# A Proposal to Set Up a Network of AARST Measurement Professionals to Act as First Responders in the Event of an Accidental or Purposeful Radioisotope Event

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## Abstract

Shortly after September 11, 2001, there was renewed discussion concerning the possibility of another terrorist attack, this one involving stolen, or purchased, radioactive material. However, even two years later, most municipalities are not equipped or trained to measure radioactivity except on a very small scale. The author proposes that the large network of radon measurement professionals in the AARST organization (and allied organizations) join together to become a nationwide resource in the event of such an attack (or any other situation that results in a significant increase in background radiation). This paper will discuss such topics as: types of radiation (and their sources) that may be expected in the case of a radiological dispersion device, how to use existing radon measurement devices to determine any increase in the background radiation (including slight modifications of some radon measuring devices), following reasonable protocols for determining current background radiation, establishing an 800 number and/or a web site that can be used to track all of this information and possible ways to communicate with federal, state and local organizations in the event of such an attack. The presentation will be in a discussion format with attendees expected to play an interactive role with the presenter.

## Background

Most readers are aware of the immense publicity and discussion surrounding the possibility of a purposeful dispersion of radioactive material through the mechanics of a "dirty bomb", aerosol spray, drinking water contamination or some other radiological dispersal device (RDD). Indeed, governmental agencies at all levels have been aware of this possibility for years(1) and have developed contingency plans should they be needed. Some of these contingency plans are available to the general public either through Internet downloads(2) or by purchased reports like NCRP-138, Management of Terrorist Events involving Radioactive Material (2001). There are weaknesses, however, in their contingency plans. Among those weaknesses is one that is the topic of this paper: the lack of radiation measurement devices that would be used to characterize the type, extent and amount (activity) of radiation that resulted from an RDD, especially during the first few critical hours immediately following the dispersal.

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(1) See, for example, the historical review of regulations surrounding the transport of spent nuclear fuel. The regulations, which are attempting to reduce sabotage of such transport containers, dates back to 1979. (Lyman, 1999)

(2) See, for example, Department of Homeland Security Working Group on Radiological Dispersal Device (RDD) Preparedness, Medical Preparedness and Response Sub-Group (DHS, 2003).

In order to increase the number of badly needed monitoring stations, this paper proposes that AARST members take on the responsibility of becoming a team of "first responders". Those members who are able will set up monitoring stations at their home or place of business using their existing radon measurement equipment, reporting the background and (possible) elevated radiation levels to some central phone number or web site. It is also suggested in this paper that these same members may want to procure an inexpensive survey instrument in the future in order to expand the types of radiation they can monitor. Finally, it is proposed that, if these first two steps are successful, these survey instruments be linked to a central computer where they will be able to automatically log in and report their readings. It is envisioned that, ultimately, the United States be blanketed with a system of automatic radiation detectors that are able to report to a central computer at AARST headquarters. Governmental authorities would have access to this computer, allowing them to get real-time radiation data in the event of an emergency.

## Types of Radioisotopes and Their Radiation

Although there has been no known RDD's placed by terrorists at this time, there have been incidents that indicate that radioisotope material is available and could be used in a RDD without significant technical difficulties. For example, in Brazil in 1987, 200 people were exposed to radioactive cesium-137. This cesium-137 came from an unused and out of date radiotherapy machine (Stone, 2003). The International Atomic Energy Agency has technicians in the former Soviet Union and other countries where atomic stockpiles once were (and, in some cases, still are) stored. In addition, the Soviets used radioisotopes for generators and calibration sources. In Georgia, for example, dozens of "teakettle" sized containers were found to be causing radiation illness among Georgian army recruits and, in 2001, a pair of canisters containing strontium-90 with an activity of 40,000 curies ($1.5 \times 10^{15}$ Bq) each caused radiation burns to three Georgian men sleeping near the canisters for their warmth (Stone, 2003).

