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August 1998

AN SAB ADVISORY: ENVIRONMENTAL RADIATION AMBIENT MONITORING SYSTEM (ERAMS) II

AN ADVISORY BY THE RADIATION ADVISORY COMMITTEE

August 28, 1998

EPA-SAB-RAC-ADV-98-001

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Re: Radiation Advisory Committee (RAC) Second Advisory on Environmental Radiation Ambient Monitoring System (ERAMS)

Dear Ms. Browner:

The Office of Radiation and Indoor Air (ORIA) requested that the Radiation Advisory Committee (RAC) of the Science Advisory Board (SAB) provide advice on technical issues pertinent to the proposed reconfiguration of the Environmental Radiation Ambient Monitoring System (ERAMS). This Advisory is the second part of the evaluation of ERAMS performed by the RAC in response to ORIA's request. The first Advisory (ERAMS I) was submitted to the Administrator in April 1996.

The RAC met in Washington, DC on November 19 and 20, 1997, and again on March 3, 1998 for presentations and discussions in regard to the second Advisory (ERAMS II). ORIA provided the RAC with supporting materials for review prior to the RAC meeting including a document titled *Reconfiguration Design for the Environmental Radiation Ambient Monitoring System* which was prepared by ORIA's National Air and Radiation Environmental Laboratory (NAREL) and which described, in detail, the design for reconfiguring the ERAMS.

We compliment the ERAMS staff for the quality of its laboratory effort in preparing the proposed reconfiguration as well as the draft document and its presentations at the meeting. The RAC found the NAREL document to be a well-organized, well-written and well thought-out high-level planning document. The focused and succinct discussion in the document provided an excellent framework on which the RAC could base its observations and recommendations. We also wish to

take this opportunity to recognize and thank Dr. Janet Johnson of the SAB's RAC for coordinating this review by the Committee.

The specific charge to the RAC for the second Advisory (ERAMS II) was to assess the proposals for reconfiguring the ERAMS program and respond to the following three questions:

1) Will the proposed reconfiguration of the current ERAMS system enable it to meet the system's three basic objectives more effectively and efficiently as described in the document titled "Reconfiguration Design for the Environmental Radiation Ambient Monitoring System?

   Response: The RAC believes that the reconfigured ERAMS can meet its three basic objectives of 1) providing data for nuclear emergency response assessments, 2) providing data on ambient levels of radiation in the environment for baseline and trend analysis, and 3) informing the general public and public officials about levels of radiation in the environment. The detailed advice given in the Advisory is intended to enhance the ability of ERAMS to meet the stated objectives.

2) Are the criteria used for matrix selection, determination of sampling locations and sampling frequency, and other network features appropriate given the reconfigured ERAMS stated mission and objectives? Are there other criteria that should be considered?

   Response: The RAC found that the criteria for selection of matrices to be analyzed and sampling locations were generally appropriate but that some elements of the system could be improved. The Advisory describes in detail some of the improvements that could be made in the system including a clearer description of the rationale for the number, distribution, and specific location of sampling sites in the context of the ERAMS mission and objectives.

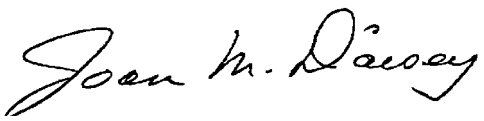
3) Will the proposed changes to the system's current data dissemination and data evaluation practices increase the data's usefulness to governmental agencies, the scientific community, and the public? Are there any other interpretation issues and/or practices that should be addressed?

   Response: *The reconfigured ERAMS includes provisions for data dissemination which will increase the visibility of the data to the public as well as governmental agencies and the scientific community. However, the RAC believes that more can be done to fulfill the ERAMS objective of "informing the general public and public officials about levels of radiation in the environment" and enhancing the quality of the data.*

4) Other Issues: *The RAC strongly supports NAREL's concept of a National Environmental Radiation Data Center (NERDC) and recommends that NAREL prepare a proposal to develop such a center in phases, with specific actions corresponding to different funding scenarios, similar to the approach used for the ERAMS reconfiguration plan.*

In general, the RAC found that the proposed reconfiguration is appropriate and Committee recommendations, in most cases, call for elaborations at a greater level of detail than was provided in the reviewed document. The RAC notes that NAREL was quite responsive to the recommendations made by this committee as part of the ERAMS I review.

We would like to again commend the NAREL for the quality of the reconfiguration proposal. The RAC appreciates the opportunity to provide this Advisory to you and hopes that the recommendations contained in it will enable EPA to enhance the ERAMS program and ensure its essential service to the public. We look forward to the response to the recommendations presented in this Advisory, and in particular to the items raised in this letter to you.



