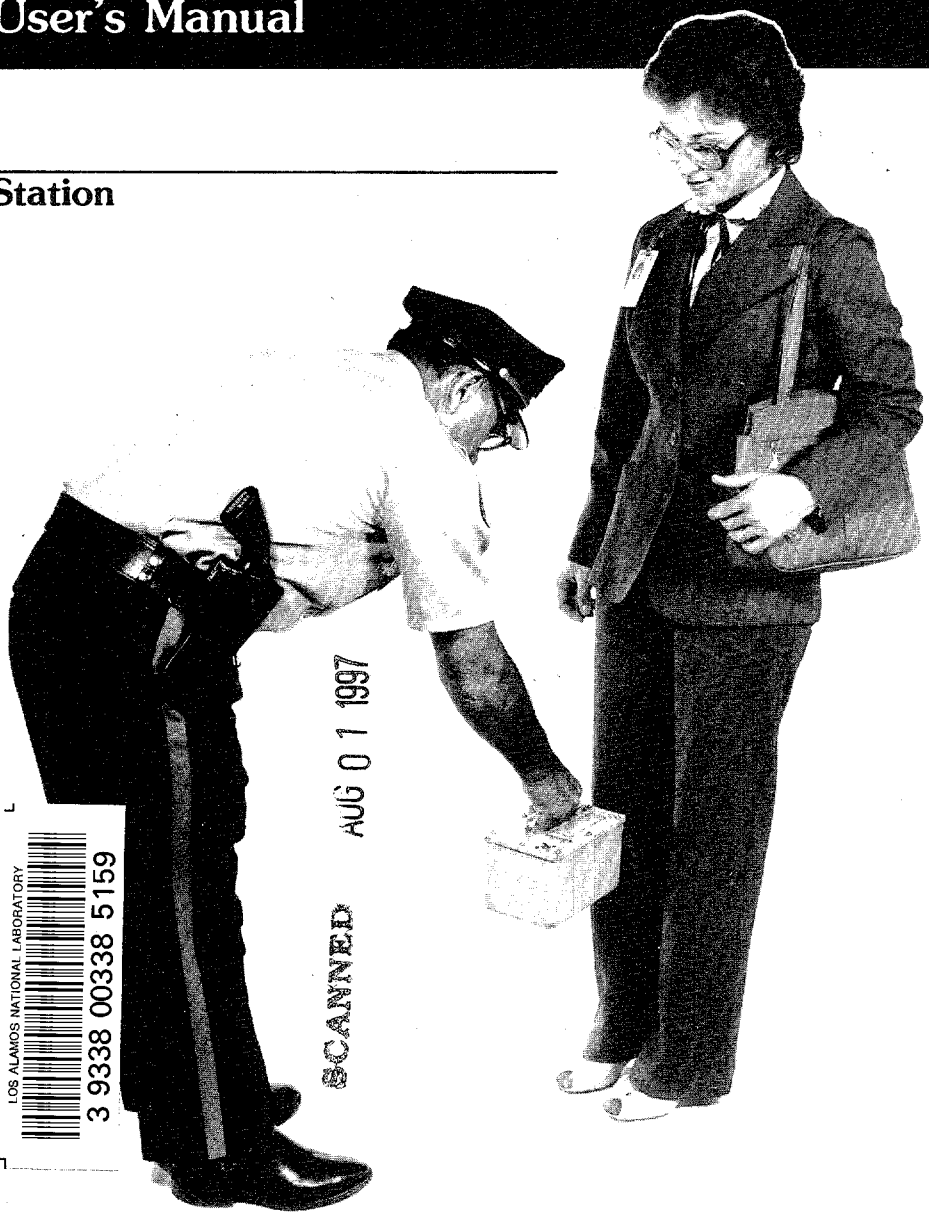
Hand-Held Search Monitor for Special Nuclear Materials

User's Manual

Station



Hand-Held Search Monitor for Special Nuclear Materials

User's Manual

Paul E. Fehlau

Contents

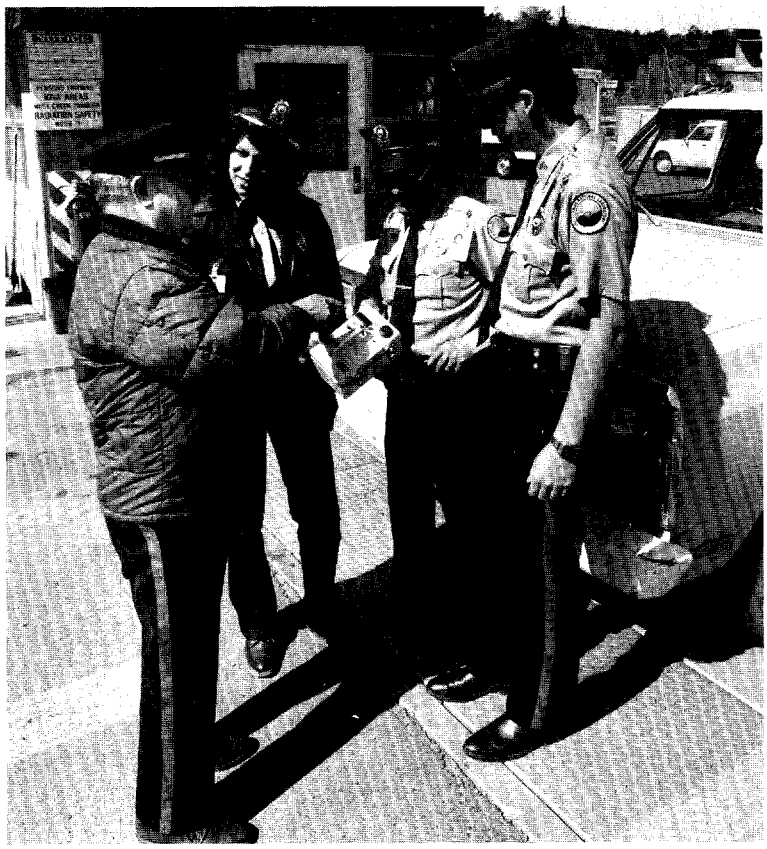
Preface

This manual is for security guards who use a hand-held monitor to search people, packages, and vehicles for radioactive material. It provides instructions for using the monitor to its maximum sensitivity in searching for radioactive materials.

