UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

July 2, 2007

EPA-SAB-07-010

Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Subject: Review of 2005 Agency Draft entitled *"Expansion and Upgrade of the RadNet Air Monitoring Network, Vol. 1 &2, Concept and Plan"*

Dear Administrator Johnson:

The Radiation Advisory Committee's (RAC) RadNet Review Panel of the Science Advisory Board has completed its review of the Agency's draft entitled *"Expansion and Upgrade of the RadNet Air Monitoring Network, Vol. 1 &2, Concept and Plan"*, dated 2005.

The SAB Panel commends the Agency for maintaining the only comprehensive United States network for monitoring radioactivity and ionizing radiation in the environment. The Panel concludes that the proposed expansions and upgrades significantly enhance the ability of the RadNet monitoring network to meet the mission and objectives of the EPA and urges the Agency to move forward expeditiously with deployment of the fixed monitors.

The SAB Panel presents a somewhat different view from that of EPA with respect to the roles of the fixed and deployable monitors in routine and emergency operations. The Panel believes that there should be a better balance between physical deployment schemes and modeling requirements for effective environmental assessment, data interpretation and decision-making. The Panel recommends declustering of the fixed monitors in population centers to gain greater geographical coverage for a national picture of radiation in the environment.

The SAB Panel's concern with under-representation of the fixed monitors in low population areas is compounded by the concern that due to limited resources, the number of fixed monitors in the near future may be less than the 180 postulated in the plan. The Panel makes some suggestions for leveraging resources with states and other nations so that data gathered from other radiation monitoring systems can supplement RadNet in specific locations. The inclusion of state and nuclear facility air monitoring networks has the potential for adding several thousand monitors (in contrast to the extensive discussion about declustering and utilizing deployables which would pertain to 70 sites at best).

The SAB Panel questions whether the correct mission for the deployable monitors has been identified. A key question pertaining to the optimal use of the deployables is whether or not the monitors could be systematically deployed for “routine” monitoring to supplement the fixed monitors. The Panel agrees that use of the deployable monitors for augmenting the fixed monitoring capability must not significantly impact their availability for an emergency or incident. It is imperative that both the similarities and differences between the fixed and deployable systems be understood and quantified so that interpretation of the resulting data will be of high quality and consistency.

Because a large volume of data will be collected during routine operation, the Panel finds a need for carefully tailored decision rules (i.e. pre-existing criteria and process by which individual readings or groups of readings are identified as “elevated”) used to test whether a particular set of data is above background.

The SAB Panel finds that the modes of data transmission from the field to a central database appear to be satisfactory, with a variety of backup systems, and that EPA’s plans for quality assurance/ quality control are adequate. The evaluation and interpretation of RadNet data involves other communication links. The Panel fully supports the need for exercises that would test the standard operating procedures for set up, siting, data transmission, data quality assurance, data presentation, use of the data by incident management, as well as message evaluation. Exercises will also test the approaches that EPA proposes to use to identify, credential, and maintain the “volunteer” operators of deployable monitors.

The SAB Panel commends EPA for including stakeholders in the Agency’s ongoing planning to aid in understanding the requirements and preferences of various groups. Raw counting data are very site, detector, nuclide, isotope, particle size, chemical form, and population specific. Thus, the raw data cannot and must not be used to make even the crudest estimates of risk. EPA should develop, empirically test, and refine, sample informational messages with the aid of social science experts. These messages should address provision of data on baseline levels of radiation in the environment and the radiological aspects of emergency situations. While EPA is not designated as the lead agency with regard to communication, they will be considered the technical experts in presentation of RadNet data.

The SAB appreciates the opportunity for conducting this review and hopes that the recommendations contained herein will enable EPA to improve the RadNet Air and Monitoring Network. We look forward to your response to these recommendations.

Sincerely,

/Signed/	***/Signed/***
Dr. M. Granger Morgan Chair Science Advisory Board	Dr. Jill Lipoti Chair, Radiation Advisory Committee Science Advisory Board

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1. EXECUTIVE SUMMARY

RadNet is the United States' only comprehensive network for monitoring radioactivity and ionizing radiation in the environment. Since its inception in 1973, RadNet (formerly known as the Environmental Radiation Ambient Monitoring System or ERAMS) has continuously monitored multiple media, including air, precipitation, surface water, drinking water, and milk. The Environmental Protection Agency (EPA) proposes to expand and upgrade the air monitoring component to address homeland security concerns, as well as comply with the original mission to monitor radioactivity in air and to provide information on nuclear or radiological accidents. The upgrade to RadNet has three major emphases: adding near-real-time data transmission capabilities, significantly expanding the number of fixed monitor locations (from 59 to 180), and adding 40 new deployable monitors to the system. EPA's Office of Radiation and Indoor Air (ORIA) requested that the Radiation Advisory Committee of the Science Advisory Board review and provide advice on the expansion and upgrade of the RadNet air monitoring network.

The SAB Panel concludes that the proposed expansions and upgrades significantly enhance the ability of the RadNet monitoring network to meet the mission and objectives of the EPA. However, the SAB Panel presents a somewhat different view from that of EPA with respect to the siting, sampling, and deployment of the fixed and deployable monitors in routine and emergency operations.

For routine monitoring, EPA views the fixed monitor network as establishing baseline values and the Panel agrees with this view. The major benefit of the expansion and upgrade plan is the designation of up to 180 monitoring sites. Since acquisition of 180 fixed monitors is not projected to be completed until 2012 (although 130 fixed monitoring sites are projected to be deployed by Fall 2007), the SAB Panel recommends that the EPA consider placing some of the deployable monitors temporarily in the locations chosen for the fixed monitors to fill in geographic sampling gaps and provide more regional baseline data. However, EPA must ensure that this does not significantly impact the availability of the deployables to be recalled and redeployed in an emergency.

In the event of an emergency, EPA anticipates that the fixed monitor network will mainly be used to reassure people that no protective action is required in population centers not impacted by the incident.. Therefore, EPA proposed placing fixed monitors in high population centers, with only a secondary concern for broad geographic coverage. The SAB Panel strongly believes that in an emergency situation, the output of modeling would be more important to public safety and useful to decision-makers than the output of individual monitors. The models would use information on the location of a release, an assumed source term, and meteorological conditions to predict plume dispersion. If a fixed monitor was in the area impacted by the plume, the monitoring results could be used for evaluating the model results. However, due to the paucity of fixed monitors, the monitoring results are most likely to be used in reassuring people outside of the impacted area that the radiation levels are consistent with normal background values. A major release on a large or regional scale could lead to different uses of the monitoring system, however, for Radiological Dispersal Device (RDD) events, where local scale data is essential, modeling along with local emergency responder data would be used for protective action decisions in the early phase of an incident, supplemented with deployable monitoring data for the later phases.

The SAB Panel recommends more declustering of the fixed monitors guided by modeling requirements, to gain greater geographical coverage for interstate-scale monitoring and providing better reassurance to the public.

Because both the fixed and deployable sampling monitors will be used to provide important information to decision-makers, it is imperative that both the similarities and differences between these two monitoring systems be understood and quantified so that interpretation of the resulting data is of high quality and consistency. The SAB Panel recommends that potential sampling biases in the fixed monitor be evaluated. The EPA should examine whether near real-time gamma exposure measurement capability should be added to the fixed monitors as is present on the deployable monitors. Consideration of cross-calibration using a series of different energy gamma emitters or against a pressurized ion chamber would add to the EPA's understanding of the performance of the monitors. The SAB Panel suggests that the EPA add the capability to distinguish among alpha emitters because the existence of such a capability may be important in assessing potential terrorist activities, as well as distinguishing alpha emissions of naturally occurring radon progeny.

The SAB Panel recommends that the EPA create a simple table of radioactivity values in nanocuries (nCi) for radionuclides deposited on the filter that correspond to the selected limit on intake related to Protective Action Guidelines (PAGs). This would confirm that the Minimum Detectable Activity (MDA) is suitably lower than the PAG to permit reliable measurement results. Calculation of the MDA should be inserted into the EPA report and include a calculation of the standard deviation with counts and background counts tabulated for each region of interest.

The SAB Panel believes that, in general, the proposed EPA approach for siting fixed and deployable monitors significantly enhances the ability of the RadNet monitoring network to meet mission objectives. Nevertheless, the SAB Panel is concerned about the interplay between the deployable and fixed monitors. In the SAB Panel's opinion there should be a better balance between the actual physical sites (whether determined by population based siting or geographical siting) and modeling requirements for effective environmental assessment, data interpretation, and decision making.

The SAB Panel has provided some guidance to the EPA for determining the locations of the fixed monitors involving the use of models and meteorological forecast predictions. The SAB Panel's concern with under-representation of the fixed monitors in low population areas was compounded by the concern that, due to limited resources, the number of fixed monitors may be less than 180. The SAB Panel suggests leveraging additional monitoring stations by working with other existing systems such as those in individual states, around commercial nuclear power plants, and federal (e.g., Department of Energy) nuclear facilities. The inclusion of state and nuclear facility air monitoring networks has the potential of adding several thousand monitors (in contrast to the extensive discussion about declustering and utilizing deployables which would pertain to 70 sites at best). The SAB Panel suggests that there should be a mechanism established for entities who wish to use their own funding to purchase stations and who agree to comply with EPA standards, to become full-fledged "members" of the network. Coordination with Canadian and Mexican authorities for coverage near the northern and southern borders of the U.S. is also needed.

The SAB Panel strongly encourages EPA to optimize the fixed monitor siting plan by integrating the results of several models and performing several sensitivity analyses for different numbers of fixed monitors, siting density, and geometry of distribution. The actual physical location of the monitors can then be determined based on such practical considerations as access to electrical power, security, and availability of appropriate volunteers to maintain the system.

The SAB Panel discussed the flexibility of the placement of the deployable monitors in response to different types of hypothetical events. A key question for the use of the deployable monitors is whether or not the monitors could be systematically deployed for "routine" monitoring to supplement the fixed monitors, thereby increasing the utility of the deployables. The SAB Panel agrees that use of the deployable monitors for augmenting the fixed monitoring capability must not adversely impact the availability of the deployables if an emergency occurred. In view of the possibility the EPA would be requested to pre-deploy its deployable air monitors, the criteria for pre-deployment should be carefully established.

The EPA envisions using volunteers to deploy the monitors in an emergency situation. The SAB Panel expressed concern about the training for these volunteers and about their availability in a situation where there may be risks to their personal or family safety. EPA must identify and maintain a sufficient cadre of cross-trained key personnel and appropriately trained volunteers to effectively implement a response in the event that the core groups are not available.

The RadNet siting plan provides flexibility for placing deployable monitors for different types of events; however, the role of the deployables is not totally clear. Are the deployables limited to monitoring the edge of a deposition area? Are they available to provide assurance to populated areas not covered by fixed monitors? Since decision-makers will be looking for more data on impacted areas, should monitoring stations that can transmit data without unnecessary and avoidable exposure to personnel be used? The SAB Panel suggests that EPA consider whether the correct mission for the deployables has been identified. The effective interplay between the fixed and deployable monitors is dependent on clarification of their respective roles.

Data that will be collected includes an estimated 35,000 data points per day related to radionuclide levels from the fixed stations alone. It is important that these data be used for rapid identification of elevated levels, while avoiding false positives that misdirect concern. The approach and frequency of data collection of near real time data appears to be reasonable for deciding during an emergency that an area is not likely to be affected by a particular event.

A process does not appear to be in place for deriving optimal decision rules for RadNet such as pre-existing criteria and a process by which individual readings or groups of readings are identified as "elevated." Careful development of decision rules will require collaboration among all agencies involved in radiological emergency response. Because a large volume of data will be collected in routine operation, careful thought needs to be given to the types of decision rules used to test whether or not a particular set of data represents an increase above background. The optimization of decision rules should also take into account the number of monitors and their physical locations, which means the rules have to change over time as the RadNet system is expanded.

The modes of data transmission from the field to a central database appear to be satisfactory. There are a variety of backup systems for communicating data including modem backup to the satellite telemetry. The SAB Panel recommends that ORIA keep abreast of improvements in the technology as well as other factors that may have a detrimental or beneficial effect.