Sincerely,

Dr. Joan M. Daisey, Chair
Science Advisory Board

Dr. Stephen L. Brown, Chair
Radiation Advisory Committee
Science Advisory Board

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ABSTRACT

The EPA Science Advisory Board's (SAB) Radiation Advisory Committee (RAC) reviewed technical aspects of the draft document titled *Reconfiguration Design for the Environmental Radiation Ambient Monitoring System* (ERAMS). The reviewed document was developed by the staff of the Office of Radiation and Indoor Air (ORIA), with lead responsibility by the staff of the National Air and Radiation Environmental Laboratory (NAREL), Office of Air and Radiation (OAR), Montgomery, Alabama. The charge to the RAC for this advisory was to assess the Agency's proposals for reconfiguring the ERAMS program and to respond to specific questions related to the effort regarding the reconfiguration design, the criteria used for matrix selection, determination of sampling locations and frequency, other network features, whether proposed changes will increase overall system usefulness to all the parties, and whether there are other issues or practices that should be addressed.

The RAC found that the proposed reconfiguration is an appropriate, well organized, well-written, and well thought-out planning document. The Committee recommendations call for elaborations at a greater level of detail, a more effective statement of the mission and objectives, improvements needed to guide emergency response actions, better elaboration on use of radiation data from other routine monitoring networks, improvements in the rationale and approach to sampling choices, such as use of a Data Quality Objective (DQO) rationale in determining such factors as the number, locations and frequency of sampling locations, as well as periodic re-evaluation of design.

Key Words: Monitoring, Ambient Monitoring, Environmental Radiation Monitoring, Radionuclide Fallout, Radiological Monitoring

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1.0 EXECUTIVE SUMMARY

1.1 Background and Introduction

The Office of Radiation and Indoor Air (ORIA) requested that the Radiation Advisory Committee (RAC) of the Science Advisory Board (SAB) provide advice on technical issues pertinent to the proposed reconfiguration of the Environmental Radiation Ambient Monitoring System (ERAMS). This Advisory is the second part of the evaluation of ERAMS performed by the RAC in response to ORIA's request. Our first Advisory (ERAMS I) was submitted to the Administrator in April 1996 (SAB, 1996).

As we noted in the ERAMS I Advisory, the Agency may ask for an Advisory when it is in the midst of an extensive, complex project that would benefit from an objective evaluation of its work. The purpose of the Advisory is to provide suggestions for refinement that would assist in meeting the intent of the project and the goals of the Agency. An SAB Advisory is similar to a Review in that it is a written report to the Administrator.

ERAMS is comprised of monitoring stations across the United States, laboratory capability for analyzing samples generated from the monitoring stations, and a system for storing and disseminating data generated by the network. ORIA is responsible for the system, which is managed by ORIA's National Air and Radiation Environmental Laboratory (NAREL). ERAMS was established by the EPA in 1973 to consolidate existing radiation monitoring networks into one system. ERAMS monitoring stations are operated by volunteers in all 50 states and the American Territories. The volunteers are often employees of state or local government agencies. NAREL analyzes samples collected from the monitoring stations and publishes the data in a quarterly journal, *Environmental Radiation Data*. NAREL is also responsible for providing supplies and information to the station volunteers. ERAMS has operated with the same mission, guidelines, and structure since 1973. In early 1995, ORIA decided to perform a thorough evaluation of ERAMS to determine whether its objectives are still relevant to the mission of EPA and whether the program was meeting its objectives.

In our first ERAMS Advisory (ERAMS I), we concluded that an ERAMS mission statement was needed and that the objectives of ERAMS should support the mission. The Advisory also noted that "A critical component in determining the objectives is defining the uses for the ERAMS data." The RAC suggested that the ERAMS mission should include the following components:

a) to gather independent, reliable baseline data on environmental levels of natural and anthropogenic radiation and radionuclides, with data capable of revealing trends;

b) to gather data that help the assessment of population exposures/doses;

c) to monitor radionuclides released into the environment during radiological emergencies; and

d) to inform the public and public officials about levels of radiation in the environment.

In addition, the first Advisory contained an overarching recommendation that the Agency should do more to interpret the data generated from the present ERAMS or a reconfigured ERAMS. Detailed responses to the specific charge to the RAC are contained in the April 5, 1996 Advisory (SAB,1996).

The RAC met in Washington, DC on November 19 and 20, 1997 and again on March 3, 1998 for presentations and discussions in regard to the second Advisory (ERAMS II). ORIA provided the RAC with supporting materials for review prior to the RAC meeting, including a document titled *Reconfiguration Design for the Environmental Radiation Ambient Monitoring System* (NAREL, 1997) which described, in detail, the design for reconfiguring the ERAMS.

1.2 Overview of Findings and Recommendations

The charge to the RAC for the second Advisory was to assess the proposals for reconfiguring the ERAMS program and respond to three specific questions that are elaborated upon below.