The manual is both a teaching tool and a handy reference. It acquaints first-time users with the search monitor and the proper techniques for searching. It also is a refresher for guards who have been reassigned to a search station. Finally, it serves as a reference at search stations by providing summaries, checklists, and places to record station-specific information.

Introduction

One of your most important duties as a security guard is to prevent unlawful removal of special nuclear materials from access areas. Plutonium and enriched uranium qualify as special nuclear materials that are vital to the security of the United States. The Department of Energy and the Nuclear Regulatory Commission require guards to search all persons, packages, and vehicles for these materials at exits from access areas.



The search is conducted with a hand-held monitor that detects radiation emitted by special nuclear materials. The monitor has detectors that are particularly sensitive to gamma radiation. By using the monitor properly to conduct exit searches, you can detect even small quantities of plutonium and enriched uranium.

When the monitor senses gamma radiation, it beeps more and more often as you move it toward radioactive material. This makes it possible for you to conduct a search by listening to the beeps. You do not have to watch the meter. You will know you have located the radiation source when the monitor beeps most frequently.

It is relatively easy to detect a large quantity of radioactive material: the monitor senses it from a distance. It is not so easy to detect small quantities of radioactive material, but they are just as important to find. Your monitor cannot sense a small quantity of radioactive material unless it is nearby. This means that you have to scan all surfaces, within a few inches, and take the time to do a thorough job.

Read this manual carefully. It will acquaint you with the parts of your monitor, examine the fundamentals of gamma radiation, explain how to operate the monitor, and recommend search techniques.

A copy of this manual should be available at every search station. Write the name of the station on the cover. Record information specific to the station in the blank spaces on pages 22, 23, and 36. Use the blank pages at the end of the manual (pages 38-39) to note special procedures in effect at that station.

Your Search Monitor

Detecting gamma radiation is the most effective way to search for hidden quantities of special nuclear materials. Although searching without a radiation monitor might meet the requirements of the Department of Energy and the Nuclear Regulatory Commission, that kind of search is slow and may not always locate the nuclear material. Because all nuclear material is radioactive and emits gamma radiation, searching with a gamma-ray monitor is a better way to find it.

Two hand-held search monitors that detect gamma radiation were developed at Los Alamos National Laboratory. You are probably using one of them, either the Personnel-Vehicle Monitor or the Delta Rate Monitor. The Personnel-Vehicle Monitor is a sensitive, general-purpose

DELTA RATE MONITOR

PERSONNEL-VEHICLE MONITOR

instrument more commonly used at search stations. The Delta Rate Monitor is a more specialized instrument for stations where the radiation intensity is highly variable. A thumbwheel switch on the Delta Rate Monitor allows the operator to compensate for these changes in intensity.

At present, these two hand-held gamma-radiation monitors with built-in intelligence are in widespread use at search stations. Newer versions of these monitors will be similar in design and operation to the Personnel-Vehicle Monitor and the Delta Rate Monitor. Even if you are using a different model, the information in this manual will be useful to you.

Built-In Intelligence

Many hand-held monitors can sense the weak gamma radiation that is part of our natural environment, which is called background radiation. They also can sense an increase in gamma-ray intensity over the background radiation near special nuclear material. However, most monitors are not particularly suited to search requirements at exit stations because the user has to watch a count-rate meter and interpret the information. This diverts his attention from the search.

The most useful instruments for searching by hand are monitors that signal increases in radiation intensity with a noise, such as a beeping sound. The beeps allow the user to concentrate on the search instead of on watching the meter. We call these monitors intelligent because they can remember the intensity of the background radiation and will beep when the new intensity is greater than the background. The Personnel-Vehicle Monitor and the Delta Rate Monitor both have built-in intelligence.

General Description

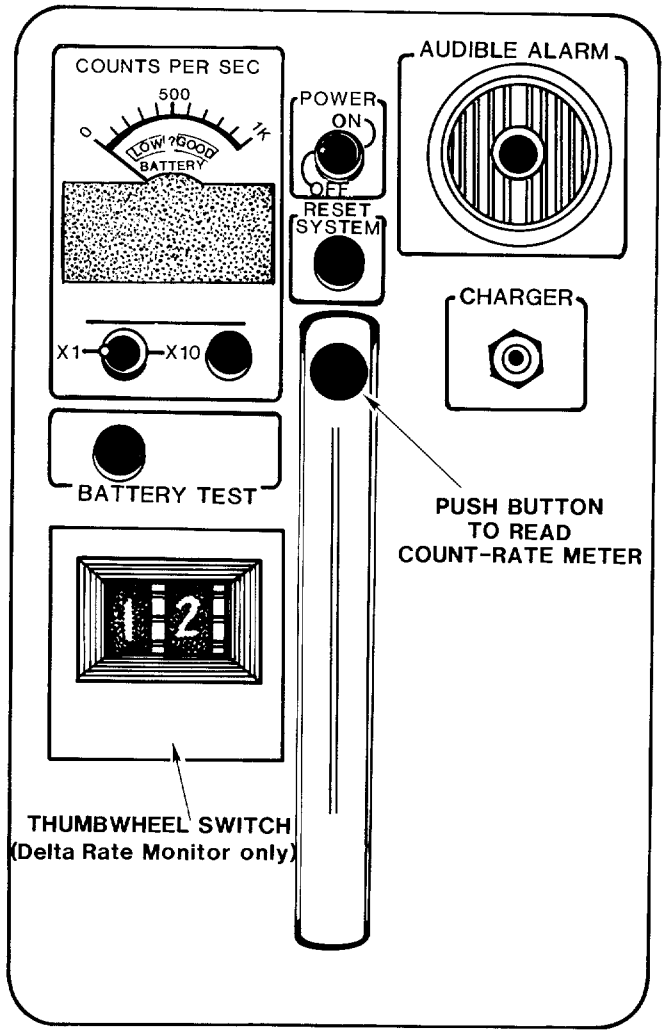
Your search monitor has a gamma radiation detector inside it along with some electronics that operate the instrument. The radiation detector is located just under the power switch inside the case. Each monitor also contains a battery to power the electronics.