The evaluation and interpretation of RadNet data also involves other communication links that are critical to the process of providing high-quality information to decision-makers and other stakeholders. The flow of data from the event to the public follows a path from the field stations, National Atmospheric Release Advisory Center (NAREL), Inter-Agency Modeling and Atmospheric Assessment Center (IMAAC), and includes all of the agencies at Federal Radiological Monitoring and Assessment Center (FRMAC), with each Center adding value. Thus, there is also a need to consider the communication links among these nodes as well.

Since the SAB Panel proposed a revised mission for the deployable monitors, it may be necessary to have a direct read-out of radiation levels on the monitor itself, rather than relying on the download of local dose rate to a Personal Digital Assistant (PDA).

The SAB Panel found that NAREL's plans for Quality Assurance/ Quality Control (QA/QC) were adequate, but notes that the standard operating procedures should be in place and accompany all of the QA/QC plans to ensure that the data are handled reproducibly prior to any release and that information from the system is accurate and reliable. The SAB Panel fully supports the need for exercises that would test the standard operating procedures for set-up, siting, data transmission, data quality assurance, data presentation, use of data by incident management, as well as message evaluation.

Great care needs to be taken in converting raw data from counts per minute, to exposure, dose, and risk. Raw counting data are very site, detector, nuclide, isotope, particle size, chemical form, and population specific. Thus, without much additional information and analysis, the raw data cannot and must not be used to make even the crudest estimates of risk.

In closing, the SAB Panel commends EPA for including stakeholders in the Agency's ongoing planning to aid in understanding the requirements and preferences of various "customer" groups such as modelers, decision-makers, and the public. In order to meet emergency needs, the Panel recommends that EPA develop, empirically test, and refine sample informational messages with the aid of social science experts. These messages should address both routine and emergency conditions. The messages should address the provision of data on baseline levels of radiation in the environment, including variability. Sample messages involving the radiological aspects of emergency situations and used to provide data release to stakeholders and the public should be tested during drills and exercises. The Panel hopes that these recommendations assist EPA in providing the maximum benefit of the RadNet system to the public.

2. INTRODUCTION

2.1 Background

RadNet is the United States' only comprehensive network for monitoring radioactivity and ionizing radiation in the environment, with more than 200 sampling stations, including 59 air monitors, nationwide. Since its inception in 1973, RadNet (formerly known as the Environmental Radiation Ambient Monitoring System (ERAMS)) has continuously monitored multiple media, including air, precipitation, surface water, drinking water, and milk. EPA is proposing a plan for expanding and upgrading the air monitoring component of RadNet. The plan is designed to go beyond the original mission of providing information on nuclear or radiological accidents. The mission now includes homeland security concerns and the special problems posed by possible intentional releases of radioactive material to the nation's environment.

EPA's plan proposes additional and updated air monitoring equipment and more monitoring stations to provide greater flexibility in responses to radiological and nuclear emergencies, significantly reduced response time, and improved processing and communication of data. The ultimate goal of RadNet air monitoring is to provide timely, scientifically sound data and information to decision-makers and the public.

Formal planning for RadNet began in the mid 1990's when the EPA's Office of Radiation and Indoor Air (ORIA) initiated a comprehensive assessment of RadNet's predecessor (ERAMS) to determine if the system was meeting its objectives and if the objectives were still pertinent to EPA's mission. The first Science Advisory Board (SAB) Radiation Advisory Committee (RAC) advisory, in 1995, concentrated on an ORIA proposed preliminary design for a RadNet reconfiguration plan (U.S. EPA SAB. 1996). The second RAC advisory, in 1997, examined the reconfiguration plan for RadNet that was developed, in large part, based on the guidance from the previous advisory (U.S. EPA SAB. 1998).

In 1999 and 2000, three events placed the RadNet national air monitoring component on emergency status and confirmed some lessons on limitations in the existing system. The three events were the Tokaimura, Japan criticality incident (IAEA. 1999) and the fires near the Department of Energy's (DOE)'s facilities at Los Alamos National Laboratory (U.S. DOE. 2000) and the Hanford Reservation (Poston et al. 2001, and Albin et al. 2002). The Tokaimura incident highlighted the fact that the existing air monitoring system was not designed to detect noble gases. The two fires underscored the limitations of having low sampling density and a relatively slow system response time. Air filters had to be shipped to NAREL for analyses. It took several days for definitive data to reach decision-makers and the public.

In early 2001, ORIA began working on a new vision for a nationwide radiation monitoring system. In August of 2001, the design team announced its goals, and was well along in its planning. The terrorist attacks on the United States on September 11, 2001 expedited and strongly influenced the subsequent planning for updating and expanding RadNet. As a result, the design team decided to concentrate on the air monitoring portion of RadNet, and elected to introduce a series of deployable monitors that could be positioned in an emergency to augment the fixed monitors positioned in predetermined locations and to add real-time monitoring capability to the system.

Since use of deployable monitors had already been planned prior to September 11, 2001 and as they could be procured more quickly, the first available homeland security funding (late in 2001) was committed to their acquisition. ORIA then turned its attention to the system of fixed monitors with testing of a prototype in 2002. By 2003, EPA had decided that the prototype had demonstrated the technical feasibility of adding near real time gamma and beta monitoring capability to the fixed air monitoring stations. A proposal was submitted to the capital budget for expanding and upgrading the fixed air monitoring station component of RadNet, and, after evaluation by the Office of Management and Budget, was funded in the FY 04 budget. An actual purchase of a fixed monitor prototype was made in 2005.

The RadNet upgrade and expansion project is currently in the early implementation phase. As of December, 2005 the first prototype fixed monitor was received, tested, and installed at ORIA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama. A set of 40 deployable monitors has been acquired, 20 of which have been delivered to each of ORIA's laboratories in Montgomery and Las Vegas, NV. The information technology infrastructure is in place for handling real-time data.

The next steps include determining the national siting plan (where to put the fixed monitors), how to distribute and operate the deployables under emergency conditions, and the best protocols for dissemination of verified RadNet data during emergencies. EPA plans to acquire and deploy the fixed monitors at the rate of five (5) per month, completing the acquisition and deployment of 180 monitors by 2012. ORIA requested that the SAB Radiation Advisory Committee (RAC) provide input for these next steps.

2.2 Charge to the RAC RadNet Review Panel

The Agency's Office of Radiation and Indoor Air requested that the EPA Science Advisory Board review and provide advice on a draft document entitled *"Expansion and Upgrade of the RadNet Air Monitoring Network, (Volume 1&2) Concept and Plan,"* dated October 2005 (U.S. EPA ORIA. 2005.). EPA requested response to the following specific charge questions:

Charge Question 1: *Are the proposed upgrades and expansion of the RadNet air monitoring network reasonable in meeting the air network's objectives?*

Charge Question 2: *Is the overall approach for siting monitors appropriate and reasonable given the upgraded and expanded system's objectives?*

2a) *Is the methodology for determining the locations of the fixed monitors appropriate given the intended uses of the data and the system's objectives?*

2b) *Are the criteria for the local siting of the fixed monitors reasonable given the need to address both technical and practical issue*s?

2c) *Does the plan provide sufficient flexibility for placing the deployable monitors to accommodate different types of events?*

2d) *Does the plan provide for a practical interplay between the fixed and deployable monitors to accommodate the different types of events that would utilize them?*

Charge Question 3: *Given that the system will be producing near real-time data, are the overall proposals for data management appropriate to the system's objectives?*

3a) *Is the approach and frequency of data collection for the near real-time data reasonable for routine and emergency conditions?*

3b) *Do the modes of data transmission from the field to the central database include effective and necessary options?*

3c) *Are the review and evaluation of data efficient and effective considering the decision making and public information needs during an emergency?*

3d) *Given the selected measurements systems, are the quality assurance and control procedures appropriate for near real-time data?*

2.3 Review Process and Acknowledgement

In response to ORIA's request, a SAB Panel was established consisting of members of the RAC and additional experts with expertise in instrumentation, statistics, modeling, risk assessment, and risk communication. The RAC's RadNet Review Panel first met via conference call on December 1, 2005 to be briefed by the Agency staff on the draft document to be reviewed, to clarify the charge to the SAB Panel, and to assign specific charge questions to the individual Panelists in preparation for the face-to-face meeting.

The face-to-face meeting of the RAC's RadNet Review Panel to conduct a peer review of the Agency's draft document entitled *"Expansion and Upgrade of the RadNet Air Monitoring Network, Vols. 1 &2 Concept and Plan,"* dated October, 2005 (U.S. EPA ORIA. 2005.) was held on December 19 and 20, 2005 in the Agency's NAREL in Montgomery, AL where many of the Agency ORIA Staff implementing and managing RadNet are housed (see ***FR***, Vol. 70, No. 220, November 16, 2005, pp. 69550-69551). The SAB Panel wishes to express their sincere thanks to the ORIA staff in accommodating their needs during the meeting and for making it as productive as possible. The SAB Panel wishes to commend ORIA on the planning that went into this meeting. During the meeting, the staff worked hard to augment their excellent draft document with additional pieces of information that the SAB Panelists felt were necessary to assist with the review. The staff took extreme care to honor all the SAB Panel's requests and demonstrated their patience as SAB Panel members struggled to understand all that went into the decisions on equipment, siting and deployment strategies, and anticipated data uses.

The RAC's RadNet Review Panel scheduled three (3) additional public conference calls to reach consensus on its draft report in critique of the Agency's RadNet draft document. The meetings were held on March 20, 2006, April 10, 2006, and June 12, 2006. (see ***FR***, Vol. 71, No. 40, March 1, 2006, pp. 10501-10502). The March 20, 2006 meeting focused on the responses to charge questions 1 and 2. The April 10, 2006 meeting focused on reducing redundancy in the report, and the response to charge question 3. During the interval between the April 10 and June 12, 2006 meetings, the executive summary and letter to the administrator were drafted, so that the June meeting could focus on making sure the SAB Panel had reached consensus on the issues of most importance.

The draft SAB Panel report was forwarded to the chartered SAB for a quality review which took place on September 21, 2006 (See FR, Vol. 70, No. 165, August 25, 2006, pp. 50411-50412). This report reflects the suggested editorial changes of the Charter Board.

3. RESPONSE TO CHARGE QUESTION 1: AIR NETWORK OBJECTIVES

<u>Charge Question 1:</u> ***Are the proposed upgrades and expansion of the RadNet air monitoring network reasonable in meeting the air network's objectives?***

The upgrade to RadNet has three major emphases: adding near-real-time data transmission capabilities, significantly expanding the number of fixed monitor locations, and adding 40 new deployable monitors to the system. EPA stated the mission and objectives of the expanded and upgraded RadNet monitoring network as (in paraphrased form):

- Provide data on baseline levels of radiation in the environment;
- Maintain readiness to respond to emergencies by collecting information on ambient levels capable of revealing trends;
- During events, provide credible information to public officials (and the public) that evaluates the immediate threat and the potential for long-term effects; and
- Ensure that data generated are timely and are compatible with other sources.

The SAB Panel concludes that the proposed expansions and upgrades significantly enhance the ability of the RadNet monitoring network to meet this mission and objectives. However, the SAB Panel's view of the respective roles of the fixed and deployable monitors in routine and emergency operations is somewhat different than that of EPA, and is a major factor in the responses and recommendations in this report. A number of specific issues are detailed below.

3.1 Roles of Fixed and Deployable Monitors

Current plans for the upgraded RadNet system of air monitoring instruments call for a system comprising 180 fixed monitors and 40 deployable monitors. The 40 deployable monitors have been purchased and are available for deployment from the National Air and Radiation Environmental Laboratory (NAREL) in Montgomery and the Radiation and Indoor Environments National Laboratory (RIENL) in Las Vegas. Procurement of the fixed monitors is in progress, but procurement of the full complement of 180 monitors is not projected to be completed until 2012. Both the schedule and final number of monitors could be impacted by budget priorities. Both types of monitors will be needed in response to a major airborne release of radionuclides. It is planned that the deployable monitors will be used to expand the sampling network of interest around the site of a known airborne release. As discussed below, deployable monitors could also be used routinely in the near future to augment the fixed station network until more fixed sampling monitors can be obtained, as long as there is no significant impact on their availability for redeployoment in the area of interest in an emergency.