The RAC compliments the ERAMS staff for the quality of their effort in preparing the proposed reconfiguration as well as the draft document and its presentations at the meeting. The RAC found the NAREL document to be a well-organized, well-written, and well thought-out high-level planning document. The focused and succinct discussion in the document provided an excellent framework on which the RAC could base its observations and recommendations.

In general, the RAC found that the proposed reconfiguration is appropriate. Committee recommendations, in most cases, call for elaborations at a greater level of detail than was provided in the reviewed document. The RAC notes that NAREL was responsive to the recommendations made by the Committee as part of the ERAMS I review.

1.2.1 Charge Question #1: Meeting ERAMS Objectives

Charge Question #1: Will the proposed reconfiguration of the current ERAMS system enable it to meet the system's three basic objectives more effectively and

efficiently as described in the document titled "Reconfiguration Design for the Environmental Radiation Ambient Monitoring System?"

The RAC believes that the reconfigured ERAMS can meet its three basic objectives of a) providing data for nuclear emergency response assessments; b) providing data on ambient levels of radiation in the environment for baseline and trend analysis; and c) informing the general public and public officials about levels of radiation in the environment. The detailed advice given in the Advisory is intended to enhance the ability of ERAMS to meet the stated objectives.

a) The ERAMS Mission Statement incorporates the elements suggested by the RAC in the ERAMS I Advisory but the mission and its objectives can be stated more effectively;

b) The RAC believes that NAREL can do a better job of showing how ERAMS data could be used to guide emergency response actions by describing potential accident scenarios, citing previous experience with nuclear accidents;

c) NAREL should evaluate the applicability of radionuclide data collected by the United States Geological Survey (USGS) and other governmental agencies to meet the ERAMS objectives;

d) Sampling sites for drinking water should be selected based on the size of the population served, to address the objectives of evaluating ambient radiological conditions and informing the public. However, preference should be given to surface water supplies, which are more likely to be affected by a nuclear emergency than ground water supplies;

e) The criteria for the selection of radionuclides for analysis and the required detection levels should include, explicitly, the potential of the radionuclide to contribute significantly to population dose; and

f) The ERAMS mission statement and objectives should be supplemented with an explicit statement describing what this monitoring system is not intended to do as well as providing reasons that such objectives would be infeasible or inappropriate.

1.2.2 Charge Question #2: Establishing Sampling Criteria

Charge Question #2: Are the criteria used for matrix selection, determination of sampling locations and sampling frequency, and other network features

appropriate given the reconfigured ERAMS stated mission and objectives? Are there other criteria that should be considered?

The RAC found that the criteria for selection of matrices to be analyzed and sampling locations were generally appropriate but that some elements of the system can be improved. The Advisory describes in detail changes and clarifications that could be made in the system to enhance its ability to meet ERAMS objectives.

a) NAREL needs to establish a technical basis for evaluating the suitability of its proposed number and distribution of sampling sites and a more explicit rationale for its selection of specific sampling locations;

b) Information should be compiled in a report on the relevant characteristics of each sampling site;

c) The sampling frequencies for the various media should be determined based on technical considerations and be sufficient to ensure that the volunteers who collect the samples maintain their competence;

d) Precipitation sampling should be evaluated based on its utility in meeting the ERAMS objectives and the potential for diverting those resources to increasing sampling of drinking water;

e) NAREL should thoroughly review the performance requirements for air particulate samplers and include these requirements in the specifications submitted to commercial vendors;

f) NAREL should consider adding gross alpha analysis to the air particulate sampling program;

g) NAREL should evaluate the technical basis for the proposed number of real-time gamma radiation monitoring stations in comparison with other strategies for assessing ambient gamma radiation levels;

h) Periodic re-evaluation, based on findings, should be built into ERAMS so that the system can respond to new challenges and can either terminate, or place on a less frequent schedule, the monitoring for radionuclides whose levels have been well defined; and

i) NAREL should work to ensure that there is a proper balance in the budget between capital acquisition and the needs of operations and maintenance.

1.2.3 Charge Question #3: Ensuring the Usefulness of the Data

Charge Question #3: Will the proposed changes to the system's current data dissemination and data evaluation practices increase the data's usefulness to governmental agencies, the scientific community and the public? Are there any other interpretation issues and/or practices that should be addressed?