The compact and lightweight monitor is designed for hand use. The aluminum case and its contents weigh only 4 pounds. For its size and weight, the monitor is highly sensitive.

Familiarize yourself with the dials and switches on the control panel. In particular, note the location of the POWER ON/OFF switch, the RESET button, the BATTERY TEST button, and the AUDIBLE ALARM (the beeper). The count-rate meter displays radiation intensity in counts per second, which is the count rate. It is not necessary to watch the meter when you are conducting a search, but it will display the count rate when you press the button in the handle.

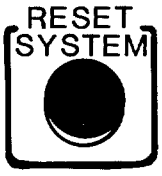
Grasp the monitor firmly in one hand so that you can read the writing on the front panel. The sensitive end of the monitor points away from you, as it should during a search. However, the monitor also senses radiation from the sides and the bottom.

SENSITIVE END



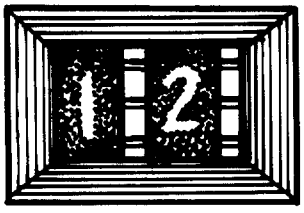
Power On/Off Switch

An essential first step to monitoring is to turn the monitor on. It can't do its job otherwise.



Reset Button

When you press and release the RESET button, the monitor begins a short background measurement that lasts about 3 seconds. At the end of the measurement, the monitor records the radiation background value. Do not use the monitor to conduct any part of a search while this background measurement is in progress. Remember to count to 3 after you release the button before you start searching.

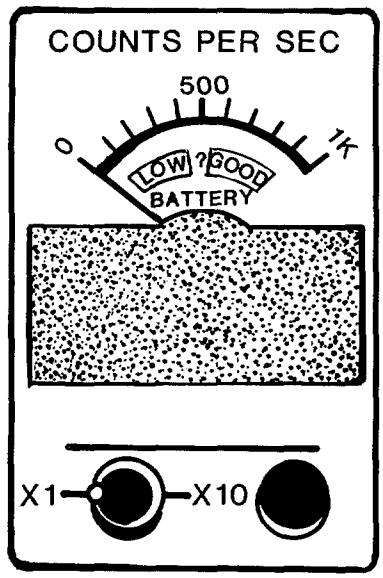


Thumbwheel Switch (Delta Rate Monitor Only)

The Personnel-Vehicle Monitor and the Delta Rate Monitor look quite similar. One difference is the thumbwheel switch, labeled DELTA SELECT, on the Delta Rate Monitor. By adjusting the switch to a higher setting, you can maintain the monitor's sensitivity during short periods of high radiation background. But remember to lower the setting as soon as possible.

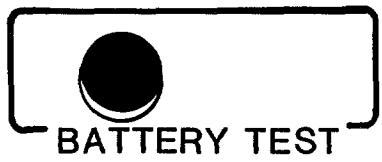
Count-Rate Meter

The count-rate meter on the Personnel-Vehicle Monitor operates when you press a button in the front part of the handle. By pressing the button, you can display the radiation intensity in counts per second. The Delta Rate Monitor has a digital display that registers the background count rate continuously.



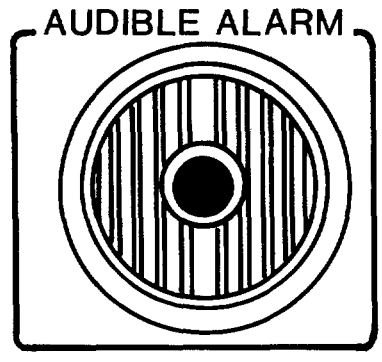
Battery Check

The BATTERY TEST button on the Personnel-Vehicle Monitor allows you to test the battery charge. When you press the button, the needle indicates whether the battery charge is adequate or low. Instead of a battery test button, the Delta Rate Monitor indicates a low battery by a flashing digital display.



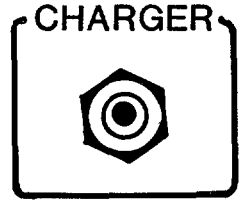
If your monitor beeps too often or not often enough, update the background.

Alarm



The monitor beeps occasionally when no source is nearby because it is continuously measuring the radiation intensity in very short counting-time intervals. The intervals are not much longer than the length of one of the beeps. The measurements are not exact. Most of them are near the background intensity, but a few always are a bit too large. The large ones trip the monitor's alarm. Therefore, if the instrument beeps too often or not often enough, the stored background needs updating. Of course, when a radioactive source is nearby, the monitor should beep frequently.

