Chapter 11
RadNet National Air Monitoring Program

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Abstract The United States Environmental Protection Agency has operated a variety of national radiological air monitoring systems for more than four decades. The current system, RadNet, operates approximately 140 fixed monitoring systems across the United States including Alaska and Hawaii. The system provides near-real-time gamma spectroscopy data and limited gross beta radiation data as detected on a 4 in. air filter on a high volume air sampler. Filters are analyzed hourly and results are sent electronically to an EPA laboratory for review. Any anomalous results outside of normal background variation are reviewed by an EPA scientist. In addition to the fixed monitoring systems, there are 40 deployable units that include low and high volume air samplers and electronically transmit ambient gamma exposure readings. The system provided continuous data to the public and interested scientists during the Fukushima release. RadNet is able to remotely detect typical gamma emitting isotopes at levels several orders of magnitude below protective action guidelines. In order to provide even more sensitive analytical results, RadNet air filters are sent to an EPA laboratory for analyses approximately twice weekly. Potential updates to the system include improved radiation detectors and improved communication devices for deployable RadNet systems.

11.1 Introduction

In the last decade, the United States Environmental Protection Agency saw a need to develop and institute a significant upgrade to the national radiation monitoring systems that it has had in place since the 1970s. The original monitoring network was primarily designed to detect fallout from early nuclear weapon testing by nation states. The new plan was defined in the 2005: *Expansion and Upgrade of the RadNet Air Monitoring Network, Volume 1 and 2, Concept and Plan* [1]. Prior to that plan, the EPA had 59 high-volume air monitoring systems located across the United

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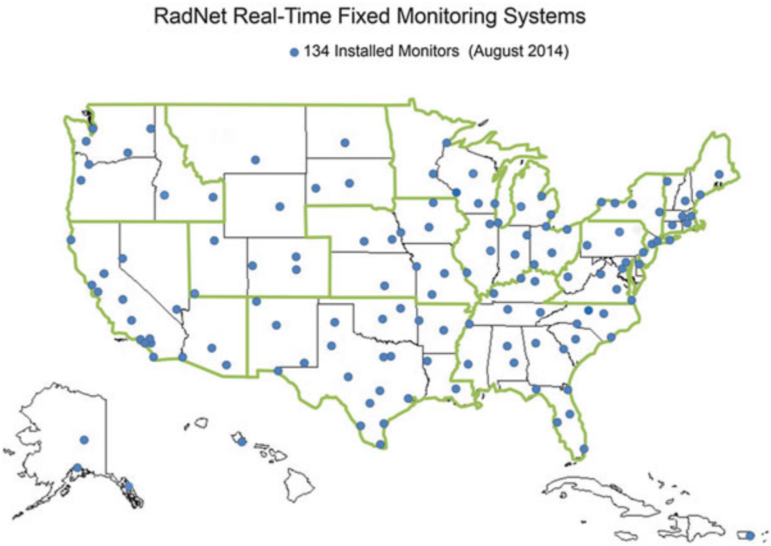

Fig. 11.1 Installed RadNet fixed location air monitors [4]

States. Those air monitoring systems were part of the Environmental Radiation Ambient Monitoring System (ERAMS) [2]. This system was different from the Comprehensive Test Ban Treaty monitoring network. Air filters from those sites were sent approximately twice weekly to the National Air and Radiation Laboratory (now the National Analytical Radiation Environmental Laboratory) for analysis. Data from the analyses were made available to scientists and the public via ERAMS data bases. That data is still being updated from the new RadNet system and includes data from the Chernobyl release. In addition to the air monitoring systems, RadNet also maintained a few sampling locations for rain water, drinking water, and milk. The updated air monitoring systems include hourly electronic data from gamma and beta detectors, a significant increase in the number of monitors (134 now installed), and 40 deployable systems with different characteristics from the fixed installation monitors. See Fig. 11.1 for locations of fixed monitors.

11.2 RadNet Mission and Objectives

RadNet's primary purpose is to track national or regional ambient levels of radioactive material in the air. This allows users to identify the degree and extent of contamination in the event of an emergency. The system operates continuously so that normal background levels and natural fluctuations are known. The system supports EPA's role in incident assessment and focuses on monitoring potential impacts to public health.

Radnet provides data quickly in the event of a radiation incident to decision makers, dispersion modelers, nuclear and radiation health experts, and the general public. Although the system might be the first to detect an incident, it is normally expected to provide data following a known incident such as Chernobyl or Fukushima. RadNet data helps determine large scale national impacts of an incident, timely data for modelers, and estimates of exposure rates to assist in protective action recommendations and dose reconstruction.