The reconfigured ERAMS includes provisions for data dissemination that will increase the visibility of the data to the public as well as governmental agencies and the scientific community. However, the RAC believes that more can be done to fulfill the ERAMS objective of "informing the general public and public officials about levels of radiation in the environment" and enhancing the quality of the data.

a) NAREL should use the Data Quality Objective (DQO) approach systematically in the design of its reconfigured ERAMS, including all aspects of sample analysis, such as analytical detection limits, uncertainties, quality control measures, and action levels;

b) The RAC strongly supports the proposal to obtain analyses of samples using more sensitive techniques periodically and encourages the use of the Currie method for estimating minimum detectable activities;

c) All ERAMS data should be reported with uncertainty limits;

d) NAREL should calculate dose levels from concentration data where feasible to lend perspective to the monitoring results;

e) Statistical summaries and analyses should be designed to address ERAMS objectives;

f) NAREL should analyze the monitoring results for trends on a sampling site basis. Data can then be grouped on a logical basis to improve robustness;

g) NAREL should enhance its public outreach by active participation in professional societies, further indexing its web pages in internet search engines, and providing links to the web sites of other agencies with radiological monitoring programs;

h) NAREL should investigate the cost-effectiveness of sharing samples with other EPA monitoring programs; and

i) NAREL should develop close working relationships with other North American countries, especially Canada and Mexico, seeking to develop environmental radiological profiles and trends.

1.3 Additional Advice

In addition to responding to the charge, the RAC Advisory includes several other recommendations that it believes would strengthen the ERAMS program.

a) The RAC strongly supports the concept of periodic reviews of ERAMS to assess what aspects need enhancement and what aspects may not be cost-effective;

b) The time-scale and process for implementing the reconfigured ERAMS should be defined in detail;

c) NAREL should define an ideal monitoring system and then compare each system proposed under the different funding levels described in the reconfiguration document to this “state-of-the-art” system;

d) EPA should be establishing and promoting standard procedures for environmental sampling and analyses in the ERAMS program (recognizing that the Multi-Agency Radiation Laboratory Analytical Procedures protocols, which are currently being formulated, will provide consensus guidance for federal agencies); and

e) The RAC strongly supports NAREL’s concept of a National Environmental Radiation Data Center (NERDC) and recommends that NAREL prepare a proposal to develop such a center in phases, with specific actions corresponding to different funding scenarios, similar to the approach used for the ERAMS reconfiguration plan.

2.0 INTRODUCTION

2.1 Background

The Environmental Radiation Ambient Monitoring System (ERAMS) comprises monitoring stations across the United States, laboratory capability for analyzing samples generated from the monitoring stations, and a system for storing and disseminating data generated by the network. The Office of Radiation and Indoor Air (ORIA) is responsible for the system which is managed by ORIA's National Air and Radiation Environmental Laboratory (NAREL). ERAMS was established by the EPA in 1973 to consolidate existing radiation monitoring networks into one system. ERAMS monitoring stations are operated by volunteers in all 50 states and the American Territories. The volunteers are provided by state or local government agencies. NAREL analyzes samples collected from the monitoring stations and publishes the data in a quarterly journal, *Environmental Radiation Data*. NAREL is also responsible for providing supplies and information to the monitoring station operators.

ERAMS has operated with the same mission, guidelines, and structure since 1973. In early 1995, ORIA decided to perform a thorough evaluation of ERAMS to determine whether its objectives were still relevant to the mission of EPA and whether the program was meeting these objectives. To that end, ORIA requested advice from the RAC during the on-going reconfiguration process.

The first RAC ERAMS Advisory, ERAMS I, (SAB, 1996) concluded that an ERAMS mission statement was needed and that the objectives of ERAMS should support the mission. The Advisory also noted that "A critical component in determining the objectives is defining the uses for the ERAMS data." The RAC suggested that the ERAMS mission should include the following components:

a) to gather independent, reliable baseline data on environmental levels of natural and anthropogenic radiation and radionuclides, with the data capable of revealing trends;

b) to gather data that help the assessment of population exposures/doses;

c) to monitor radionuclides released into the environment during radiological emergencies; and

d) to inform the public and public officials about levels of radiation in the environment.

In addition, the first Advisory contained an overarching recommendation that the Agency do more to interpret the data generated from the present ERAMS or a reconfigured ERAMS. Detailed responses to the specific charge to the RAC are contained in its April 5, 1996 Advisory (SAB, 1996).

NAREL subsequently prepared a document presenting a design for reconfiguring ERAMS, *Reconfiguration Design for the Environmental Radiation Ambient Monitoring System* (NAREL, 1997). This document describes the reconfiguration of ERAMS as follows:

> *"The assessment of ERAMS focussed on the examination of a number of fundamental questions including: Is there a need for a national environmental radiation monitoring system? If there are needs for such a system, what are they? How would the radiation monitoring system promote the protection of public health and the environment? How would data generated from such a monitoring system be used and who would use the data? To answer these questions and to ensure a thorough assessment of ERAMS, ORIA utilized inputs from a number of sources including a national survey of ERAMS data recipients, a review of ERAMS data requests, and a contractor-performed evaluation of ERAMS. The process utilized in developing the network design presented in this document was to take the inputs from the various sources and starting essentially from "ground zero", design a national radiation monitoring system. The mission statement and objectives were developed using the various inputs and the working components of the system such as media to be sampled, sampling locations and frequency, sampling equipment and protocols, and analytical protocols were designed to ensure that the system objectives would be met".*

The RAC has reviewed this document and discussed the proposed reconfiguration with Agency staff. This Advisory (ERAMS II) is the second phase of the RAC response to ORIA's request for advice regarding the on-going reconfiguration plans.