The objectives associated with the interplay of fixed and deployable monitors are specific to the two basic operational scenarios: a) "routine" and b) "emergency" (i.e., a radiological 'incident,' whether accidental or intentional). In practice, the necessary monitoring data to characterize the radiological 'environment' in these two scenarios exist at multiple levels of scale. For the sake of simplicity, the SAB Panel identifies three scales: national- or interstate-scale (multi-state; 100s to 1000s mile radius), regional-scale (10s to 100s of mile radius), and local-scale (1-10 mile radius).

a) "Routine" monitoring is predominately an interstate-scale activity. The measurements from individual monitors are intrinsically useful in routine monitoring, and represent the primary data of interest. The purpose of this monitoring is to characterize, on an on-going basis, the ambient radiation environment in space and time. For this purpose, air monitoring needs to be supplemented with other existing RadNet-based media sampling, including water and milk sampling. Routine monitoring is not expected to provide the first indication of a radiological event.

b) "Emergency" monitoring requires data inputs at all three scales. Interstate- and regional-scale data are used to track transport of major releases, typically from nuclear power plant accidents or the detonation(s) of improvised nuclear device(s) (IND). Local-scale data are most relevant for smaller Radiological Dispersion Devices (RDD) events. In addition, EPA should address the pros and cons of "routinely" pre-deploying the monitors to places where intelligence information suggests that they may be needed (e.g., Times Square NYC during New Year's eve, Super Bowl game, World Series, Olympics, Mardi Gras). For such decision-making, real-time data are critical and deployable monitors must be well integrated with fixed Networks in terms of data integration and immediate availability to the key decision-making agencies, Federal Radiological Monitoring and Assessment Center (FRMAC) and the end user, Inter-Agency Modeling and Atmospheric Assessment Center (IMAAC), which generates the plume projections. During emergency situations, data should be utilized from all the monitors in the nation (e.g. state, local, utility, DOE) in spite of data quality variability.

In an emergency, EPA anticipates that the fixed monitor network will be used to reassure people in population centers who are not expected to be impacted by the event that no protective action is warranted. That is, EPA views the measurements from individual monitors as the primary data of interest in an emergency. As a result, EPA's fixed monitor siting approach primarily focuses on adequate population coverage, by placing fixed monitors in high population centers, with only a secondary concern for broad and uniform area or geographic coverage. The SAB Panel views things differently. The SAB Panel strongly believes that, in an emergency situation, the output of modeling is significantly more important and useful for decision-making than the output of individual monitors because there are simply too few monitors to provide adequate coverage. The models would use information on the location of a release, an assumed source term, and meteorlogical conditions to predict plume dispersion. If a monitor was in the area of the plume, the monitoring results could be used for evaluating the model results.

Direct measurement applies only to a few hundred feet around the monitor. An area of hundreds of square miles around a particular monitor can be designated as having "no elevated radiation" only because an isodose line can be drawn connecting a number of monitors surrounding the particular monitor defining a region of no elevated radiation. The RadNet could demonstrate, through the interplay of monitor data, modeling, and meteorlogical conditions, that relatively large areas of the United States were not impacted by a plume. However, if a large city is the scene of an incident, one, two, or even five monitors will not define the radiation dose pattern; response monitoring will be needed. EPA cannot have a sufficient density of monitors in RadNet to make precise measurements with only 180 monitors. Due to the paucity of monitors, unless there was a major release of a large or regional-scale, the monitoring results would be most useful in reassuring people outside of the impacted area that the radiation levels are consistent with normal background. For RDD events, where local-scale data are essential, modeling along with local emergency responder data would be used for protective action decisions in the early phase of an incident, supplemented with deployable monitoring data for the later phases.

In the event of an emergency, EPA anticipates deploying the deployable monitors locally (and perhaps regionally) around the event site, so that deployable monitor measurements can be rapidly used to complement measurements from the fixed monitors, but for a smaller, more focused area. The SAB Panel agrees that the deployable monitors (if appropriately deployed in an emergency) can provide regional trends, but believes it is unrealistic to think that the deployables can be sited with enough sampling density to provide useful local level data. Such local-scale data will be provided by monitoring conducted by local, state, and other assets.

For routine monitoring, EPA views the fixed monitor network, and the deployable monitors (if pre-deployed), as establishing baseline values; the SAB Panel agrees with this view. In this regard, the major benefit of the expansion and upgrade plan is the addition of up to 180 monitoring sites. Here, the fixed monitors will provide large-scale data; the deployable monitors can (if appropriately pre-deployed) fill in geographic sampling gaps and provide more regional baseline data (if some clustering of the deployables is possible).

Because of the SAB Panel's view of the central importance of modeling in an emergency, the geographic distribution of the fixed and deployable monitors (the "sampling" as input data to the model) becomes critical. In the EPA's deployment plan for the fixed monitors, with the total of 180 monitors, 56% will be in proximity to a population center, with 82% geographical coverage (see Table 3.6.2). The SAB Panel is concerned that even these percentages would not be attained if budget priorities do not allow EPA to purchase all 180 monitors. For instance, with 150 monitors, there is only 63% population proximity and 77% geographic proximity. Accordingly, some of the SAB Panel's strongest recommendations below deal with more declustering of the fixed monitors (to improve the geographical proximity) and pre-deployment of the deployable monitors (to increase the number of monitors available). As noted above, these recommendations stem from an intrinsically different view of the use of data from the fixed and deployable monitors, in both routine and emergency situations.

The SAB Panel recommends more declustering of the fixed monitors to gain greater geographical coverage for interstate-scale monitoring. The SAB Panel further recommends that EPA consider placing some of the deployable monitors temporarily in the locations chosen for the fixed monitors to bridge the time interval until the fixed monitors are purchased and in place. However, the SAB Panel emphasizes that use of the deployable monitors for augmenting the fixed monitoring capability must not adversely impact the availability of the deployables if an emergency occurs.

3.2 Issues with the Monitors Themselves

Because of timing and resource issues, there are some differences in the design and operation of the fixed and deployable types of monitors selected by ORIA. The design of the deployable monitors was in response to the fires at Hanford and Los Alamos. Procurement of these monitors began before the conceptual design of the fixed monitors was complete. Additionally, practical considerations dictated that the deployable monitors be sturdy enough to withstand damage from repeated shipping and handling.

Both the fixed and deployable types of monitors are capable of sampling air at high volumetric rates (35-75 m^3/hr) through a 4"-dia. filter. The fixed stations use a polyester filter, while the deployable monitors use a glass fiber filter. The deployable monitor also has a second sampling head operated at a lower sampling rate (0.8-7 m^3/hr) utilizing a charcoal filter suitable for sampling radioactive gases, including ^{131}I. The sampling heads are located in different places in the two types of monitors. The two sampling heads on the deployable monitors are located on extensions several feet above the system's equipment enclosure, whereas the sampling head in the fixed monitor is located in the top portion of the system's enclosure along with two radiation detectors that provide periodic in-place measurements of the accumulation of radionuclides on the filter medium. These detectors are a 2"x2" sodium iodide (NaI) detector to measure gamma emissions and a 600 mm^2 ion-implanted silicon detector to measure alpha and beta emissions from radionuclides on the filter sample periodically during the sampling cycle. These radiation measurements can be transmitted via satellite to NAREL for analysis and storage.

The deployable monitors have no built-in capability for monitoring either the high volume or low-volume filters in place, so the filters must be counted and analyzed at NAREL or in a mobile laboratory brought near the area of interest. Another difference between the deployable and fixed monitors is the ability of the deployable monitors to provide measurements of the external gamma radiation field at the sampling site. Measurements from two compensated Geiger-Mueller (GM) detectors also can be transmitted to NAREL via satellite. The fixed monitor has no comparable capability for quantifying external photon radiation fields.

Because both the fixed and deployable monitors will be used to provide important information to decision makers, it is imperative that both the similarities and differences between these two monitoring systems be understood and quantified so that interpretation of the data will be of high quality and consistency. (For further discussion see Section 4.5.)

3.3 Potential Sampling Biases in the Fixed Air Monitor

The configuration of the detector and filter in the fixed monitor may result in bias in collection of larger particles due to their deposition on the detector or associated support surfaces. The EPA report should include a figure that shows, with dimensions, the locations of the two detectors relative to the filter and indicates the expected airflow path. **The impact of**

this geometrical arrangement on the deposition of airborne particles should be evaluated by an experienced professional using laboratory or field tests that address, among other questions*:*

- Is particle deposition on the filter uniform across the filter?
- Does a significant fraction of particles deposit on the surfaces of the two detectors thereby contaminating them?
- Are there sampling biases related to different particle-size regions?

While large particles (greater than 10 µm Activity Median Aerodynamic Diameter (AMAD) may not be of biological significance with regard to inhalation by humans, they may be of concern for ingestion of swallowed particles and in evaluating the potential for soil and surface-water impacts. Also, depending on the type of incident that results in generation of air particulates, NAREL should consider that "hot particles" might be in the larger size range and thus would not be collected on the filter in proportion to their presence in the airborne material.

The currently designed instruments have not been tested for the collection efficiency of airborne particulates as a function of the wind speed and direction at which they arrive at the monitor. The relationship between sampling efficiency and particle size might also be affected and should be tested. A wind tunnel would be a good place to conduct such tests. It is better to know these characteristics now, than to learn that there might be a problem later. This seems to be particularly critical for the new fixed monitors where local siting criteria include, but are not limited to, allowing the monitor to be located no closer than two meters from walls, five meters from building ventilation exhausts and intakes, 20 meters from a tree drip line, and 50 meters from streets and highways. Each of these factors can impact the measurements' representation of ambient air.

One of the arguments for large particles not being of major concern for RadNet is the expectation that an event resulting in the generation of airborne dust is most likely to occur at a considerable distance from the monitor. Thus, the large particles would fall out before the plume reached the detector. This would be true for most of the fixed monitors involved in a single event, but not for the fixed monitors located in the population centers in which the probability of a terrorist incident involving release of radioactive material is the greatest. In such a situation, a monitor in the vicinity of the incident is of primary importance and should be capable of representative sampling of airborne dust.

3.4 Measurement of External Photon Radiation Fields

The deployable monitors use GM detectors to provide near real-time data on gamma exposure rates, but no similar measurements can currently be made with the fixed monitors**. If it is assumed that the near real-time collection of these gamma exposure measurements is an important function of the deployable monitors, then consideration should be given to making similar gamma exposure measurements on the fixed monitors as well.** The NaI detectors on the fixed monitors can also be used as dosimeters by weighting each of the recorded regions of interest for energy response and summing the result. This capability should be further explored.

Certain quality assurance efforts are needed for the radiation exposure data collected by the GM detectors with the deployable monitors. These data may contribute significantly to the evaluation of a radiological incident and need to be accurate and credible. The following aspects should be considered:

a) Results are reported (on p.60) to be accurate within 15% at the low end of the scale at 2 μR/h, and 10% at the high end of 1 R/h. Is this information certified by the manufacturer? In any case, EPA should test reliability initially and at intervals for selected monitors by comparison to a direct exposure-rate detector such as a pressurized ionization chamber (PIC).

b) The instruments are reported to have been calibrated with ^{137}Cs and to have an energy response within 20% between 60 keV and 1,000 keV. Does the manufacturer certify this information? EPA should test instruments for energy dependence by exposing selected detectors to point or extended sources. For example, radionuclides may be selected that emit single gamma rays of approximately 30, 60, 120, 300, 600, and 1,200 keV, of which one should be ^{137}Cs at 661 keV. Such sets also can be used for intercomparison with monitors by cooperating organizations, such as state agencies.

c) Quality Control (QC) considerations for exposure-rate measurements, discussed on p.90, should include specific actions such as the ones suggested above.

d) The international unit equivalent (SI) to 1 roentgen (R) is 2.58 x 10^{-4} C/kg dry air, not 10 mSv, as shown on p.60. The decision to convert R to mSv should be left to the organization responsible for estimating radiation dose.