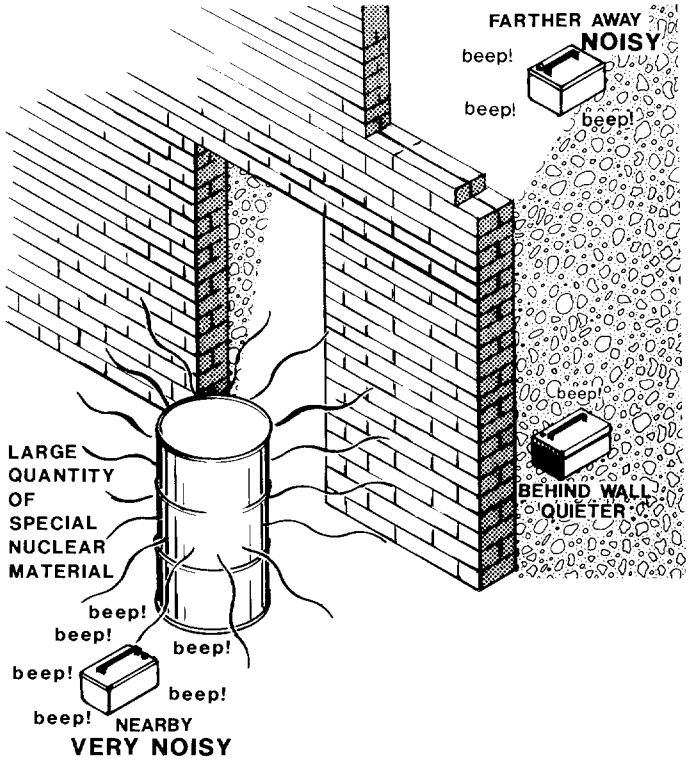
Battery Charge

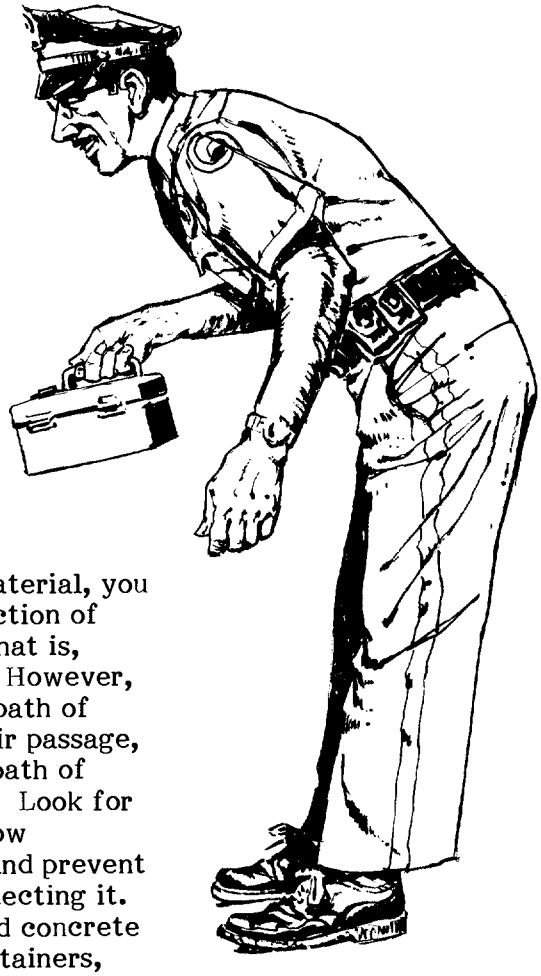


When the battery is low, it can be recharged. First turn off the monitor. Then attach the charger cable to the monitor and plug the charger into a wall socket.

Gamma Radiation

Gamma radiation is emitted by radioactive atoms that are part of the natural environment. Gamma radiation is similar to light, except that the eye cannot see it. A radiation source emits gamma rays in all directions, just as a light bulb emits light in all directions. And, just as the intensity of light fades rapidly as you move away from a light bulb, the intensity of gamma radiation fades as you move away from its source. This comparison is true for bare light bulbs only; reflectors or lamp shades can redirect visible light, but there is no way to redirect the flow of gamma radiation.





Move in close with your monitor to find radioactive material.

The closer your monitor comes to radioactive material the greater the gamma-ray intensity and the easier it is to find the material. To find radioactive material, you should follow the direction of increasing intensity, that is, more frequent beeps. However, certain shields in the path of gamma rays block their passage, just as objects in the path of light create a shadow. Look for shields that may shadow radioactive material and prevent your monitor from detecting it. For example, brick and concrete walls, thick metal containers, and sheets of lead are shields that stop gamma rays.

Radiation Sources

The natural surroundings and special nuclear material are not the only sources of gamma radiation. Occasionally, you may find radioactivity in everyday items. For example, some people still wear watches with glow-in-the-dark radium dials that your monitor will sense. Radium-dial watches are intense radiation emitters and a health hazard to the skin of a person who wears the watch for long periods of time. Now most glow-in-the-dark watches have harmless tritium dials that your monitor will not detect because they emit beta radiation, which is totally absorbed inside the watch.

In addition to radioactive watches, some camera lenses are radioactive because they are made with a type of glass that contains thorium, a natural radioactive element. Another common item that contains thorium, perhaps less likely to be encountered at a search station, is a Coleman lantern mantle. The mantle, a small net bag, is the part of a gasoline lantern that glows when the lantern is lit. Most of the thorium-containing items are low-intensity gamma-ray emitters; you may not be able to detect radiation from a mantle, for instance, unless your monitor is almost touching it.

A relatively uncommon form of radioactivity that security guards encounter once in a great while is inside people who are undergoing diagnosis with a medical radioisotope. When these individuals present themselves for search before their bodies have had time to eliminate the radioisotope, they can be very intense sources of gamma radiation. Normally, these individuals are cleared through a search station by their supervisor or the facility health department.

Contamination

Another infrequent source of radiation detected at search stations is contamination. Occasionally, a security guard will detect a person with contaminated protective clothing or equipment. For example, a guard may detect contamination on someone's coveralls. This can happen when a persistent gamma-ray emitter does not wash out in the laundry. Or the contamination may be fresh. Security guards detect contamination because their search monitors are highly sensitive and can detect very small amounts of radioactive materials.

Background Radiation

Finally, a word about the background radiation at a monitoring station. The background may vary occasionally. Perhaps it will be a slight natural variation caused by changes in the weather. Some natural radioactive atoms are part of the atmosphere or are attached to dust that is suspended in the air. When it rains, these particles are washed out of the air onto the ground, and the background radiation level temporarily increases. Other more noticeable changes in background may be caused by temporary operations at a work site, such as movement of radioactive material or operation of a nuclear reactor. In any case, your monitor is so sensitive that it will notice even slight variations in background radiation.

Summary

As we have seen, special nuclear material emits gamma radiation that your monitor can detect. You should also keep in mind the other sources of radiation that your monitor will detect. Familiarize yourself with the following list of radiation sources that you may encounter on the job.