2.2 ERAMS II Charge to the Committee

The charge to the RAC for the second phase of the evaluation is to provide responses to the following questions:

a) Will the proposed reconfiguration of the current ERAMS system enable it to meet the system's three basic objectives more effectively and efficiently as described in the attached document [*"Reconfiguration Design for the Environmental Radiation Ambient Monitoring System (NAREL, 1997*)]?

b) Are the criteria used for matrix selection, determination of sampling locations and sampling frequency, and other network features appropriate given the reconfigured ERAMS stated mission and objectives? Are there other criteria that should be considered?

c) Will the proposed changes to the system's current data dissemination and data evaluation practices increase the data's usefulness to governmental agencies, the scientific community and the public? Are there any other interpretation issues and/or practices that should be addressed?

3.0 RESPONSE TO CHARGE

The ERAMS staff is to be complimented for the quality of its effort in developing the proposed reconfiguration plan as well as preparing the draft document and presentations at the meeting. It is clear that the Agency has done a substantial amount of work in reconfiguring ERAMS.

The RAC found the NAREL document, *Reconfiguration Design for the Environmental Radiation Ambient Monitoring System* to be a well-organized, well-written, and well thought-out high-level planning document. The focused and succinct discussion in the NAREL document provided an excellent framework on which the RAC could base its observations and recommendations. In general, the RAC found that the proposed reconfiguration is on the right track and Committee recommendations are in most cases elaborations at a greater level of detail than provided in the reviewed document. The RAC notes that NAREL was quite responsive to the recommendations made by this Committee as part of the ERAMS I review (SAB, 1996).

3.1 Mission Statement

The ERAMS mission, as stated in the Reconfiguration document, is:

> *"to monitor environmental radioactivity in the United States and its Territories in order to provide high quality data for assessing public exposure and environmental impacts resulting from nuclear emergencies and to provide baseline data during routine conditions."*

Advice: The ERAMS Mission Statement incorporates the elements suggested by the RAC in the ERAMS I Advisory (SAB, 1996) but the mission and its objectives could be stated more effectively.

Although evaluation of the Mission Statement was not specifically included in the charge to the RAC, it is an integral part of the reconfiguration and is relevant to each of the three areas defined by ORIA in the charge. The Mission Statement, as described in the November 1997 ERAMS Reconfiguration document, incorporates the elements suggested by the RAC in the ERAMS I Advisory. However, the RAC suggests that the Mission Statement be strengthened. The RAC believes that the ERAMS mission is to provide the United States Government with the capability to assess on a regional basis, the radiation doses to the public and the environmental consequences of exposures to naturally occurring radionuclides as well as to radionuclides released into the environment by human activities. This assessment is to be accomplished by:

a) developing and operating an environmental radioactivity monitoring program encompassing the US and its territories;

b) developing baseline and real time radioactivity and public dose data capable of revealing trends;

c) having in place a functioning radioactivity monitoring network that would operate routinely but also be responsive during emergency conditions, both immediate and long term; and

d) developing and operating a program for communicating radiological information to the public and governmental officials routinely and during emergencies.

Advice: The ERAMS mission statement and objectives should be supplemented with an explicit statement describing what this monitoring system is **not** intended to do as well as providing reasons that such objectives would be infeasible or inappropriate.

Examples of issues that ERAMS is not designed or intended to address are: a) providing site monitoring of potential radiation sources; b) providing data for site-specific assessments of radiological doses; c) monitoring radiation along transport routes for radioactive shipments, or d) providing an early warning system for nuclear accidents. Such a statement would minimize ambiguity for the States, other government agencies, and the public as to who has responsibility for the various functions.

In addition, the relationship of ERAMS to and its role in U. S. nuclear emergency responses should be clarified. The Reconfiguration document suggests its role is to evaluate only long-term effects rather than the immediate impact on the radiation environment (page 12, lines 2-3).

3.2 Charge #1: Meeting ERAMS Objectives

Will the proposed reconfiguration of the current ERAMS system enable it to meet the system's three basic objectives more effectively and efficiently as described in the attached document ("Reconfiguration Design for the Environmental Radiation Ambient Monitoring System," NAREL report dated November 19-20, 1997)?