While ^{137}Cs may be an important gamma-emitting radionuclide in the event of a nuclear incident, ^{60}Co – with gamma photons that have twice the energy of the ^{137}Cs photons – may be of equal or greater importance in a “dirty bomb” event. It is also important to note that the GM detector response to scattered ^{137}Cs gamma radiation may be different from the response to the unattenuated ^{137}Cs radiation. **While it might be impractical to cross-calibrate each deployable system against a PIC, NAREL should consider cross-calibrating the prototype using a series of different energy gamma emitters, including naturally occurring thorium with its relatively high energy gamma ^{208}Tl decay product and uranium with its lower average energy decay products.**

While the SAB Panel understands that the GM detectors are energy compensated, cross-calibration would afford a degree of assurance that the GM detectors are accurately measuring exposure when a variety of different gamma energies are present. Said another way, the EPA report should address the following aspects of detector response:

- the pattern of the energy response in the form of a curve or tabulated values from the low-energy cutoff to about 3,000 keV;

- the standard deviation of measured exposure rates for the full claimed range of 2 μR/h to 1 R/h ; and

- the response to beta-particles and associated Bremsstrahlung.

The use of the radiation measurement units sievert (Sv) and rem for the output of the GM detectors is somewhat misleading since a GM detector measures counts per unit time. With appropriate cross-calibration against a PIC, the output could be converted to roentgens. However, if the units Sv and rem are being used in the sense that they represent effective dose, the one-to-one ratio of roentgen to rem may not be appropriate. The conversion from exposure in roentgen to effective dose in Sv or rem depends on both the receptor (e.g., adult or child) and the energy of the gamma radiation. The SAB Panel recognizes that the use of roentgens is because of first responder familiarity with that unit. (Further discussion on this issue is in Section 5.4.5 regarding communication of results.)

3.5 Measurements of Alpha Emitters at Fixed Monitors

The description of major components of the fixed air monitoring stations on p.25 of the EPA report includes "Instruments for measuring gamma and beta radiation emanating from particles collected on the air filter media." Measurements of alpha emissions are not mentioned on p. 25, but the detailed specification sheet provided mentions the capability to measure both low and high energy alpha particles. During the December 19-20, 2005 meeting, ORIA staff told the SAB Panel that a complicated algorithm is needed to distinguish alpha emissions measured in the fixed monitor from the measurements of alpha emissions of naturally-occurring radon (Rn) progeny**. It is important that this capability be perfected because other alpha emitters besides ^{241}Am may become important in assessing potential terrorist activities.**

3.6 Need for Numerical Clarity and Transparency

3.6.1 Value of the Protective Action Guide (PAG)

The Protective Action Guide (PAG) is the level at which decision-makers would be expected to recommend that the public take a protective action (e.g., shelter, evacuate, ingest potassium iodide, and interdict crops). In the EPA report the PAG is stated to be "the committed effective dose equivalent (CEDE) of 1 rem that results from inhaling a specified radionuclide continuously during a 4- day period", (p.24, para. 5). The measurement requirements, including the minimum detectable activity (MDA) for selected radionuclides specified in the EPA report, are related to this value.

While the instruments provide the output in roentgens (R), it is expected that EPA will do the necessary conversion to provide the information to the decision-makers in rem so that they can compare it to the PAG. Since the PAG is just guidance, decision-makers may recommend taking protective actions at some value less than the PAG or, if there are barriers to implementation of a protective action, they may allow the public to be exposed to levels exceeding the PAG for a short time. The SAB Panel was not asked to comment on the appropriateness of the PAG; however, it is necessary to point out that the assumptions for conversion from R to rem should be explicit in the documentation so that the conversion can be replicated at a later time. Decision-makers are not expected to perform the conversion, but the conversion should be transparent.

3.6.2 Relation of the EPA-specified MDA Value to the PAG for Fixed Monitor

The MDA values (at the 95% confidence level) are given in terms of nanocuries (nCi) for each of seven radionuclides on a filter to be counted for no more than 1 hour with the specified NaI(Tl) detector and spectrometer (p. 27, para. 1). Of the seven radionuclides, ^{241}Am, ^{137}Cs, ^{60}Co, and ^{192}Ir were considered to be important because of their availability in large quantity (p.24, para. 3). An MDA value also is given for ^{90}Sr counted with the silicon detector and spectrometer (p.27, para.2).

The EPA report should include the nCi value on the filter that corresponds to the selected limit on intake related to the PAG (see part A) for each of the eight radionuclides. The purpose is to confirm that the MDA is suitably lower than specified by the PAG to permit reliable measurement results.

This information can be extracted from the two tables that were distributed by EPA staff in response to a request at the meeting. One table is a list of radionuclide concentrations (in pCi/m^3) that correspond to the PAG for 1 rem by inhalation during a 4- day period (and fractions of this PAG) for five of the eight radionuclides. The other table is a list of nCi for a 30 m^3 sample related to estimated risk per nCi inhaled given in Federal Guidance Report 13, (U.S. EPA. OAR. 1999.) for all eight radionuclides (and two others). The EPA staff should decide which data set is appropriate, apply the selected factors for m^3 collected on the filter for counting and m^3 inhaled in the 4-day period, and discuss the appropriateness of the specified MDA values.

3.6.3 Calculation of the MDA Values for the Fixed Monitor

Calculation of the MDA for radionuclides detected by the NaI(Tl) detector was addressed in the document MDA *for the EPA's fixed RadNet monitors,* (WSRC. 2005.) that was distributed at the meeting. The value of the MDA is related to the standard deviation, σ, by MDA = (2.8 + 4.65 σ)/constant.

The constant relates counts accumulated for this study in 10 minutes to nCi. Values of σ were obtained by measuring the counts recorded with the detector in the regions of interest for various radionuclide standards and obtaining the counting efficiency for these measurements. The Westinghouse Savannah River Company (WSRC) report notes that the calculation of σ is more complex than shown if background peaks intrude on the regions of interest for another radionuclide, as is the case of radon progeny intruding on ^{241}Am and ^{137}Cs. The radon-progeny background on filters is stated in the EPA report to fluctuate from 0.3 to 30 nCi (p.26, para.6). The calculated MDA values based on measurements that do not include radon-progeny fluctuation range from 12.3 to 1.1 nCi for the seven radionuclides. The MDA value for ^{241}Am is above the specified MDA for the 10-min count but equals it for the expected 60-min count; the MDA for each of the other radionuclides is 1 – 3 orders of magnitude below the EPA-specified MDA value.

The calculated MDA values reported in the WSRC report should be inserted into the EPA report with an explanation of the reasons for the much larger EPA-specified MDA values (p.27, para. 1), except for ^{241}Am. One reason is the indicated radon-progeny fluctuation. The extent of increase in MDA values over those calculated in the WSRC report should be tested in a field study. Relative to the EPA-specified MDA values, however, the fluctuation appears to be significant only for ^{241}Am.

Before inserting the WSRC data in the EPA report, some improvements in the WSRC report are recommended. Calculation of σ should be explicitly shown, with counts and background counts tabulated for each region of interest. Apparent errors made in the sample calculation for ^{137}Cs should be corrected in calculations of MDA in counts per second (cps), MDA in disintegrations per second (dps), and MDA (nCi).

The MDA calculation for ^{90}Sr measured by the silicon detector should be shown for the direct beta-particle count and counter background, and for the influence of radon-progeny fluctuation. Any difference between these values and the EPA-specified MDA should be explained.

The implications of the change in the thickness (from thick to thin) of the silicon-detector window reported by EPA staff at the meeting should be discussed in the EPA report. If the alpha-particle spectra that now can be measured are useful to compensate for radon-progeny fluctuations, the appropriate calculations and test results should be presented. Conversely, any detrimental effects of cross talk on ^{90}Sr counting sensitivity should be reported.

4. RESPONSE TO CHARGE QUESTION 2: OVERALL APPROACH FOR SITING MONITORS

4.1 Response to Charge Question # 2

Is the overall approach for siting monitors appropriate and reasonable given the upgraded and expanded system's objectives?

The SAB Panel recognizes that within the context of the limited number of monitors based on resource constraints, the proposed EPA approach for siting fixed monitors significantly enhances the ability of the RadNet monitoring network to meet mission objectives. Nevertheless, the SAB Panel is concerned about a number of specific implementation issues and underlying assumptions that are detailed below. The SAB Panel questions whether the correct mission for the deployables has been determined.

The SAB Panel accepted the constraint that the maximum number of fixed monitors was 180. The siting plan was derived as a balance between placement of these monitors based on population density versus placement based on geographic location. The siting plan proposed is therefore the result of a compromise between monitoring people and spanning the nation. The siting plan is driven by socio-political considerations (putting monitors where people are) and EPA mission requirements (providing baseline levels of radiation in the environment across the nation). This is reflected in the dichotomy between the stated RadNet objectives in the context of EPA responsibilities and the interplay and use of deployable versus fixed monitors. It is the view of the SAB Panel that this results in a lack of clarity in the usage of deployable monitors.

For the purpose of clarifying key underlying assumptions the following questions must be addressed:

a) What decision-making processes and prioritizations are used to accommodate different types of events ranging from long term monitoring deficiencies to catastrophic incidents?

b) How has the agency determined the needs of the decision-makers in response to different events?

c) Are the objectives for the usage of deployable monitors strictly identical to those for the fixed monitors?

RadNet data alone will not be sufficient for decision-making. Models that integrate data from a wide range of sources are intended to be coupled with RadNet data. It is essential that the RadNet network be optimized in terms of these models. These process-oriented environmental models are typically underdetermined as they contain more uncertain parameters than the variables available to them for calibration. **Therefore the SAB Panel strongly advocates the use of sensitivity analyses in the siting of monitors (both fixed and deployable**).

4.1.1 Population-based versus Geographic-based Siting

Although the siting plan is not intended to monitor a city-based incident, it has been designed to accommodate one monitor per major city. For populated Western and Eastern coastline areas this results in an anomalously high density of fixed monitors at the expense of other regions, notably the US-Canadian border, Central Northern United States, Central and Eastern Nevada and Eastern Oregon as well as the states of Vermont and Delaware. Some of these concerns could be addressed by including the results of monitoring conducted by other agencies (such as the state of Nevada) or through cooperation with the Canadian authorities**. In the SAB Panel's opinion there should be a better balance and interplay between physical deployment schemes and modeling requirements for effective environmental assessment, data interpretation and decision-making. The SAB Panel provides an example of how to optimize the siting plan using models in Section 4.3.1.**

Based on these considerations and the limited resources currently available, **the SAB Panel suggests that:**

a) **More declustering of fixed monitors should be considered initially, particularly in the vicinity of the Los Angeles and New York metropolitan areas. Local and regional meteorological models should be used along with other considerations, to reduce the density and to redistribute fixed monitors.**

b) **Model sensitivity analyses should be performed on siting configurations and distribution densities so as to meet EPA goals and optimize the placement of fixed monitoring stations in terms of the limited resources available**.

This approach will result in better geographic coverage than is currently planned, consistent with the primary decisions for siting a 'receptor-based system' with a focus on national impact. This approach will also provide more flexibility to adapt to limited resources but every effort should be made to at least reach 180 fixed monitors. Finally, this deployment scheme will better serve public safety, even in populated regions, by increasing the reliability of model results and improving predictions used by decision-makers.

4.1.2 Fixed versus Deployable Monitor Networks

It is unclear whether the proposed use of deployable monitors is predicated solely on the RadNet objectives outlined for the deployment of fixed monitors, for the collection of environmental data within the context of a national scope, or for the sole purpose of monitoring, assessment and baseline data collection. Given the urgent need for the monitoring of radioactivity on a national scale, and possible limitations associated with the number of fixed monitors installed in the near-term, it appears that at least some of the deployable monitors could be pre-deployed (i.e., in the absence of an event) to fill coverage gaps identified through modeling. Put another way, the deployable monitors could be used in the interim to provide some routine monitoring coverage until all the fixed monitors (i.e., 180 fixed monitors) are available and installed.