It is presumed that the radiological materials will be dispersed by one of three methods. First, the radioisotopes will be embedded or wrapped around a conventional bomb. The putative damage will mostly come from the relatively low level of radiation that persists long after the event and the accompanying psychological distress caused by the "unseen" radiation and the inability to reoccupy the affected area (Levi, 2002). Second, the radioisotopes could be manufactured in powder form allowing for a quiet dispersal using hand-held sprayers or car mounted sprayers. The first indication of such an attack may be an announcement by the terrorists that it has occurred. Third, using a variety of modalities, terrorists may insert the solid or liquid phase of the radioisotope in foodstuff or drinking water. Livestock food could also be contaminated in this way (NCRP-138).

What kind of radioisotopes would be used by terrorists? Although the following list may not be complete, it shows many of the radioisotopes that could be used in the event of a terrorist attack, not including fission products from an actual nuclear bomb. In table 1 below, the radioisotope is given in the left column. Next, from left to right, is listed the type of radiation predominately associated with each isotope (Kocher, 1981), the energy of the radiation (average beta energy is given for a single beta or for several betas per isotope), the half-life, and, finally, a possible source for the material.

| Radioisotope | Radiation | Energy | Half-Life | Possible Source |
|---|---|---|---|---|
| Cs-137 | beta | 156 Kev | 30y | hospitals |
| Ba-137 | gamma | 662 Kev | 2.5 m | comes from Cs-137 |
| Co-60 | beta | 95 Kev | 5.3 y | hospitals |
| Co-60 | gamma | 1.1 Mev and 1.3 Mev | 5.3 y | |
| Co-60 | gamma | 58 Kev | 10.5 m | a second decay path for Co-60 |
| I-131 | beta | 191 Kev | 8 d | hospitals |
| K-40 | beta | 508 Kev | 1.3 Gy | from normal potassium sources |
| K-40 | gamma | 1.4 Mev | 1.3 Gy | |
| Sr-90 | beta | 195 Kev | 29 y | spent reactor fuel, generators |
| Y-90 | beta | 934 Kev | 64 h | comes from Sr-90 |
| Am-241 | alpha | 5.5 Mev | 432 y | smoke detectors |
| Kr-85 | beta | 241 Kev | 10.7 y | spent reactor fuel |
| Ir-192 | beta | 180 Kev | 74 d | hospitals |
| H-3 | beta | 5.6 Kev | 12.3 y | signs |
| P-32 | beta | 694 Kev | 14.3 d | comes from longer lived Si-32. Used in hospitals |
| Cs-137 | beta | 170 Kev | 30.2 y | well logging device |
| Ru-103 | beta | 67 Kev | 40 d | spent reactor fuel |
| Ru 106 | beta | 10 Kev | 368 d | hospital |
| Sr-89 | beta | 583 Kev | 51 d | spent reactor fuel |
| Pu-238 | alpha | 5.5 Mev | 88 y | spent reactor fuel |
| Pu-239 | alpha | 5.2 Mev | 24,000 y | spent reactor fuel |

Table 1: A partial list of radioisotopes that could be used in a RDD.

A more complete list of radioisotopes that are used commercially can be found on the web in a report recently put together by the General Accounting Office (GAO, 2003).

With little or no modifications, existing radon measurement devices could be used to quickly establish an increase in background levels caused by many of the isotopes in table 1. How this would be done is covered in the following section.

## Using Radon Measurement Devices to Monitor Radiation

Basically, what we are trying to do is to measure the increase in background radiation caused by air-borne radioactive particles. So, if any modification of the existing radon measurement instrument is required, it is simply to allow the particles, normally radioactive dust (in the case of a "dirty bomb"), to get into the device. Ideally, the radon measuring device will have to be placed outside for this purpose so that the suspected radioactive airborne material can pass through it or settle onto it. [(3)]

For charcoal canisters, this will require no modification at all. Simply place the canister outside with its lid removed. After a few minutes, replace the lid and read the canister in the normal gamma scintillation device. There is no need to delay reading as there is no requirement for secular equilibrium between the radon and the radon decay products to form. Look for the gamma signatures listed in table 1. You should be able to identify the isotope from its gamma signature and even estimate the activity by comparing it to the normal background for that same area. This may require lowering the lower energy boundary in the window if you are presently excluding low energy gamma from being counted.