Response: The RAC believes that the proposed reconfigured ERAMS would be capable of meeting its three basic objectives of: a) providing data for nuclear emergency response assessments; b) providing data on ambient levels of radiation in the environment for baseline and trend analysis; and c) informing the general public and public officials about levels of radiation in the environment. However, the RAC

recommends some improvements to specific aspects of the program, as described below.

3.2.1 Nuclear Accident Scenarios

Advice: The RAC believes that NAREL could do even better in showing how ERAMS data could be used to guide emergency response actions by describing potential accident scenarios, citing previous experience with nuclear accidents.

ERAMS will not draw much support from the public or decision makers if its primary role is perceived as one of gathering data of scientific interest. The potential utility of the data for taking action in the event of an emergency needs to be emphasized in greater detail, recognizing that ERAMS is not intended to be an early warning system.

NAREL's discussion of ERAMS objective #1 should include a description of realistic potential nuclear accident scenarios, making reference to historical incidents or present day activities such as: Chernobyl, above ground or vented nuclear weapons tests, reentry of radionuclide thermal generators in spacecraft, Three-Mile Island (TMI), foreign intrusions, and interstate radioactive shipments to nuclear-waste disposal sites.

Experience with nuclear accidents should be used to present arguments for or against existing or proposed monitoring patterns. For example, an article in *Health Physics* concerning the radiation dose to the US population from Chernobyl fallout calculated with ERAMS data (Broadway, 1988), stated that most of the dose to adults was from ^{137}Cs via food other than milk. The doses had to be inferred by use of a food/milk ratio obtained from other sources. Although the RAC agrees that food monitoring presents problems and is certainly not cost-effective, this situation should nonetheless be addressed. NAREL should clarify or document what provisions exist for standby capability for collecting and analyzing specific food items (e.g., grains, vegetables), or typical diets in the event of an emergency or to establish baseline levels.

Also, based on Chernobyl fallout experience, there should be an evaluation of the utility of precipitation and airborne particle collection as indicators of radiation dose to the population in the event of an accident. The TMI experience should be used to evaluate the usefulness of a network as an early indicator of the potential effects of a nuclear accident. NAREL should consider how dense a network of sampling stations would have been optimal for this accident.

EPA should position the ERAMS program to assure environmental radiological monitoring of US surface waters in the event that a major international incident should occur.

3.2.2 Ambient Radiation Level Data Collection

The second objective of the reconfigured ERAMS is to provide data on ambient levels of radiation in the environment for baseline and trend analysis. The ability of the program to meet this objective is dependent on the types of media collected and analyses performed. The reconfigured ERAMS provides for sampling surface and ground water, milk, air, precipitation, and drinking water. The following sections address specific elements of the ambient radiation level and radioactivity concentration data collection.

3.2.2.1 Surface and Ground Water

Advice: Before making the decision to end ERAMS monitoring of surface water, NAREL should evaluate the utility of data collected by the United States Geological Survey (USGS) in meeting the ERAMS objectives.

The USGS program of measuring radioactivity in surface water, other than drinking water, was stated to be part of the justification for ending ERAMS monitoring of surface water. NAREL should provide a written evaluation of the extent to which the USGS sampling locations, frequencies and analyzed nuclides meet ERAMS objectives. This evaluation should cover the following aspects: a) identify explicitly the criteria used by the USGS for its sampling site selection, b) estimate the population coverage of these sites, c) confirm, to the extent possible, whether the USGS program will continue in its present form; and d) find out in what time frame and through what channels the USGS data are made available to the public and public officials. The ERAMS reports should note the availability of radiological analyses of surface water from the USGS and provide proper references thereto.

3.2.2.2 Drinking Water

Advice: Sampling sites for drinking water should be selected based on the size of the population served in order to address the objectives of evaluating ambient radiological conditions and informing the public. However, preference should be given to surface water supplies because these are more likely to be affected by a nuclear emergency than ground water supplies.

The first and second of the three objectives of the new ERAMS are to: a) provide data for nuclear emergency response assessments; and b) provide data on ambient levels of radiation in the environment for baseline and trend analysis. It would seem reasonable, in selecting sampling media and sites for the second objective, to consider the first objective. That is, establish a baseline and determine any trends in media and at sites that would be expected to be influenced by nuclear emergencies. To this end sampling air, milk, and drinking water derived from surface water is appropriate, but

sampling drinking water derived from ground water is of little utility for assessing nuclear emergencies. Most ground water would not be affected by nuclear emergencies in the short term, when nuclear emergency response assessments are needed, and may never be affected. However, for drinking water sampling locations selected to address ERAMS objective #3 (informing the public about levels of radiation in the environment), the RAC agrees that the size of the population served by a given system—regardless of whether the source is surface water or ground water—is the most appropriate criterion for selecting a drinking water sampling location.