RadNet is not intended to be regulatory in nature. As such it is not used to monitor nuclear reactors or provide early warning of nuclear accidents. As a national level system, it is not intended for use in the immediate locality of an incident. Other federal, state, local, or tribal assets will be used to monitor at a specific incident site.

11.3 RadNet Basics

While this paper primarily address the air monitoring aspects of RadNet, the program has been and continues to be multi-media including water and milk. However; the milk program has recently been discontinued and will be assumed by other federal agencies. RadNet air monitoring systems are typically operated by volunteers from EPA, states, and locals. All air filter and iodine cartridge samples are analyzed at the National Analytical Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama. The hourly and analytical data are available to the public.

RadNet air samplers (at fixed locations) operate at 60 cubic meters per hour and collect air samples on a polyester filter. A 2 in. by 2 in. sodium iodide (NaI) detector and a 600 square millimeter ion-implanted silicon detector make and transmit hourly measurements of the filter. Data from the sodium iodide detector is broken down into ten energy regions of interest for ease of data transmission. Staff at NAREL review the data if a computer algorithm indicated values are above typical background variation. There are two levels of alert depending on the size of the variance. If the count rates exceed the higher alert level, immediate notifications are sent to staff. While normal data flow only includes counts in the ten regions of interest and the beta count, staff are able to download the full NaI spectrum for analysis. An example of the spectrum from a calibration run is shown in Fig. 11.2. All air filters received by NAREL are screened for gross beta and undergo gamma analysis if above typical background levels.

The RadNet air monitoring systems at fixed locations provide excellent sensitivity for radionuclides of interest. Typically more than 90 % of the systems are operational at any given time. Remote sensitivity for several isotopes of interest is approximately 2 nCi (74 Bq) on the filter as shown in Fig. 11.3. For those filters analyzed at the laboratory, the sensitivity is approximately two orders of magnitude better. During the response to Fukushima, a few filters were counted for 5,000 min to ensure that all necessary isotopes were included in the gamma spectroscopy isotope analytical library. Yearly, over one million electronic data sets are reviewed and over

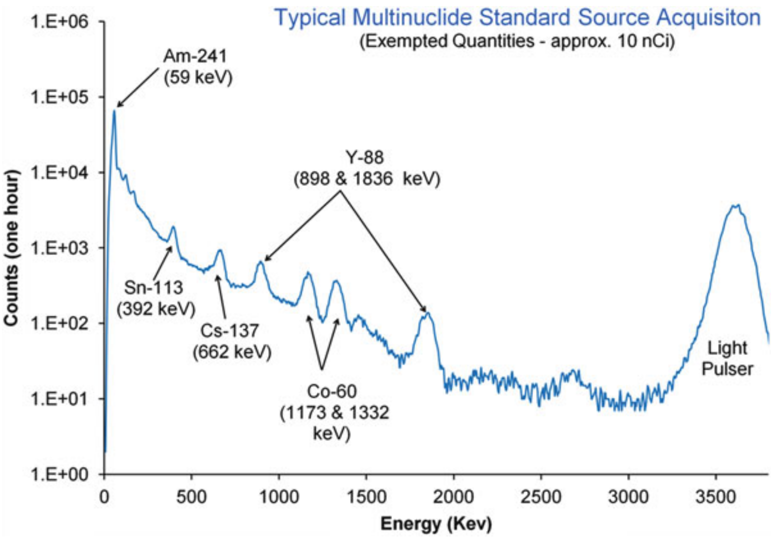

Fig. 11.2 Remote calibration spectrum from NaI Detector

Isotope	1-hour MDA*	PAG DRL †
Am-241	13.2 nCi	114 nCi
Cs-137	1.2 nCi	1,440,000 nCi
Co-60	2.0 nCi	222,000 nCi
Cs-134	1.1 nCi	960,000 nCi
Ir-192	1.6 nCi	1,620,000 nCi
Sr-90	50 nCi	38,400 nCi

*One hour measurement Minimum Detectable Activity at 95% confidence level
†DRL equivalent to Protective Action Guide

Fig. 11.3 Remotely measured sensitivity of NaI Detector compared to derived response level

14,000 laboratory analyses are performed. An additional, highly sensitive, analysis for plutonium in the air is performed on a composite sample of ash from all filters collected from a specific monitor for that year.

Data from the early and current RadNet systems are available at:

http://www.epa.gov/radnet/radnet-data/
http://iaspub.epa.gov/enviro/erams_query_v2.simple_query

The fixed location monitors send data via four redundant means to the monitoring center including phone lines, internet, cellular modem, and satellite. The deployable monitors transmit their data via analog modem, satellite, or directly to a personal digital assistant attached via cable to the system.