SOURCES OF GAMMA RADIATION
Natural background
Special nuclear material
Wristwatch, radium dial
Camera lens containing thorium
Medical treatment with radioisotopes
Low-level contamination

Monitor Operation

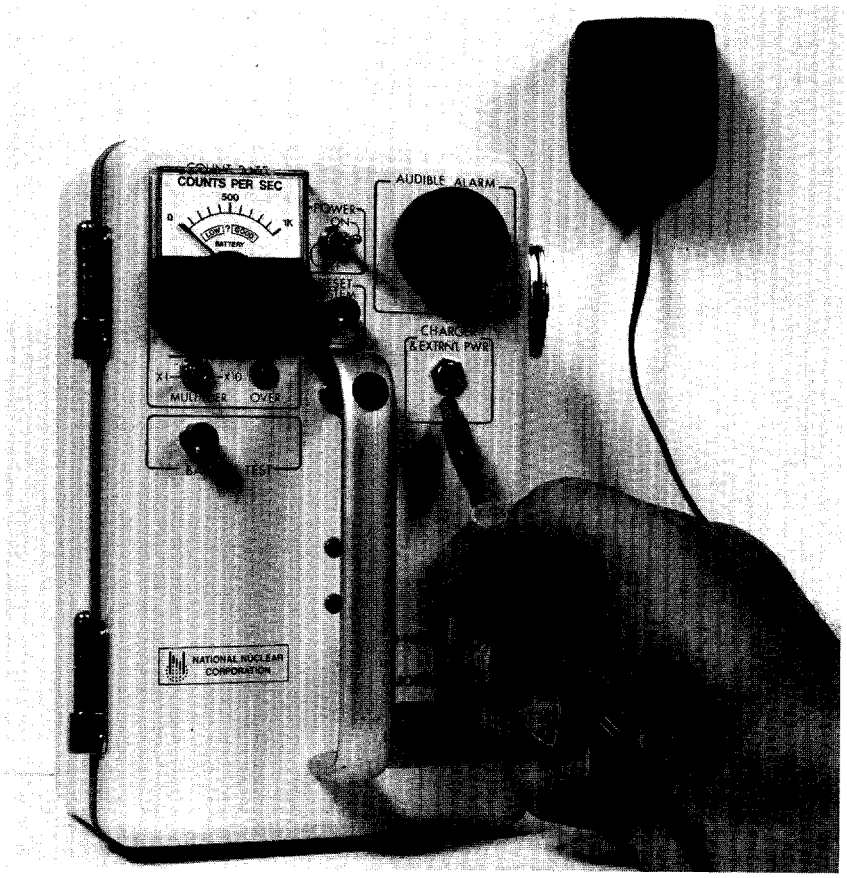
Operating your monitor properly takes a certain amount of care, preparation, and knowhow. Make sure the battery is charged and the power turned on. Be sure to reset the background. The monitor should beep once or twice every minute. If you are using a Delta Rate Monitor, set the thumbwheel to the proper value. To conduct a search, grasp the instrument firmly in one hand so you can read the writing of the front panel. The sensitive end of the monitor points away from you. Always keep the monitor within 4 to 6 inches of the surface you are scanning.

Battery Recharge

The rechargeable battery will operate the monitor for about 14 hours. When you are not using the monitor for long periods of time (4 hours or more), recharge it by attaching the charger to it and plugging the charger in an electrical outlet. If you forget to charge the battery, you can plug in the charger while the monitor is turned on and operating, if your workload permits. However, don't make a habit of charging the monitor during duty hours because it is unhealthy for the batteries. When the batteries are charged in short, frequent intervals, they will, sooner or later, lose their ability to provide power. If a spare monitor is available, one monitor can be charged while the other is being used.

Power On

To operate the monitor, turn on the power by flipping the toggle switch to the ON position. You will know that the monitor is on and ready to be used when you hear an occasional beep.


COUNTS PER SEC
500
0
1K
POWER ON
AUDIBLE ALARM
CHARGE & EXTRNL PWR
TEST
NATIONAL NUCLEAR CORPORATION

Setting the Background

When you turn on the power, the monitor will probably start beeping. This is because no background radiation intensity is stored in the monitor's memory. After the monitor is turned on for 10-15 seconds, you can store the background radiation by pressing and releasing the RESET button. A few seconds after you press the button, the memory will have a new background value and the monitor should behave normally.

When you first turn on the monitor, wait about 10 seconds before you set the background or you may have to set it twice. Cold weather or a slow starting monitor may cause this delay. Turn on the monitor, wait 10 seconds, then press and release the RESET button. If the monitor needs further resetting, it will beep too much or not at all. In that case, press the RESET button again. Usually one or two beeps per minute is about right.

At Los Alamos the normal background value is about 140 counts/second. Other locations will have different values. Write the normal background value for your location at the bottom of this page.

If you suspect the monitor is not working properly, compare the displayed background value on the count-rate meter with the normal reading for your location. If it has changed, your monitor may need repair. Tell your supervisor immediately. He will have the instrument repaired and will bring you a replacement to use while the repair is taking place.

Normal background radiation at your location:

_____counts/second.

There is a good way to tell when you need to take a new background: the monitor beeps too often or not often enough. When the background is properly set, the monitor should beep once or twice each minute. Use your watch to time the beeps instead of guessing.

When the monitor is turned on and has a recent background measurement, it is ready for use. If the monitor is already at the search location, you are ready to conduct a search. If the monitor is inside the guard station and you take it outside to search, you probably will have to reset it. Or, if it has been quite a while since you set the background, you may have to reset it just before starting a search. In either case, reset the background in the search area but not close to the search object. Your best bet is to leave the monitor at the search location to minimize the amount of background resetting.

Setting the Alarm Level (Delta Rate Monitor Only)

When the radiation background is high, you will need to adjust the sensitivity of the Delta Rate Monitor. First, as with any background change, reset the stored background by pressing the RESET button. Then slowly increase the thumbwheel setting from 07, its normal reading, to 11 until only one or two beeps a minute occur. Remember to reset the background and decrease the thumbwheel switch setting when the background returns to normal.

Normal thumbwheel setting for your location: _____.