The SAB Panel suggests that the discussion on monitor siting address the degree to which the use of deployable monitors fulfill EPA's new monitoring responsibilities as outlined in the post 9/11 *National Response Plan, Nuclear/Radiological Incident Annex* (U.S. DHS. 2004.). Specifically the mission of the RadNet Air Network includes providing "data for radiological emergency response assessments in support of homeland security and radiological accidents." This objective is vague and brings into question whether use of the deployable monitors is at the discretion of the EPA or under the more broad authority of the Department of Homeland Security (DHS). Under most emergency circumstances, EPA is not the lead but a supporting organization to the Coordinating Agency (CA). Therefore, EPA may not have the authority to make the decision to use the deployable monitoring stations for filling in gaps in the fixed system sites without consultation with the CAs. If the monitors were in use at locations around the nation, they would not be immediately available for use in an emergency, but would need to be recalled and subsequently redeployed. **The SAB Panel recommends that EPA work with partner agencies to clarify issues of chain-of-command and assess whether some deployable monitors could be used to fill coverage and time gaps.** In the SAB Panel's opinion integration of the two separate systems comprising the deployable and fixed monitoring networks can be better defined. Planning for the integration of the fixed and deployable monitors should be in consultation with the Federal Radiological Monitoring and Assessment Center (FRMAC) and the IMAAC.

4.2 Response to Charge Question # 2a

Is the methodology for determining the locations of the fixed monitors appropriate given the intended uses of the data and the system's objectives?

The SAB Panel strongly suggests that the declustering of fixed monitors within high density population areas be more aggressive and involve the use of general model constraints, historical meteorological data, and timely meteorological forecast predictions. To this end the SAB Panel supports the use of sensitivity analyses and confirmatory transport modeling proposed by EPA, in conjunction with Westinghouse Savannah River Company, the US Weather Bureau, IMAAC and/or other partners.

Overall, the SAB Panel considers that the methodology for determining the locations of the fixed monitors is appropriate with some reservations: There appear to be a few gaps in the proposed siting methodology for fixed monitors, resulting from (1) the apparent lack of recognition of local and regional meteorological constraints; (2) large geographic areas without coverage; (3) deficiencies in siting scenarios in the context of uncertainty in the near-term number of operational fixed monitors; (4) the need for greater clarity in RadNet mission priorities; and (5) the lack of data integration with other entities conducting monitoring .

4.2.1 Meteorological Constraints

In the sensitivity analysis performed by EPA, and shown in Table 3.6.2, the proposed EPA scheme for adapting fixed monitor locations to both population density and land coverage achieved about 56% population proximity and about 82 % geographic proximity. The population metric is based on the number of people within 25 miles of a monitor. The geographical metric is a number that represents the percentage of "area coverage" of the approach being tested against a grid of the continental US that would provide 100% area coverage for 175 monitors (180 monitor minus three for Alaska, one for Hawaii, and one for Puerto Rico). With the constraint of 180 independent stations, this scheme appears satisfactory as an initial siting basis. However, meteorological and natural background radiation conditions (e.g., radon) may demand adjustments to this distribution as experience is gained (i) through the actual operation of the system, (ii) its deployment over a number of years, and (iii) results from preliminary models are considered. The data from the RadNet Air Monitoring Network should eventually be combined with a standard US Weather Bureau computer code for projecting variations in the local geological and meteorological conditions in the area of the monitor and regional atmospheric conditions and trends. Meteorological monitoring associated with the fixed monitor network is desirable in some cases, and should be decided on a site-specific basis, based on two considerations: (a) no "canyon effect" exists, and (b) no alternative "close" meteorological monitoring exists (where "close" still needs to be defined). In this way, elevated radiation conditions and their atmospheric transport could then be predicted and their significance assessed with respect to natural and/or man-made anomalies.

4.2.2 Uncertainty in Number of Near-term Fixed Monitors

Given the limited resources and possible limitations on the number of fixed monitors deployed in the near-term, it appears that scenarios with less than 180 fixed monitors need to be examined in terms of their immediate impact on system response. In addition at least some of the deployable monitors could be used to fill coverage gaps in routine monitoring identified through modeling. This approach has the advantage of being more flexible and responding to changing environmental conditions. It requires a thorough study of costs and of the added complexity in the event that deployable systems are required elsewhere in response to an unanticipated radiological incident.

4.2.3 Mission Priority

In keeping with EPA responsibilities and the continuity of the RadNet mission, the most important function of the fixed monitors is the continued and improved routine evaluation of the ambient radiation environment. In the context of the new RadNet network, this involves continued coordination of the air monitoring network with the other current EPA networks involving water and milk monitoring, even in the light of a later evaluation and update of those systems. This again emphasizes that population density is not necessarily the main driver but that isolated areas that involve many rural communities also support the monitoring infrastructure of the nation. In view of the resource limitations to the new RadNet system, ORIA should not lose sight of the basic EPA function that involves tracking the transfer of ambient airborne radiological conditions to the nation's food supply.

4.2.4 Integration with Existing Networks

Even though RadNet is a receptor-based system, it should strive to leverage additional monitoring stations by integrating with other existing systems, such as those in individual states and around nuclear power plants and other source areas. Moreover, **there should be a mechanism established for entities to become full-fledged 'members' of the network**. **This could include States and/or cities that wish to use their own funding to purchase stations and agree to comply with certain EPA standards.** The inclusion of state and nuclear facility air monitoring networks has the potential of adding several thousand monitors (in contrast to the extensive discussion about declustering and utilizing deployables which would pertain to 70 sites at best.) However, this would take considerable effort including arranging for participation by the operating groups, operator training, cross-calibration, a notification system after an incident, means of transporting air filters quickly to Montgomery, a feedback system for guidance, changes, questions, etc.

There also appears to be a lack of coordination with Canadian monitoring networks. Specifically, the US southern border appears to be well covered by the proposed siting plan, whereas monitors along the northern Canadian border appear scarce. Health Canada maintains monitoring stations in Edmonton, Calgary, Saskatoon, and Regina and perhaps elsewhere, but the EPA does not appear to have engaged Health Canada and there is no mention of the monitoring capabilities or planned joint coordination efforts between the US and Canada.

4.3 Response to Charge Question #2b

Are the criteria for the local siting of the fixed monitors reasonable given the need to address both technical and practical issues?

. In planning the distribution of fixed monitors, EPA assumed that:

- Modelers and planners require a well-spaced network that includes readings above background in contaminated areas and readings not distinguishable from background in non-contaminated areas in order to validate model predictions. EPA states that an area based approach is consistent with the siting objective to provide modelers with a large number of distributed data points to reduce the uncertainties in their protected plume trajectories.

- Decision-makers may request monitors where large population centers are located, as well as other areas that would contribute to population exposure (e.g., food production sites). This distribution is consistent with the siting objective to protect human health by assessing potential impacts in major population centers.

- The public may also request that monitors be located in their area. Other relevant concerns include agriculture (monitoring of areas that are otherwise unpopulated or geographically "uninteresting"), business and tourism areas, and border areas that anticipate plumes from other countries.

In order to satisfy these assumptions, EPA took an approach that is both population-based and geographically-based,

i) start with the largest cities (population-based);

ii) remove the "over" clustering of monitors in certain areas; and

iii) fill in the gaps (geographically-based).

In addition to the criteria above covered in the RadNet draft document, the SAB Panel strongly encourages that several additional criteria be considered. They are:

- **Model Requirements**. Given that the models will be used for rapid decision-making and analysis, it follows that criteria satisfying required model inputs be prioritized so that the model results are quantitative and their predictions are robust.

- **Operational Security.** Siting protocols should be prioritized in terms of monitoring station security and operation requirements.

- **Location requirements.** In view of the role of possible monitoring obstructions, consider different sampling environments (e.g., monitors at different elevations sampling different plume horizons).

- **Integration with Other Resources**. The effective use of other existing resources could benefit rapid detection and analysis of a radioactive plume.

Additionally, siting criteria based on a combination of "population" and "cluster density" – as EPA is proposing – may or may not make sense depending on the answers to two additional considerations:

a) Whether or not other fixed and deployable monitoring networks will complement RadNet and provide similar and/or compatible data; and

b) What sampling requirements are necessary for the mathematical models to best estimate environmental distributions in space and time. For example, the models may require or be optimally served by more uniform geographic sampling, or conversely, require a non-uniform sampling scheme that is driven by geographic/geologic and meteorological factors (in three dimensions) rather than population or sampling density.

Ideally, the siting plan would evolve from modeling considerations, rather than from subjective and arbitrary ones. Given the current approach to siting, at a minimum, sensitivity analyses and post-hoc confirmatory modeling (i.e., siting plan calibration and validation) should be used for local siting of the fixed monitors. The sensitivity analyses will help focus limited resources on those siting configurations that are optimal to RadNet objectives, and help identify to which variables the models are most sensitive and less certain in terms of their formulation and/or parameterization for a given siting geometry. The analysis will also help reduce uncertainty by identifying any potential interactions or variables that exert the greatest influence on the dependence of model outcomes and interpretation.

4.3.1 Model Requirements

Given the importance of models in integrating and understanding complex time-dependent data, their requirements represent a crucial input to the siting of the monitors. Models may best be served by input data that require more uniform geographic sampling, or a non-uniform sampling scheme that is driven by geographic/geologic and meteorological factors in three dimensions, rather than by a population or sampling density scheme. For quantitative analysis and understanding of the network data, optimal siting is therefore the product of simulation requirements, anticipated scenarios, and variations within each. In practice, the sampling requirements are also model specific and, as different models come into play, optimizing the siting plan involves integration of several results that together stochastically predict the space and time distribution of a radioactive plume in three dimensions.

The SAB Panel was not able to review the methodology for sensitivity analyses proposed by Westinghouse Savannah River Company, so the following approach is offered by way of example:

Step 1: Model three to five different, plausible scenarios, using one or more mathematical models, including any used by IMAAC. The initial tests should involve a dense monitoring coverage or over-sampling (e.g., simulating the availability of input from thousands of monitors), thereby establishing the 'ground truth' distribution in space and time.

Step 2: Use a preferred model to simulate a case with 180 monitoring stations as proposed in the RadNet siting plan and vary the siting density distribution using proposed EPA siting plan(s).

Step 3: Perform a sensitivity analysis in which a number of monitors are "removed" from a "preferred RadNet siting configuration" to evaluate the effect of reducing the total number of stations from 180 to [180 – 20] or [180- 40].

Step 4: Using a realistic number of monitoring stations, change the geometry of their distribution so as to capture model sensitivity to site geometry and distribution.

Step 5: Compare all model run results. This sensitivity analysis could render (i) the optimum deployment for 180 fixed monitors; (ii) provide a comparison of the preferred monitor distribution to an optimal siting scenario involving a greater or ideal number of monitors

(>>180); (iii) optimize the use of a resource-limited monitor sampling scheme (<180 stations); (iv) help in the design of deployable stations' placement either as temporary stations to offset perceived coverage gaps or for use in rapid deployment scenarios and their effective integration with other networks, including fixed RadNet monitors; and (v) provide a defense in depth for the EPA's siting protocol and justification for any required modifications (e.g., additional stations).

4.3.2 Practical Issues

The approaches discussed above focus on the selection of 180 "optimum" sites (or geographic sites throughout the country) without regard to either technical or practical issues, but based only on sampling considerations, either from a population- and clustering-basis, or in the context of modeling. The actual selection of sites, however, must also be driven by technical and practical issues. These include:

a) the availability of and access to the appropriate electrical power;
b) an accessible and secure place to site the system; and
c) the availability of specifically trained volunteers to maintain and "operate" the system.

Additional practical issues include decision-makers' needs for particular information. The Review Panel heard a comment from a Native American Tribe advocating placing a monitor on tribal lands. EPA was careful to ensure that the siting plan is flexible enough to accommodate partner preferences with regard to local siting decisions.