The RAC recommends that: a) sampling sites for drinking water be biased toward population centers that derive their drinking water from surface sources; and b) for population centers that derive drinking water from both surface and ground sources, that effort be made to obtain samples from a point in the system where all or at least some of the water is from surface sources. This approach would help ensure that any effects on the drinking water supplies from nuclear emergencies would be detected and factored appropriately into the emergency response assessments.

3.2.2.3 Selection of Specific Radionuclides for Analysis

Advice: The criteria for selection of radionuclides for analysis and the required detection levels should include, explicitly, the potential of the radionuclide to contribute significantly to population dose.

Before implementing the reconfiguration plan, NAREL should use available information to describe, by radionuclide, what is known and what must be measured in the future. Some radionuclides, such as ^{90}Sr and isotopes of U and Pu, are currently detectable at levels that are low and changing very slowly, so that once-yearly national coverage is sufficient. Other radionuclides are generally not detectable by NAREL's present analytical techniques (^{137}Cs and ^{3}H), but would be detected if measured at 10-times lower detection limits. NAREL needs to decide if the lower detection levels are worth the added cost. At the few locations where these radionuclides are detected, continued monitoring is worth-while. Documentation of the ERAMS reconfiguration should be more transparent with respect to selection and exclusion of specific nuclides from its monitoring program. For example, short-lived radionuclides such as ^{131}I are not in the category of defining the background conditions but may be present downstream from medical facilities and thus become part of "background" relative to releases from nuclear accidents. Another radionuclide (^{85}Kr) has been dropped from ERAMS but should be reconsidered in the context of emergency response capability. Other radionuclides that have not been monitored (^{222}Rn, ^{210}Pb, ^{129}I, ^{147}Nd, ^{152}Eu) should also be considered for future monitoring to meet the objectives of the ERAMS program since they may contribute significantly to population dose under normal or accident conditions. The reason for excluding these nuclides from routine monitoring should be stated explicitly.

An additional criterion should be explicitly added to those listed for the selection of a given radionuclide for analysis (see p. 29 of the draft document): "identified as a nuclide with the potential to pose a significant contribution to population dose, based on pathway modeling (or a surrogate for such a nuclide)." This criterion is included in the draft NAREL report rather obliquely, as a radionuclide of "concern to the system client." The explicit addition of this criterion merely reiterates a later statement in the text (p. 31), that "Priority will be given to radionuclides that are significant contributors to dose and those that are short-lived."

3.2.3 Public Information

The third objective of the reconfigured ERAMS is to inform the general public about levels of radiation in the environment. Dose assessment may be performed to enhance the effectiveness of ERAMS in meeting that objective.

(The ability of the reconfigured ERAMS to inform the public effectively regarding ambient radiation levels is covered in more detail in Section 3.4 of this Advisory.)

3.3 Charge #2: Establishing Sampling Criteria

Are the criteria used for matrix selection, determination of sampling locations, and sampling frequency and other network features appropriate, given the reconfigured ERAMS stated mission and objectives? Are there other criteria that should be considered?

Response: The RAC found the criteria for selection of matrices to be analyzed and sampling locations were generally appropriate but that some elements of the system could be improved. Determination of the number of sampling stations needed to meet the objectives of ERAMS and the selection of monitoring locations should be based on technical considerations to the extent feasible. The RAC is concerned that the sampling frequency specified in the reconfiguration plans may not be sufficient to maintain an adequate level of sampling team proficiency.

3.3.1 Determination of Sampling Locations.

3.3.1.1 Number of Sampling Locations

Advice: NAREL needs to establish a technical basis for evaluating the suitability of its proposed number and distribution of sampling sites.

The ERAMS program should cover the continental USA (including Alaska), and non-continental areas. Non-continental areas are defined in other EPA programs to include the State of Hawaii, Virgin Islands, Guam, American Samoa, Commonwealth of

Puerto Rico, and the Northern Mariana Islands. This coverage would be consistent with the ERAMS mission "to monitor environmental radioactivity in the United States and its Territories..."

3.3.1.2 Site-Specific Locations.

Advice: NAREL should provide a more explicit rationale for its selection of specific sampling locations.

Justification for sampling locations in the reconfigured ERAMS is incomplete. For each of the sampling and monitoring categories, ERAMs should present a sensitivity analysis, for example in the form of a plot of fraction of population or geographic coverage vs. number of optimally placed sites. This would indicate whether there are break points beyond which only minor benefits would accrue from large expenditures, and how funds could be apportioned to maximize the geographic or population coverage.

The maps in the reconfiguration document show large regions without a single monitoring station. This imbalance in national geographical distribution should be redressed. In addition, it may be desirable to give every state the opportunity to be included in each network, so that the citizens of each state can relate to results pertinent to them. In designing the ERAMS network, consideration should be given to the sampling networks of other organizations such as the Environmental Measurements Laboratory (EML). Other sampling networks include the Los Alamos National Laboratory (LANL)/Environmental Protection Agency (EPA) and the Department of Energy's (DOE's) precipitation monitoring. Predominant global weather patterns should also be taken into account in selecting ERAMS monitoring locations.