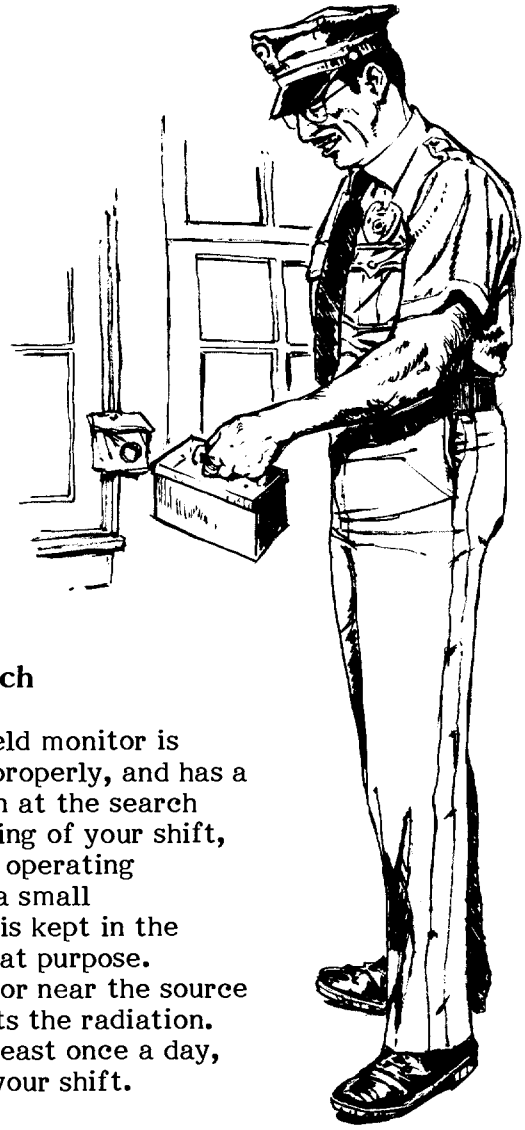
Search Techniques

Your sensitive and intelligent monitor is only as good as your search technique. The care and thoroughness that you take in conducting a search are essential to the security of the access area that you are protecting. The recommended search techniques that follow are for locating small quantities of special nuclear material. Large amounts are easy to detect, of course, and require no additional steps.

General Procedures

To conduct a thorough, effective search, you must scan the monitor over the surface of every person, package, and vehicle. Avoid contact: a distance of 2 to 6 inches from a surface is close enough. When the monitor senses a source of gamma radiation, it will begin beeping and you may notice that the intervals between beeps shorten as the monitor approaches a radiation source. If the monitor beeps but there is no change in beep intervals as you move the monitor around an object, the radioactivity may be distributed uniformly over the object. This sometimes happens in the case of contamination.

You can pinpoint small sources of radiation by moving the monitor around a radioactive area to find the strongest response. If the source is a very strong one, reset the background while the monitor is near it. The monitor will be less responsive, but when it does start beeping it will be very close to the source. Reset the monitor to a normal background before using the instrument again.



Preparation for Search

Be sure the hand-held monitor is turned on, is operating properly, and has a recent background taken at the search location. At the beginning of your shift, you can verify that it is operating properly by monitoring a small radioactive source that is kept in the guard station for just that purpose. Simply bring your monitor near the source and verify that it detects the radiation. Verify your monitor at least once a day, perhaps at the start of your shift.

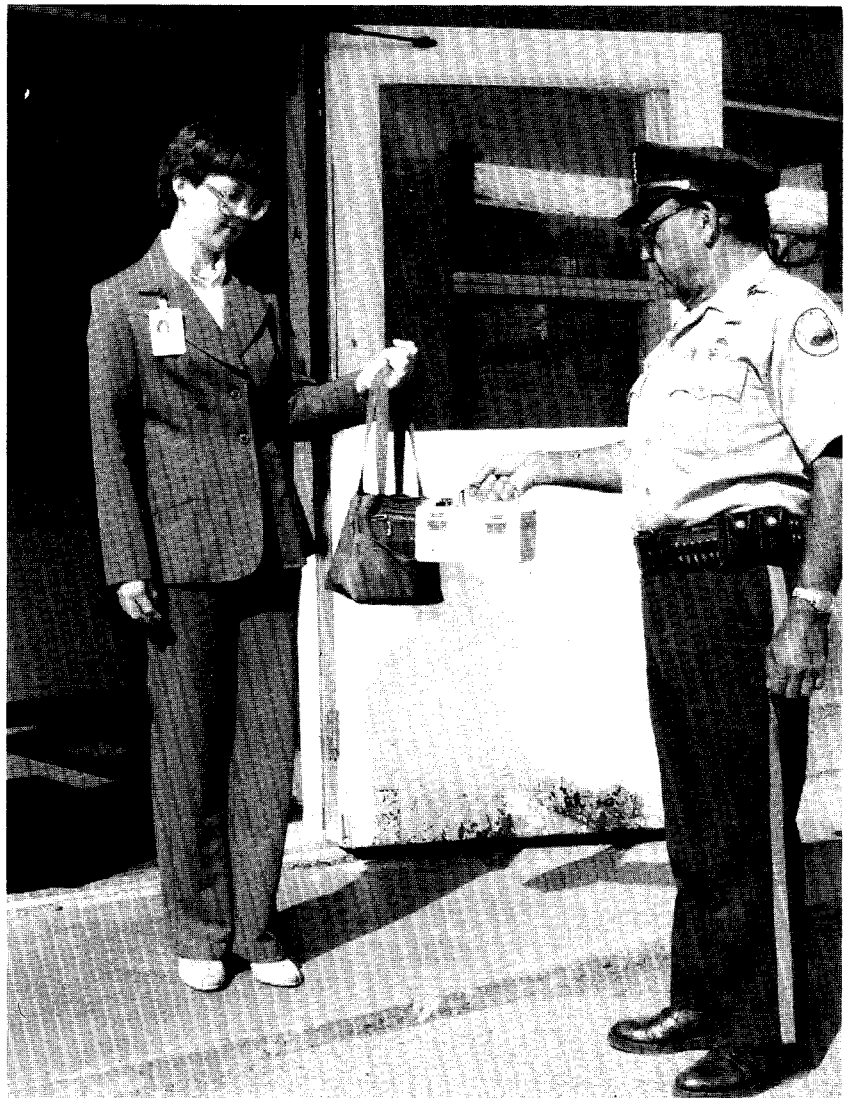
Personnel Search

Allow 15 seconds to perform a thorough radiation search of a person. This is enough time to search the person, front and back. You may move your monitor rapidly, but remember that it will only detect radioactive material if it is close enough to sense it.