4.3.3 Location Requirements

A key issue that needs further specification and refinement is the physical location of the fixed monitors, especially with regard to the immediate terrain and monitor location requirements and the potential impact of siting on the air monitoring results. In urban environments a rooftop location may be the preferred location and could potentially be standardized to avoid the "canyon effect" that might otherwise be present, especially in large cities. The SAB Panel suggests that the "two-meter rule" be reviewed in the context of tall buildings or large vertical structures, and, if necessary, amended or redefined. The "two-meter rule" is defined in 40 CFR Part 58, Appendix E, "Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring," (U.S. EPA. 2004.) and is focused on minimizing the influence from any localized effects for monitoring systems for gaseous and particulate pollutants. The Part 58, Appendix E criteria provided the starting point for the RadNet siting criteria.

4.3.4 Coordination with Other Resources

Appendix C contained a *Summary of Selected Radiological Environmental Monitoring Activities*. This document describes a sample of radiological environmental monitoring acitivites being conducted in the US and other countries around the world. A complete inventory of all existing, functional radiation equipment in the US should be performed by EPA to determine available non-EPA resources, which may include the environmental radiation equipment at nuclear power plants, resources at universities, federal, state, industrial and medical facilities, including laboratories. Thereby, in the event of a major incident within a given region the EPA could rapidly assess national needs and enlist these resources for extended coverage. International resources (e.g., Canada, Mexico, Atlantic and Pacific nearest neighbors) should also be assessed.

4.4 Response to Charge Question #2c

Does the plan provide sufficient flexibility for placing the deployable monitors to accommodate different types of events?

Three possible scenarios were presented for siting the deployables. In an event of a large-scale event with nationwide impact, the deployable units may be placed to maximize the RadNet coverage and supplement the fixed monitor locations. In a regional-scale event, the EPA envisions siting the deployables on the perimeter of the radiation incident site. The third scenario is to combine perimeter monitoring with some units inside the impacted area to increase coverage. ORIA also notes that the deployable units can be moved around to suit the changing incident conditions. The SAB Panel questioned whether the correct mission for the deployables had been identified, given the extraordinary range of possibilities for use. **A key question is whether or not the monitors can be systematically deployed for "routine" monitoring to supplement the fixed monitors, thereby increasing their utility, and still be as readily deployable in an emergency.**

This question requires resolution of the apparent discrepancy noted earlier between the stated RadNet objectives and the interplay and use of deployable versus fixed monitors. Both the RadNet draft document and the EPA RadNet presentations bring uncertainty as to the ultimate objectives for the usage of deployable monitors. EPA's plan currently does not include using the deployable monitors in the absence of an emergency. To the degree to which deployable monitors are actually a response to EPA's new monitoring responsibilities as outlined in the post 9/11 *Nuclear/Radiological Incident Annex* (U.S. DHS. 2004), then the flexibility of the deployment depends on the ability to adapt to rapid response times and deployment requirements. This can only be accomplished if the siting is 'pre-planned' by incident type, regardless of location. This in turn requires that the deployment scenarios be tied to 'realistic' model renditions of different scenarios and that both model and siting plan be responsive to the input of new incident boundary conditions in a timely and effective way. At present, this is not the case and the SAB Panel urges the EPA to take measures in this direction and lead the way to the use of the RadNet results.

Other considerations are the practical deployment requirements within the framework of limited resources:

- deployable monitor storage,
- pre-deployment,
- personnel training, and
- flexible response to incident scenarios.

4.4.1 Deployable Monitor Storage

The EPA proposes to house the deployable systems in ORIA's two main environmental radiation laboratory sites (Las Vegas and Montgomery). EPA believes that it is important to do so in order to provide continuing maintenance and to deploy the monitors with trained staff. Alternatively, it may be more sensible to store the systems at a more diverse set of regional locations, where they could be potentially deployed more rapidly in the event of an emergency

4.4.2 Pre-Deployment

Under certain circumstances and in response to a DHS request, if a pre-deployment option for the deployable stations were envisaged, it would drastically change the nature of the RadNet mission and transform it into an event detection and early warning response system. Prior to large gatherings of people (e.g., political or sports events) the EPA may be asked by the DHS to pre-deploy the monitors. Fairly routine pre-deployments have positive and negative aspects. On the positive side, pre-deployment enables operators to become familiar with shipping and setting up the monitors. It also increases the probability that they will be in place when needed. On the negative side, apart from the cost, routine pre-deployment increases the probability that the monitors will be in some other location when they are needed to be used post-event or need to be re-deployed due to environmental changes. **In view of the possibility that the EPA could be requested to pre-deploy its deployable air monitors, the SAB Panel recommends that the criteria for pre-deployments be clearly addressed and carefully established**.

4.4.3 Personnel Training

Ideally, the large number of deployable monitors permits rapid deployment and operation of field monitors to adequately monitor specific situations where and when required. Since the tactics and location of a radiological-based terrorist attack may not be known, the deployable monitors must permit rapid response to a given situation in 'real time.' However, there are several indications that deployment and activation of the RadNet monitors will take several days. For example, in relation to the use of deployable monitors the EPA states that the "information concerning the exact location of each monitor relative to buildings, terrain level changes, other obstacles, along with a description of the surface terrain (for surface roughness determination), will need to be relayed to meteorologists so they can determine the value of the data prior to use." In addition, EPA relies on volunteers to deploy the monitors and bring flexibility to the deployment scenario.

The SAB Panel suggests that without prior training or experience of volunteer personnel, it is difficult to imagine the success of this enterprise in the context of a national emergency, where potential risks to personal and family safety are to be envisioned. EPA needs to clarify how, without specific training, these volunteers will know how to adequately provide the required terrain descriptions in a timely and accurate manner before starting the sampling activities; and assure themselves of the robustness of the Agency's deployment plan. **The SAB Panel lacked the information necessary to determine whether or not the numbers of cross-trained key personnel and specifically-trained volunteers will be sufficient to affect a response in the event that the core groups are not available for whatever reasons. The SAB Panel recommends that the approaches EPA proposes to use to identify, credential, and maintain the "volunteer" operators be described and training exercises be implemented.**

4.4.4 Flexible Response to Incident Scenarios

The overall plan for the deployment of the RadNet deployable monitors appears to rely on the expectation of a single radiation incident and does not consider multiple near-simultaneous incidents in the same or geographically-separated locales. Based on the history of the 9-11 attack, where three or four entities in different locations across the U.S. were targeted simultaneously, the single incident assumption is inadequate. Simultaneous, coordinated "dirty bomb" or nuclear device attacks on several cities (e.g., Boston, New York, Miami, Chicago, and Los Angeles) are as plausible as a single event scenario. ORIA should therefore revisit its fixed and deployable siting plans and determine the effectiveness of the proposed methodology if only five to ten deployable stations are available for deployment at each of several locations instead of the 20 to 40 monitoring stations per site they depict in the Report. **Plans for storing, deploying and siting the deployable monitors should include sufficient flexibility to effectively respond to simultaneous potential or real radiological events in a timely manner and in the absence of viable infrastructure (e.g., appropriately and adequately trained support personnel, communication equipment, electrical power, transportation routes and modes.)**

As discussed in the Charge Question 2b answer, the deployment and siting of deployable air monitoring stations would be greatly improved by a modeling exercise where the siting is closely tied to model scenarios involving different types of incidents (e.g., dirty bombs versus nuclear devices), as well as different types of locations (e.g., large cities versus industrial or military centers).

4.5 Response to Charge Question #2d

Does the plan provide for a practical interplay between the fixed and deployable monitors to accommodate different types of events that would utilize them?

The RadNet siting plan provides flexibility for placing deployable monitors for different types of events; however, the role of the deployable monitors is not entirely clear. These monitors are flexible, well-designed systems, but the various locations in which they will be placed relative to a contaminated plume need better definition. There are also some practical operational issues that need resolving.

a) Are the deployables for monitoring the edge of a plume, or are they to provide assurance to populated areas not covered by fixed monitors that they have not been affected?

b) How (and by whom) will the siting of the deployable monitors be determined in response to an unexpected incident?

c) In practice, how long will it take to deploy the monitors relative to the start of an event, and how does this lag time influence the desirability of pre-deployment?

d) Are the deployable monitors considered fixed stations once positioned or will they be remobilized to track possible contaminant plume movements?

The air concentration and external gamma radiation data from the RERT teams and the deployables should be integrated. These should be the easiest data to integrate since they are collected by the same organization and provide an extra safeguard to the operators. In the early phase of an incident, the deployable monitors are to provide gamma radiation and airborne radioactive particulate data to modelers to assist in validation of model output or adjustment of input parameters. However, the deployment scheme depicted by ORIA is to place the deployable monitors outside the contaminated area, leaving measurements taken inside the contaminated area to field teams deployed by state and local response organizations. To assist the modelers, the monitors may have to be placed inside the plume to measure gamma or airborne levels above background values.

The scheme for siting deployable monitors is to put them where they will measure background or pick up resuspension. Decision-makers will be looking for more data on the impacted areas, particularly from monitoring stations capable of transmitting data electronically to the emergency operation center without unnecessary and avoidable exposure to personnel. The SAB Panel suggests that EPA clarify the role of the deployable monitors.

Finally, the RadNet report should also reference and when possible, follow the guidance provided by the *Environmental Engineering Committee's Modeling Resolution* (U.S. EPA SAB. 1989.) and the recent guidance provided by the EPA Regulatory Environmental Modeling (REM) Guidance Review Panel of the SAB (U.S. EPA SAB. 2006). Even though these reports do not specifically address the use of model sensitivity analysis in the optimization of the design for siting monitoring instruments, many fundamental model requirements are presented in the context of data integration and interpretation in the context of a regulatory decision-making environment and information dissemination.

While the SAB Panel's view of the expanded and upgraded RadNet Air Network's capabilities to meet EPA objectives is essentially consistent with EPA objectives, the SAB Panel's view of the respective roles of the fixed and deployable monitors is significantly different than that of EPA. The EPA needs to address the following foreseen shortcomings in the RadNet program in the near term: (1) shortage of fixed monitoring stations and (2) scenario dependence of the balance and interplay between fixed and deployable stations.

5. RESPONSE TO CHARGE QUESTION 3: OVERALL PROPOSALS FOR DATA MANAGEMENT AND COMMUNICATION

<u>Charge Question 3:</u> *Given that the system will be producing near real-time data, are the overall proposals for data management appropriate to the system's objectives?*

> *3a) Is the approach and frequency of data collection for the near real-time data reasonable for routine and emergency conditions?*
> *3b) Do the modes of data transmission from the field to the central database include effective and necessary options?*
> *3c) Are the review and evaluation of data efficient and effective considering the decision-making and public information needs during an emergency?*
> *3d) Given the selected measurements systems are the quality assurance and control procedures appropriate for near real-time data?*

5.1 Issues with Data Analysis and Management

A fundamental issue raised by the briefing document is the need for and use of background readings. A closely related issue is the portrayal of 'not distinguishable from background' values and their dissemination to incident commanders, policy makers, and the public. **The SAB Panel recommends the use of PAGs, not simply MDAs, for definition of trigger levels.**

EPA staff explained that hourly data for the ten regions of interest of the gamma-ray spectrometer, and ^{90}Sr data from the alpha/beta particle spectrometer from 180 fixed sampling stations, will be transmitted by telemetry to a central group for collection and analysis. The resulting radionuclide concentration data will be stored, promptly distributed to appropriate government agencies, and made available to the public.

Two important aspects of evaluating these estimated 35,000 data points per day related just to radionuclide levels are:

a) rapid identification of elevated levels to identify locations of concern; and

b) avoidance of false positives or false negatives that misdirect concern.

The EPA report should consider prioritizing the information distributed by the central analysis group to emphasize measurements that exceed a critical value predetermined for each radionuclide. For example, the critical value should be selected to be significantly greater than the 2 σ MDA, but well below the limit on intake by inhalation. By selecting a 2 σ limit, 2.3% of null values – about 800 data points per day – would randomly exceed the limit thereby becoming the focus of concern. This leads to the suggestion that a data-pattern recognition program should be instituted and controlled by an experienced radiological professional at the central location since even at the 3.1 σ limit, or 0.1% of null values (about 3 per day), the limit is exceeded. One of the important reasons why an experienced professional is needed to examine the raw data is that a computerized analysis of the regions of interest (ROI) for the sodium-iodide detector and spectrometer will fail spectacularly when radionuclides other than the specified ones appear in the mix on the filter. For example, fission products or one of the many activation products beyond the ones listed on p.27 of the EPA document could add counts to each of the ROI. These would be reported as Bq/L for the corresponding radionuclide, while the actual radionuclides of concern would not be reported.