Deployable RadNet monitors include a low-volume air monitor, a high-volume air monitor, and a pair of compensated gamma radiation monitors. The gamma radiation monitors are Genitron Gamma Tracers and can measure exposure rates from 10 nSv/h to 10 mSv/h. External exposure rates from the gamma detectors are typically sent every 15 min to the monitoring center at NAREL when the deployables are dispatched and operational. The low-volume air sampler normally uses both an air filter and a cartridge (activated charcoal or silver zeolite) for collecting particulates and iodine vapor. The high-volume air sampler only uses an air filter.

EPA maintains 40 deployable monitors ready for use in an incident. Currently 20 are stored at NAREL and 20 are stored at the National Center for Radiation Field Operations (NCRFO) at Las Vegas, NV. In the future, the majority will be stored and maintained ready for use at NCRFO.

11.4 RadNet Isotope Detections

Figure 11.4 shows the detectors and interior of a fixed RadNet monitor. There is no special shielding provided for the NaI detector. Because of this, it is able to detect radionuclides in its environment in addition to monitoring the air filter. Because of this, RadNet monitors have seen a number of isotopes in their vicinity. The first was the detection of a radiographer using a cobalt-60 source in a major city. The source was about a block away, but clearly identifiable. Because the count rate went back to normal after the source was secured by the radiographer, the situation was clearly not due to collection of radioactive material on the filter.

Since that first detection, RadNet has seen iodine-131 and technetium-99m from medical patients, cesium-137, iridium-192, and most recently a positron emitter (most likely fluorine-18.) Each of these instances caused a low level alert so that an EPA scientist evaluated the spectrum to identify the source and confirm that it did not indicate an airborne release.

11.5 Fukushima Response

Within hours of learning about the damage to the Fukushima reactors, RadNet systems were continuously monitored for any indication of the plume reaching the United States. Because the airborne concentration was not expected to be high

Fig. 11.4 RadNet fixed location monitor detectors

enough to be detected by the near-real-time NaI or beta detectors on the fixed location RadNet systems, NAREL scientists analyzed several of the first filters that might contain isotopes from the event. Normal gamma analyses are for 3,000 min but a few of those early filters were analyzed for 5,000 min. Isotopes detected included Cs-134, Cs-137, I-131, I-132, and Te-132. As the plume moved across the United States, it was also detected in rain water samples. NAREL analyzed each rain water sample rather than compositing them monthly while the plume was present. During the entire time that RadNet systems were monitoring the event, there was only about 3 h where isotopes presumed to be from Fukushima were detected remotely on an air sample. The filter was analyzed remotely and approximately 1 nCi (37 Bq) of radioactive iodine was detected. After filter change, no further radioactive iodine was detected. The remote analysis was later confirmed by laboratory analysis at NAREL.

Discussions with other federal, state, and industry representatives indicated that they were also able to detect the plume using laboratory analysis of air samples. This raised the question of how to properly inform the public. RadNet fixed location monitors were not seeing the plume above background yet more sensitive analyses showed its presence at levels extremely far below any protective action level [3]. The added radioactive material was completely lost in the normal background variation seen by the RadNet monitors.

11.6 Upgrades Being Considered

For the fixed location RadNet systems, EPA is considering potential upgrades to the NaI detector to improve resolution, to the beta detector to reduce radiofrequency interference, and increased data transmission rates either for satellite or modem systems.

For the deployable RadNet systems, EPA is considering a significant change to the system that collects the gamma exposure, air sampler flow rates, and other data. This work is being done in conjunction with the US Department of Energy. Another potential change may be the elimination of the low and high-volume air samplers from the system as there are numerous such samplers in the EPA radiation response inventory. These proposed changes would reduce the weight and physical footprint of the deployable monitors.

11.7 Conclusion

The 134 fixed location and 40 deployable RadNet air monitoring systems have significantly improved the ability of the Environmental Protection Agency to monitor actual and potential large area releases of radioactive material in the air. The original system of 59 air monitors provided significant data to the agency following the Chernobyl incident. The new system provided hourly data to the scientific community and public during the Fukushima incident. While the airborne concentrations in the United States were far below any levels requiring protective actions, the public wanted to see for themselves. Data hits on the RadNet website prior to the incident averaged perhaps 30 a day. During the Fukushima event, that rose to several million hits a day. Clearly the public wants almost immediate access to information that they consider important to their health. RadNet was able to provide that.

References

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