A good place to begin your scan is near one foot. Scan up one side of the body to the head, then scan down the other side. Ask the person to turn around and repeat the inverted U-shaped sweep. Pace your scan. Each sweep from head to foot should take 2 or 3 seconds. Hence, a front scan will take 5 or 6 seconds, turning around takes a few more seconds, and a back scan takes 5 or 6 seconds, for a total of 15 seconds.

Package Search

Briefcases, purses, and packages are the common items that people carry. Search each item by passing the monitor over its surface. Ask the person to open large items for a visual search. Look for large, heavy objects that may be radiation shields. The open lead container in the photograph below is a commercial radiation shield. Similarly shaped objects may be intended as shielding. If a package is sealed and cannot be opened for a visual search, use more care in scanning to make sure it does not contain special nuclear material. Search slowly over the surface of the package, taking plenty of time to scan all sides.

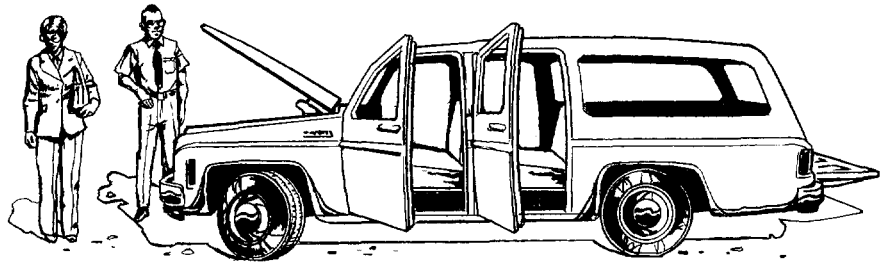


Motor Vehicle Search

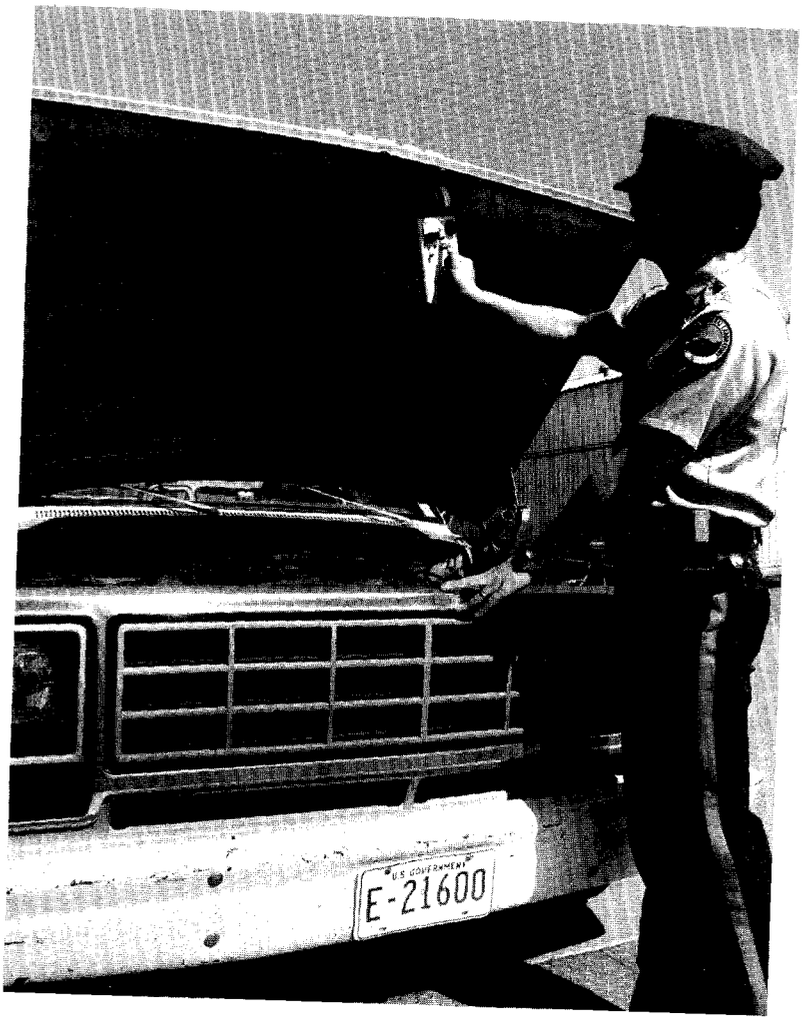
Motor vehicles are more challenging to search for special nuclear materials than people or packages. The search is a much longer procedure. Follow steps 1-5 when you search a motor vehicle. Steps 6, 7, and 8 are for specific cases. Remember to do a visual search as you scan with your monitor. Check large, heavy containers very carefully with your monitor.

1. Preparation. Prepare to search in the usual way by making sure the monitor is turned on, is operating properly, and has a recent background. In addition, prepare the vehicle for search by asking the driver to shut off the engine and open the hood, trunk, and all doors. Request that the driver and passengers get out of the vehicle and stand away from it during the search.

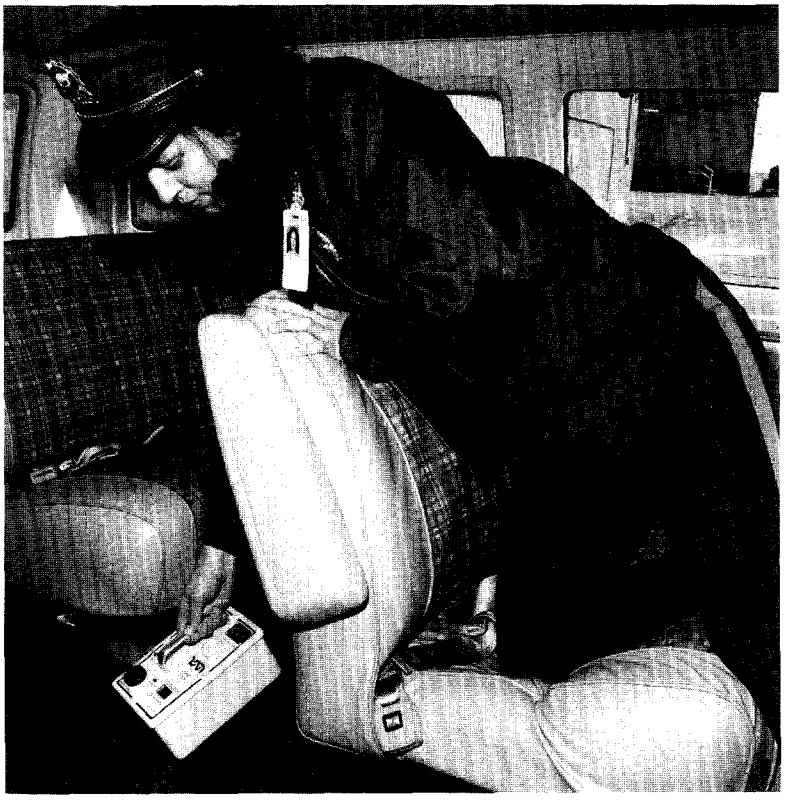
2. Personnel Search. Search each occupant as well as the vehicle. Scan the occupants with your monitor while they are out of the vehicle before you allow them to go back inside.