Concerning the interplay between fixed and deployable monitors, EPA proposes, in essence, to treat the data from the two types of monitors in a similar fashion. Yet, the fixed stations do not include exposure rate measurements, and the deployable monitors do not include gamma spectrometry. In addition, the collection filters (for air sampling) are different on the two types of monitors. These differences lead to a number of issues and fundamental questions.

a) How will the fixed and deployable data be integrated (e.g., in the context of modeling), especially given the different gamma-ray detectors?

b) How will cross-calibration of the systems, considering the use of different air sampling filters, be accomplished? Are there plans to calibrate both systems against each other at the same site?

c) Why is exposure rate measured on the deployable, but not on the fixed, monitors?

d) What is the purpose of the exposure rate monitoring on the deployable monitors?

5.2 Response to Charge Question #3a

Is the approach and frequency of data collection for the near real-time data reasonable for routine and emergency conditions?

The answer to this question depends to some extent on how the data will be interpreted in relation to the multiple objectives outlined for RadNet. During an emergency, **the approach and frequency of collection of near-real-time data appear to be reasonable for deciding that an area is not likely to be affected by a particular event or events.** The data in this case would be used by a decision-maker in determining whether a PAG might be exceeded with a recommendation for evacuation. The decision would revolve around a relatively high exposure rate compared to the normal exposure rate so the outlined approach and frequency appear to be reasonable. As emphasized in the ORIA presentations, the primary objective is to identify areas that do not need to be evacuated during an emergency based upon a PAG. The frequency of data collection appears to be reasonable for what is needed in an emergency.

The same approach and frequency of data collection need to be applied for routine monitoring as well as during an emergency situation so that 1) the system is continuously monitored and always ready for emergency operations, and 2) baseline data are available for comparison. For these purposes the approach and frequency of near-real-time data collection appear to be reasonable. However, if routine collection is also used to detect events, then a better analysis is needed. Because a large volume of data will be collected in routine operation, decision rules used to test whether a particular set of data represents an increase above background will need clarification. Decision rules could be defined as pre-existing criteria or processes by which individual readings or groups of readings are identified as "elevated." During routine operation of the fixed monitors, consideration should be given to how frequently false positives can be tolerated given that they would trigger an immediate data review. Immediate data reviews require a commitment of valuable human resources that can commit to capricious schedules that involve any hour of the week, night or day.

Hypothetically, if there were eight Regions of Interest (ROI's) for 24 hours each day and 180 monitors, it would require performing about 35,000 statistical tests per day with perhaps 35 significant per day at the p=0.001 level, or 1 in a thousand, level. This number is excessive and probably much greater than could be accommodated by review. **Careful development of decision rules will require much thought and collaboration among all members of the RadNet team and their partner agencies. In developing these rules it is also necessary to balance data information needs against the desire to detect a plume from a monitoring station. It would be tragic to set decision rules for triggering a review at too high a level and to miss the early evidence of an event. The optimization of decision rules should also take into account the number of monitors and their physical locations. This means that the rules would have to change over time as the RadNet system is expanded. There does not appear to be a process in place for deriving optimal decision rules for RadNet.**

When an actual event occurs, a different type of decision criterion is needed as it now becomes important to detect a different type of event that addresses the question "when does the monitor detect the plume?" rather than "does a plume exist?" At this stage the concern is not about false positives but about false negatives. At the same time, filters will be counted more frequently and more detailed data on spectra will become available which will alter how decisions are made. At later stages of the emergency, decision rules designed specifically for areas along the boundaries of the plume will be needed. There are a number of additional uses outlined for RadNet such as identification of resuspension events that will require different decision rules.

Another issue that should be considered when designing decision rules is the type of terrorism events that might occur. Most of the events considered seem to center around single large releases or explosions. Some actual terrorism events in this country involving nonradioactive materials have used contamination over a longer period of time at lower concentrations (e.g., chlordane in Wisconsin – see Wisconsin DNR no date. http://dnr.wi.gov/environmentprotect/pbt/chemicals/chlordane.htm#innovative). Although it is hard to imagine an event of this type involving an airborne release that would be dispersed over a wide enough area that RadNet could detect, it probably deserves consideration when decision rules are developed. For example, could an actual event be missed because an adjustment was made for an apparent "trend" in background?

5.3 Response to Charge Question #3b

Do the modes of data transmission from the field to the central database include effective and necessary options?

Generally, the modes of data transmission appear to be satisfactory. There are a variety of backup systems for communicating data including modem backup to the satellite telemetry. Since all of the systems appear to be based on existing technology, the SAB Panel recommends that ORIA keep abreast of improvements in the technology and utilize them as the systems are deployed. Some panelists considered that it is premature to conclude that the data systems are appropriate because it appears that they have been tested for only a few days. Modifications to the systems should become clearer once there has been additional testing of multiple data streams over longer time periods.

Even though a communication technology may not change in terms of its technical specifications, other factors may have a detrimental or beneficial effect on the existing technology. An example of such a situation would be that as a communication technology becomes more popular, the existing infrastructure may be inadequate to sustain the volume of use during an emergency. Also there should be an ongoing evaluation of the degree of independence between alternative communications methods — are infrastructure changes causing two previously independent communication methods to become dependent on the same resources?

The present plan offers several modes of data transmission as a solution to the problem of potential failure of one or more communications links. There is a need to consider how decisions should be made when data transmission is incomplete due to partial failure of all or some of the communication methods. If only partial information is received from the field stations, how will the available data be prioritized? Should decision rules be changed when data are incomplete or data variability is larger than anticipated?

The charge question deals with the transmission of data from the field to the central database at NAREL. **The evaluation and interpretation of RadNet data also involves other communication links that are critical to the process of providing high-quality information to decision-makers and other stakeholders. The vulnerability of these communication links should also be considered in any evaluation of the RadNet system.** Effective interpretation of RadNet data requires modeling at a center remote from NAREL — what alternative communication methods are available to link to this center? Similar concerns arise over communication of results to decision-makers since for many scenarios the decision-makers are likely to be located at the site of the emergency where communication methods may not be working. FRMAC and coordinating agencies also need to have alternative communication methods. Also if the field stations, NAREL, modeling center, FRMAC, agencies, and decision-makers are identified as a communications system to provide information to the public in an emergency, then there is a need to consider not only the communication links between the parts of the system but also the need for alternative sites such as the modeling center to preserve the communication system to the public.

The SAB Panel expressed some concern with regard to the operators being a weak link in some aspects of the transmission of data. While understanding the plan to use non-radiological personnel for such tasks, it is believed that there are sufficient trained radiation safety personnel available to be able to use some of them for this role. For example, there could be many volunteers from the Health Physics Society who are unlikely to have a formal role in an emergency and who would be willing to help. In addition, radiation safety staff from other, unaffected states may be called upon through mutual aid agreements. This becomes important if the role of the deployable monitors is revised in line with other SAB Panel recommendations. If the deployables are used in areas where there are measurable radiation or contamination levels, non-radiological personnel may not respond appropriately.

In the SAB Panel's opinion the revised mission of deployable monitors as proposed in this report has a number of other impacts. It makes it important to have a direct read-out of radiation levels on the monitor itself. Similarly, there is likely to be more need for electrical generators than has been planned for up to this point as well as a greater need for security of the deployables once positioned.

Given the number of local-scale decisions which would be left to the volunteers handling the siting of the deployable monitors, and the importance of adequately describing and assessing these local-scale parameters, the span of control for supervising these volunteers proposed by ORIA is inadequate. **In the SAB Panel's opinion having only one person from each lab responsible for twenty systems is too few. The SAB Panel suggests that having a ratio of four lab experts for twenty systems would be preferable.**

5.4 Response to Charge Question #3c

Are the review and evaluation of data efficient and effective considering the decision-making and public information needs during an emergency?

5.4.1 Review and Evaluation of Data

NAREL staff's presentations to the Review Panel on methods to provide Quality Assurance/Quality Control (QA/QC) of the data demonstrated that the plans for ensuring the quality of the data were adequate. In addition, the automatic and computerized methods currently in place to determine if the equipment is working properly and that data are accurate were well thought out. Given that any incident response plan or EPA decision based on RadNet will depend on analyses from models that integrate data from a wide range of sources, it is essential that the RadNet network be optimized in terms of these models. These process-oriented environmental models are typically underdetermined as they contain more uncertain parameters than the variables available to them for calibration. **Therefore the SAB Panel strongly advocates the use of sensitivity analyses in the siting of future monitor stations (fixed and deployable).** This represents a necessary step to optimize the value of collected monitoring data to the decision-makers.

The SAB Panel notes that standard operating procedures (SOP) should be in place and accompany all the QA/QC plans to ensure that the data are handled reproducibly prior to any release and that information from the system is accurate and reliable. The QA/QC system should be tested over an extended period of time with "dry runs" to determine if the methods can ensure that the equipment is operating correctly at both the fixed and deployable monitors.

In the rare case when one of the fixed stations has a reading that is outside the predetermined range of acceptability, everything possible must be done to expedite the QA/QC process to validate the readings. Even in an emergency, it is essential that the appropriate QA/QC be completed before release of data. The timetable for releasing the data should not be compressed in any way that may jeopardize data quality.

The air monitoring and data management/transmission systems have only recently been delivered to NAREL and have not been completely tested. The discussion of data in the Concept and Plan document is brief and provides only a conceptual plan for data management. The SAB Panel did not see complete raw data sets or data in the form that will be provided to users, including the public. The NAREL proposal for data management appears to be adequate, but it cannot be conclusively stated that it is appropriate to the system's objectives until the data management procedures are developed and tested.

5.4.2 Communication with Decision-Makers and the Public

Part of the stated mission of the RadNet Air Network is to protect the public health and the environment by providing information to public officials and the general public about the impacts resulting from major radiological incidents/accidents and on baseline levels of radiation in the environment. As EPA staff noted in documents and presentations provided to the SAB Panel, to convey technical information accurately, the manner in which the data is presented must be tailored to the nature of the event and the diverse needs and levels of technical expertise of users. Various groups will need information of varying types at different times and with differing amounts of context and explanation, after completion of the appropriate quality assurance and quality control (QA/QC) review.

The SAB Panel commends EPA for including stakeholders in the Agency's ongoing planning to aid in understanding the requirements and preferences of various "customer" groups such as modelers, decision-makers, and the public and encourages outreach activities. EPA should develop, empirically test, and refine, sample informational messages with the aid of social science experts. These messages should address both routine and emergency conditions. The messages should address the provision of data on baseline levels of radiation in the environment, including variability. Sample messages to provide data for release to stakeholders, including the public, in an emergency concerning the radiological aspects of specific situations should be tested during drills and exercises. However, it must be acknowledged that these messages will need to be tailored to specific concerns of the public, and there must be a mechanism to provide information about whether the messages are credible, persuasive, and understandable.

In an emergency, the EPA's primary responsibility is to assist other government agencies by providing accurate and reliable data from RadNet and other sources that can be used as a basis for decision-making. First, EPA must convey the data to the National Atmospheric Release Advisory Center (NARAC) Inter-Agency Modeling and Atmospheric Assessment Center (IMAAC) at Lawrence Livermore National Laboratory as soon as possible so that models can be run to help understand the distribution and direction of the plume and the resulting dose levels. As soon as the data have been conveyed to IMAAC and properly evaluated, it is the responsibility of IMAAC to convey the results along with all other information on the event to the Federal Radiological Monitoring and Assessment Center (FRMAC). FRMAC, rather than EPA, has the initial responsibility for releasing information to the public. **The flow of data from the event to the public should follow this line of communication (EPA to IMAAC to FRMAC), so that each Center can add value. The messages the public receives should be consistent and accurate to be useful.** For example there should not be one message reporting activity in disintegrations per minute and another suggesting some type of radiation dose. EPA documents that the Panel reviewed noted that all data would be coordinated through the FRMAC to develop a single common operating picture, as required by the National Response Plan (NRP). EPA could, however, also provide important assistance during the development of the message by contributing its own expertise in message development and its understanding of the data and the historical context.

