentgen—A unit of exposure dose of gamma (or X-) radiation. Survey meters and dosimeters show readings either in roentgen units or milliroentgen units.

Stay Time—The period of time personnel can work or stay in an area at the existing dose rate of radiation without exceeding the prescribed maximum dose.

Shielding—Any material or obstruction which absorbs (attenuates) radiation and thus tends to protect personnel or materials from the effects of a nuclear (or atomic) explosion. A moderately thick layer of any opaque material will provide satisfactory shielding from heat radiation, but a considerable thickness of material of high density may be needed for nuclear radiation shielding.

Survey Meter—A portable instrument, such as a Geiger Counter or ionizing chamber, used to detect and measure nuclear radiation. These measurements are in terms of the rate of radiation, either roentgens per hour or milliroentgens per hour.

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