For a *femto*-Tech® 510, remove the cover by removing the four screws holding the cover on. Replace the cover with a 1/8 inch wire cloth, approximately 7 inches by 10 1/2 inches. Replace the screws, holding the wire cloth in place. The wire cloth acts as a Faraday shield, reducing interfering EMF but allowing the radioactive particles to enter unimpeded. Look for increases in the alpha counts from those alpha emitters in table 1. As an aside, this procedure does not alter the calibration of the instrument nor does it change its ability to measure radon accurately. [(4)]

For the Sun Nuclear® 1027, there appears to be no modification that would allow the unit to be used in the way needed here. This is because the unit is purposefully designed with a long and tortuous path length that radon and its decay products must follow in order to eliminate reading radon decay products from the room when used normally.

For the Pylon® AB-5 continuous radon monitor, simply remove the filter from the inlet and run in the active mode. It will, of course, read the alpha particles from the air being taken in by the onboard fan. Alternatively, use the radon decay product attachment and measure all alpha sources trapped on the filter.

For the Eberline ®RGM-3 continuous radon monitor, again, simply remove the filter and allow outdoor air to pass through unimpeded. The RGM-3 is only run in the active mode.

If one has a portable gamma ray scintillometer, like the Eberline® ESP-2 with a scintillation probe, simply use it in its normal survey mode.

Of course, a Geiger counter makes an ideal survey instrument and requires no modification at all. In order to get a rough idea if you are reading an alpha, beta or gamma source, place a piece of paper over the face of the Geiger-Mueller tube. Any

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(3) With the exception of f*emto*-Tech® and Sun Nuclear®, the author has had no discussion of these modifications with the manufacturers of the devices. Therefore, no approval of these modifications is implied or intended.

(4) Thanks to Dick Manning and Rick Straub for doing the verification testing at *femto*-Tech®.

decrease in counts is directly related to the fraction of the incoming radiation that is alpha. A thin piece of lead sheet will shield from betas, leaving gamma and higher energy x-rays only.

Since radon decay product measurement devices are designed to trap particulate from the air and measure the radon decay products caught on a filter, radon decay product devices, by there very nature, are ideal for measuring alpha emitters in the air. Run them as is normally done, only outside. Look for increases in alpha counts.

E-Perm® electret systems may be used in one of two ways. Placed outside, open but in a plastic bag, they will measure gamma. Look for an increase in gamma above background over the exposure period. Using the gamma correction given in the instruction manual, it is even possible to convert to standard units, like mR/h. Alternatively, one could remove the filter from the ionization chamber and place the opened chamber outside for a short period of time. This will allow radioactive dust to enter the unit. Interpreting the result will be difficult (because of the interaction of the dust with the charge on the electret) but an increase in voltage loss could be qualitatively determined. Finally, Rad Elec Inc. has recently announced a modification of their product that allows for measuring of radon decay products. Used in this configuration, the elecret system will probably be equivalent to using any other radon decay product measuring device. This was discussed earlier.

There are many radon and radon decay product devices available to the membership. This list by no means is exhaustive. Part of the evolution of this proposal will be to inform the AARST members of the usefulness of other commercially available radon and decay product devices and what, if any, modification they may require. Manufacturers are encouraged to contact the author with recommendations. In general, however, what is needed is for the outdoor air to be able to get into the device unimpeded. Then, any difference in what the device reads and what it reads under controlled conditions (background) may be attributable to the airborne or deposited radioisotopes from the RDD.

If there is an actual RDD utilized, you will probably need to clean your measurement device later as there is the possibility of contamination by the radioactive particles that got inside your device. In the unlikely event that your device was directly in the path of a radioactive plume, you should minimize handling of your device and, using rubber gloves, bag it in plastic and carry it to a decontamination center. Of course, if things are this bad, you probably need further assistance with decontamination of your body, residence, etc.