3. Hood Area Search. Search under the vehicle's hood by moving the monitor within 6 inches of all surfaces that you can reach. Don't forget to search the hood itself.



4. Trunk and Interior Search. Search the vehicle's trunk and interior. Enter each door and search around every object and surface within reach. Scan unlikely places, such as the dashboard, sunvisor, headliner area, floor, and under the seats. Search the space behind the rear seat. Search the cargo areas in trucks. If you cannot reach an area, search it from outside the vehicle, through glass whenever possible instead of through metal. Remember to move the monitor within 6 inches of every surface. When you are searching the inside of a vehicle from outside, be sure to take extra time.



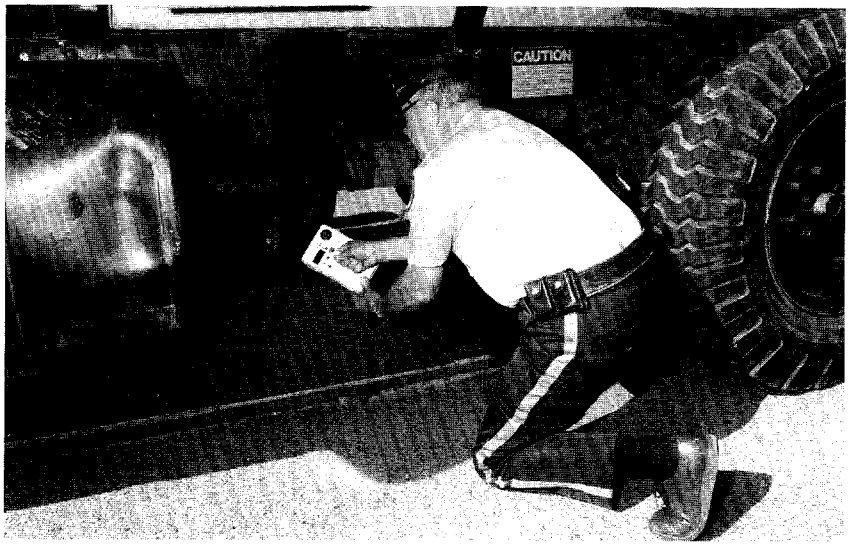
5. **Exterior Search.** When you search the outside of a vehicle, scan under frame rails and bumpers as well as check the wheel wells in front and behind the tires.

6. Pickup Beds. Scan the bed of pickup trucks. Just because the bed is empty does not mean you can skip it. A container of special nuclear material may be attached to the undersurface.

7. Large Trucks. Step van, flatbed trucks, dump trucks, garbage trucks, and many other large trucks present a particular challenge. You must search wherever possible. It helps to have a small stepladder or stepstool to reach the high places. Search all the accessible spaces and search the exterior of any inaccessible spaces.

8. Escorted Vehicles. Escorted commercial vehicles should be searched even though they have been watched by a security escort. The escort is responsible for watching the occupants, which may take his eyes off the vehicle. Therefore, conduct a full search of the vehicle.

Use your eyes as well as your ears in searching.


CAUTION

What To Do When You Find Radioactive Material

Your station orders tell you specifically what to do when you detect special nuclear material that has no removal permit. In other cases when you find something that seems to be contamination, medical radiation, or radioactive camera lenses or wristwatches, have the item or person examined by a health physics surveyor. Then ask the nuclear material custodian or site supervisor to clear the item or person. Write the names and telephone numbers of the persons you will need to contact in the spaces provided.

Health Physics Surveyor	Telephone
Nuclear Material Custodian	Telephone
Site Supervisor	Telephone

SEARCH CHECKLIST

NOTE: Search distance, 2 to 6 inches from surface

Preliminaries
- Monitor is turned on
- Background is current

Personnel Search (15 seconds)
- Front (inverted U-shaped sweep)
- Back (inverted U-shaped sweep)

Package Search
- Monitor inside and conduct a visual inspection
- Monitor outside very carefully for sealed packages

Motor Vehicle Search
- Engine shut off
- Driver and passengers get out and open compartments
- Search occupants before they reenter vehicle
- Search engine area under hood
- Search hood
- Search trunk area
- Search trunk lid
- Search under seats
- Search dashboard
- Search sunvisor
- Search headliner
- Search floor
- Search behind rear seat
- Search cargo area of trucks
- Search under frame rails
- Search under bumpers
- Search wheelwells
- Search bed of pickup trucks

Notes

Remember to take 15 seconds when you search a person.

☆U.S. GOVERNMENT PRINTING OFFICE: 1984 — 776-101/1029

Produced by the Energy Division,
Advanced Nuclear Technology Group

Technical writing and editing: Dorothy C. Amsden
Design, composition, and layout: Dorothy C. Amsden
Technical illustrations: Barbara W. Edwards
Artist renderings: Rodney L. Furan
Photographs: Daniel F. Morse, Enrique F. Ortega, Robert M. Peña
Models for photographs: Los Alamos National Laboratory employee Belinda K. Haag and Mason & Hanger-Silas Mason Co., Inc., security guards Francisco E. Chavez, Gerald J. Keene, Patricia Molina, Pete Montoya, Horacio E. Roybal

Text copy was composed in Bold font on a Wang word processor with proportional spacing.

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545