Immediately following the recognition of a radiation incident, a local Incident Command center will be established to direct local responders in the rescue and treatment of people who are directly affected and to protect the public who are not affected. Incident Command will make decisions on the basis of the information at hand. These decisions must be informed by data that describe the nature and significance of any potential radiation exposure. Very early qualitative data will be collected locally and provide information for early decisions, but historical and quantitative data collected by EPA, including RadNet data, should be forwarded through channels as soon as possible. Because data need to be reviewed to assure quality, there will be some delay. Everything possible should be done during emergencies to minimize the time necessary to review the data and forward it to inform local Incident Command as soon as possible.

5.4.3 Units for Communication

The SAB Panel was concerned that in the preparation of documentation, such as the *"Expansion and Upgrade of the RadNet Air Monitoring Network Concept and Plan,"* the appropriate international units (SI) to express activity, radiation exposure, dose and risk were not used. This may be related to the fact that SI units were adopted and came into wide-spread use after much of the monitoring data were derived by the systems that have been replaced by RadNet. The SAB Panel considered a strong recommendation that all data should be re-evaluated using the appropriate SI units with the corresponding older units in parenthesis. However, convincing arguments were presented that instrumentation commonly used by first responders does not use (appropriate) SI units, nor is their training presented in these units. The SAB Panel was convinced that clarity of communication and comprehension was more important than international conformity at this time, so the recommendation has been softened to suggest that SI units may be presented in parentheses in preparation for a transition in the future.

5.4.4 Communicating Risk

Great care needs to be taken in converting raw data from counts per minute, to exposure, dose, and risk. Raw counting data are very site, detector, nuclide, isotope, particle size, chemical form and population specific. Thus, without much additional information and analysis, the raw data (counts per minute) **cannot and must not** be used to make even the crudest estimates of risk. In conveying the raw data to the public, it is important that the message does not convey an inappropriate perception of the risk from any event. For example, Figure B.1 page B-2 in the report records the level of activity as Monthly Maximum Gross Beta Concentration (MMGBC in pCi/m^3) over a 13 year period. It shows that the activity during this time varies by more than 100,000 times. By building on the monitoring information gathered while measuring "background," and providing contrasting information during events, the public's perception can be influenced through a strong historical perspective.

5.4.5 Other Factors that Complicate Accurate Communication

The difficulty in communicating raw data from RadNet is further complicated by the wide range of background radiation and radioactive materials in the environment. **Information on background radiation and its variability also needs to be communicated to the public relative to the changes measured by RadNet.** Using comparisons between background radiation (including the variability) and elevated readings can provide perspective, particularly if they are from the same location.

The difference between "calculated risk" based on estimates of radiation doses to populations or individuals and "measured increases in cancer frequency" based on observations of the number of cancer cases in epidemiological studies following low dose radiation exposures of large populations needs to be further established. The magnitude of the risk of radiation-induced cancer compared to the risk of developing cancer in the absence of prior radiation exposure (i.e., spontaneously) needs to be *correctly and clearly* communicated in any releases to the public. **Care should be taken to avoid using unprocessed RadNet monitoring data in the estimation of the number of excess cancers that could be expected in future years among a large population potentially exposed to very low doses of radiation. ORIA staff clearly stated that such estimations are not considered to be a responsibility of the RadNet program.**

5.4.6 Preparing for Communication in an Emergency

The SAB Panel recommends that ORIA develop a range of standard informational messages that can be tailored for specific situations for use in press releases and emergency broadcast messages. These statements should be part of any exercise with RadNet participation. These statements need to be related to exposure, activity, dose and risk utilizing a range that would encompass those typically found from hypothetical data. **Social scientists and communications experts must carefully review such statements to be sure that the messages**

are understandable and accurate. The rest of the press release can address the population, geographic, jurisdictional and cultural issues specific to the event, but having standard language to address radiation levels will help to assure that the information is released in a timely manner and not delayed while messages are developed during an emergency.

The messages derived for use in exercises also need to be discussed with decision-makers associated with the area where the exercise is conducted. These decision-makers should include individuals such as Governors, City Managers, Mayors, Health Officers, Media managers, Chiefs of Police and Fire Chiefs. The decision-makers should be asked to respond to the information provided and let EPA, IMAAC, and FRMAC know what information they need to make decisions and how the data and messages supplied would influence the decisions that they must make in the time of a real event or emergency. Studies of this type will help to develop useful, understandable and accurate messages that can be used to convey the data derived from RadNet following an event involving RDDs or improvised nuclear weapons.

Government credibility is improved if a member of the public is able to understand exact locations of radiation exposure, the levels of the exposure, the radiation doses associated with the exposure and the level of damage or risk associated with the exposure. Accurate and timely information can provide a rational basis for any action or sacrifice that the public is asked to make by the decision-makers, however, it is also essential that information is gathered and relayed back to the decision-makers about the public's perception of the risk. Precautionary protective actions can be taken to address the public's perception of risk, especially in the face of uncertainty in the early stage of an event. Additionally, decision-makers must be aware of the possibility of voluntary evacuations, which may affect the ability to implement evacuations of effected populations. Risk perception, as well as actual risk, plays a part in emergency communication.

5.5 Response to Charge Question #3d

Given the selected measurements systems, are the quality assurance and control procedures appropriate for near real-time data?

It is EPA policy that all EPA environmental programs observe 48 CFR 46.202-4 (48 CFR 46.202-4. 2000). *Quality Assurance for the Federal Acquisition Regulations System*, EPA Order 5360.1 A2 (U.S. EPA. 2000), *Policy and Program Requirements for the Mandatory Agency-wide Quality System*, and comply fully with the American National Standards Institute ANSI/ASQC E4-1994 (ANSI/ASQC E4-1994.1995). Standards 48 CFR 46 and ANSI/ASQC E4-1994 provide the regulatory and operational basis for EPA QA/QC procedures and are appropriate and adequate to support the RadNet Air Monitoring Network. However, given the extensive array of requirements and activities provided in these regulations and standards, important issues regarding the RadNet Air Monitoring Network arise and include the following:

- The specific EPA QA System established will assure that environmental data from the RadNet Air Monitoring Network are of adequate quality and usability to support all federal, state, and local requirements;

- All organizations and individuals under direct contract to EPA for RadNet Air Monitoring services, equipment, products, deliverable items, personnel training, and work are in full conformance with 48 CFR 46 and ANSI/ASQC E4-1994;

- EPA has audited supporting organizations and suppliers and documented that the required quality and performance of these services, products, deliverable items, personnel training, and work are adequate; and

- Periodic audits and assessments (as confirmatory documents available to interested parties) of the effectiveness of each quality system component associated with the RadNet Air Monitoring Network demonstrate conformance to the minimum specifications of ANSI/ASQC E4-1994.

Because the integrity and accuracy of the data measured, gathered, processed and disseminated are essential to the successful mission of the RadNet Air Monitoring Network, a controlled testing and periodic assessment of the overall performance of the system is essential for national security and confidence in the network.

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APPENDIX A –ACRONYMS

AL	Alabama
Am	Chemical symbol for americium (^{241}Am isotope)
AMAD	Activity Median Aerodynamic Diameter (Reference to particle size)
AMADF	Activity Median Aerodynamic Diameter Factor (Reference to particle size)
ANSI	American National Standards Institute
ASQC	American Society for Quality Control (also American Society for Control of Quality (ANSI/ASQC)
Bq	Symbol for Becquerel, SI unit of radioactivity (1 Bq equivalent to 2.7 E-11 Ci in traditional units)
C	Chemical symbol for carbon (^{14}C isotope)
CA	Coordinating Agency
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
Ci	Symbol for curie, the traditional unit of radioactivity (1 Ci is equivalent to 3.7E10 Bq in SI units)
Co	Chemical symbol for cobalt (^{60}Co isotope)
cps	counts per second
Cs	Chemical symbol for cesium (^{137}Cs isotope)
d	day
DFO	Designated Federal Officer
DHS	Department of Homeland Security (U.S. DHS)
dia	diameter
DOD	Department of Defense (U.S. DOD)
DOE	Department of Energy (U.S. DOE)
dpm	disintegrations per minute
dps	disintegrations per second
EPA	Environmental Protection Agency (U.S. EPA)
ERAMS	Environmental Radiation Ambient Monitoring System (Predecessor to RadNet)
FR	Federal Register
FRMAC	Federal Radiological Monitoring and Assessment Center
GM	Geiger-Mueller (Detector)
Gy	Gray
hr	hour
I	Chemical symbol for iodine (^{131}I isotope)
IMAAC	Inter-Agency Modeling and Atmospheric Assessment Center
IND	Improvised Nuclear Device(s)
Ir	Chemical symbol for iridium (^{192}Ir isotope)
keV	kiloelectron volts
kg	kilogram
L	Liter
MDA	Minimum Detectable Activity
MGBC	Maximum Gross Beta Concentration
min	Minute

MMGBC	Monthly Maximum Gross Beta Concentration
mm^2	square millimeter
m^3	cubic meter
mSv	milliSievert
µ	micro
µm	micrometer
µR	micro Roentgen
NaI	Sodium Iodide
NaI (TI)	Sodium Iodide Thallium (Crystal/Detector)
NARAC	National Atmospheric Release Advisory Center
NAREL	National Air and Radiation Environmental Laboratory (U.S. EPA/ORIA/NAREL, Montgomery, AL)
NIST	National Institute of Standards and Technology
NMS	National Monitoring System
NRP	National Response Plan
nCi	Symbol for nanocuries, traditional units of radioactivity (1 nCi is equivalent to 37 Bq in SI units)
NYC	New York City
ORIA	Office of Radiation and Indoor Air (U.S. EPA/ORIA)
p	probability
PAG	Protective Action Guide (also Protective Action Guidelines)
pCi	Symbol for picocuries, a traditional unit of radioactivity (1 pCi is equivalent to 37 mBq in SI units)
PDA	Personal Digital Assistant
PIC	Pressurized Ionization Chamber
QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
R	Roentgen; a unit of measurement of ionizing radiation in air (x or gamma rays). It is the amount of radiation required to liberate positive and negative charges of one electrostatic unit of charge in 1 cm^3 of air at standard temperature and pressure (STP). This corresponds to the generation of approximately 2.08 X 10^9 ion pairs.
RAC	Radiation Advisory Committee (U.S. EPA/SAB/RAC)
rad	Traditional unit of radiation absorbed dose in tissue (a dose of 100 rad is equivalent to 1 gray (Gy) in SI units)
RadNet	Radiation Network, a Nationwide System to Track Environmental Radiation
RDD	Radiological Dispersion Device
R & D	Research and Development
rem	Radiation equivalent in man; traditional unit of effective dose equivalent (equals rad x tissue weighting factor) (100 rem is equivalent to 1 Sievert (Sv))
RERT	Radiological Emergency Response Team
RIENL	Radiation and Indoor Environments National Laboratory (U.S. EPA/ORIA/RIENL, Las Vegas)
R/h	Roentgen per hour; traditional measure of exposure rate
Rn	Chemical symbol for radon

ROI	Region(s) of Interest; indicates regions of the energy spectrum which are summed to determine whether there is some unusual contribution to the background for specific ranges of energy
SAB	Science Advisory Board (U.S. EPA/SAB)
SI	International System of Units (from NIST, as defined by the General Conference of Weights & Measures in 1960)
SOP	Standard Operating Procedures
Sr	Chemical symbol for strontium (^{90}Sr isotope)
Sv	Sievert, SI unit of effective dose equivalent in man (1Sv is equivalent to 100 rem in traditional units)
Th	Chemical symbol for thorium
Tl	Chemical symbol for thallium (^{208}Tl isotope)
TR	Toxicological Review
US	United States
WSRC	Westinghouse Savannah River Company (contractors for Savannah River)
σ	Standard Deviation