## How to Get Started

Begin by establishing a background for the place in which you will be measuring, preferably outside, near your residence or place of business. Place the (modified) device outside (protected from the elements, of course). It must be placed in such a way that it would be exposed to a passing radioactive dust plume if one occurred. Place it on a stable platform a few feet off of the ground. Expose the device for a period of time. A reasonable time period would be 10 minutes on the low side and one hour on the high side. Of course, for a Geiger counter, a reading can be taken essentially instantaneously. Now, record the date, time, location (including height above ground), type of radiation read and the radioactivity. Use whatever units you have available on the device. Counts per minute are preferable. Also include the type of radon or radon decay device you are using, its calibration constant (pCi/L per cpm, for example) and its serial number. If you are able, make a permanent record of this reading (print out, computer screen dump, etc.). Do this several times over a period of a week or so. Use the average determined from these several readings. This will average out normal radiation changes caused by variations in radon and radon decay products in the outside air that occur because of disturbance of nearby soil or changing weather conditions.

## What to Do in an Emergency

Given sufficient notice, place your (modified) monitoring device in the same location as you did for the background determination. Expose for the same amount of time. Read the device and note any increase in radiation, recording the same information as was done in the background phase. If qualified, convert the radon or radon decay product units to counts per minute. By the way, no increase in radiation is valuable information also.

If you are able, and you are not putting your life or health in jeopardy, you should continue to monitor over the next several hours and days as this information will be equally important to authorities.

## What Do You Do With the Information?

It is the author's goal to have AARST set up a 800 number or a web site dedicated to this project. The web site would allow AARST members to log on, record pertinent information (possibly on a map) and to add new information as it becomes available. Governmental authorities at all levels would be informed of the web site once it was operational. It will take time to design and set up this web site. Members are encouraged to keep abreast of the evolution of this project (if anything happens at all) by reading AARST publications and emails.

Should this goal not be reached, or should there be a terrorist attack before the goal is implemented, it is up to the individual to contact local authorities with the radiation results. However, it is not recommended that one routinely call authorities every time one sees an increase in background levels. This is because allowing unfiltered air into a device allows radon decay products to enter also. A variation in radon decay products in the outside air is expected. This would cause false alarms. It is best to withhold the impulse to report radiation increases (on an individual basis) until it is known that a RDD has been implemented.

## What May the Future Hold?

Since radon and radon decay product devices are not designed to measure beta, many of the radioisotopes in table 1 can not be detected with them. The author suggests, if this project does indeed move forward, that the membership purchase inexpensive Geiger counters. Geiger counters make ideal survey instruments as (many of them) measure alpha, beta and gamma rays, although their sensitivity to alpha particles is quite low. It is even possible that by the 2004 symposium, arrangements could be made to purchase Geiger counters in bulk or, perhaps, building a Geiger counter could be part of that symposium.

In any case, once there was a widespread use of Geiger counters, a more systematic and uniform monitoring could take place. The reported numbers would all be comparable, regardless of who took them or regardless of their location. [(5)]

Finally, it may be possible to purchase or build Geiger counters that are able to "call in" and report their readings without human intervention. Modern electronics has made modem/radiation counting devices relatively easy to manufacture and relatively inexpensive. Should this ultimately transpire, it is conceivable that governmental authorities would have access to a map that covered the entire country and automatically updated itself, say, once a minute. The author believes this is possible. It will take time, however. It will take a commitment by the AARST membership to make it happen.

(5) For example, a Geiger counter can read out in units of counts per minute (cpm) or a thousandths of a roentgen per hour (mR/h) which can be easily converted to mrem per hour (for gamma and beta). NCRP (1993) recommends a maximum annual exposure of 100 mrem (1 mSv). NCRP also recommends that a reading of 10 mrem/h (0.1 mSv/h) indicates an area that is not safe to stay in and that a reading of 10 rem/h (.1 Sv/h) or higher indicates an area that should not be entered unless the person is willing to accept permanent radiation damage, including later stochastic illnesses (like cancer) or death.

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