Placement of the few border locations for gamma-ray monitoring is undoubtedly guided by convenience, but seems arbitrary when viewed on the map, and certainly unlikely to permit reaching any systematic conclusions. ERAMS staff needs to specify their purpose and use some algorithm (e.g., for plume width) to determine the number required to meet the specified needs. If hundreds of stations are needed, one, two, or three would be useless.

Once a general location has been established for a sampling site, criteria for evaluating the suitability of a specific location for the sampling station should be explicitly stated. In its present form, the review document gives the impression that undue reliance has been given to operator convenience rather than scientific criteria for siting the stations. An example of a site-specific criterion would be the specification of a minimal acceptable distance from buildings for air and precipitation collectors. However, since the stations are operated largely by volunteers, it should be acknowledged that the convenience factor cannot be ignored in sampling site selection.

3.3.1.3 Site Characterization

Advice: Background information on the relevant characteristics of each sampling site should be compiled in a report or web-accessible data base and made readily available to users of the data.

Examples of standard information that would be useful to include in a sampling-site report are as follows:

a) For all sampling sites: longitude, latitude, elevation, objective of sampling site (e.g., monitoring potential point source, border station, global fallout), type of land use surrounding site;

b) Air and precipitation sampling sites: wind rose, population within specified distances of the site, site sketch;

c) Milk sampling sites: wind rose, location and size of population served by milk suppliers in the area; and

d) Drinking water: type of source (river/stream, reservoir, ground water well, mixture), population served by this particular source, location of sample, and collection site (if different from location of water supply).

3.3.2 Sampling Frequency

Advice: The sampling frequencies for the various media should be determined based on technical considerations and be sufficient to ensure that the volunteers collecting the samples retain their competence.

The reconfigured ERAMS calls for sampling some media on a semi-annual basis. Considering the mission of ERAMS as defined in the draft document and the expected budget limitations, the proposed reduced sampling schedule seems reasonable and probably necessary. However, maintaining a high level of consistency and quality of samples when these are only collected twice per year by volunteers will require a special effort and even then may not achieve the state of readiness described on page 12, lines 12-13 of the NAREL document (NAREL, 1997).

NAREL should consider increasing the sampling frequency for precipitation, milk, and drinking water samples and archiving those that are not analyzed immediately. Archived samples would have a limited storage time, e.g., not to exceed a year, or to be held until analytical results are available for the next regularly scheduled collection. (Obviously, the archived samples could not be analyzed for short-lived radionuclides, so some information would be irretrievably lost.) Analyses of the

archived samples would only be conducted if the more recent results showed a significant change relative to the previous results. This increased sampling would also keep the sample collectors "up to speed and at the ready" as well as have samples available in the event of a sudden emergency.

For those media to be sampled twice per year, as specified in the reconfiguration document, NAREL should consider establishing a two-tiered system of sampling frequencies for each location and type of media, with more frequent sampling being conducted when a trend is apparent or suggested by the data, when an anomalous result has been confirmed, and when elevated concentrations have been observed in another sample from the same location but in a different medium or for a different radionuclide. Implementing such a recommendation would require the establishment of an action level for each category, e.g., based on dose levels corresponding to a particular concentration or trends. It would also require the establishment of “stopping rules,” defining in advance how long the increased frequency of sampling should be in effect.

The crucial point regarding frequency is not only how often a location should be monitored to avoid missing an increased level of a particular radionuclide, but also how often a sample should be collected so that sampling staff retains its competence. This question needs to be addressed directly, rather than arbitrarily answering it "twice yearly." The experience with reliability of quarterly collections should be reviewed. If it has not already been done, collection reliability should be checked in the field. Methods of providing guidance and remote prompting for once-yearly collections should be considered.

A sound rationale should also underlie the basis for establishing the timing of sample collection for samples collected only twice a year. Staggering the analytical schedule, as suggested in the reconfiguration document, does not appear to have a sound technical basis and may be inappropriate for some media. Factors that affect radiological levels in a given media (such as milk) should be identified in order to evaluate whether the timing of sample collection is optimized to address ERAMS objectives. Seasonal effects and coordination with other sampling locations may also be relevant considerations.

In addition to sampling frequency and timing, the sampling periods for collecting airborne particles, precipitation, and drinking water should be clearly defined. However, the RAC recognizes that these issues may be addressed in the ERAMS sampling manual.

3.3.3 Matrix Selection

3.3.3.1 Surface Water Sampling

Surface water sampling issues are addressed in Sections 3.2.2.1 and 3.2.2.2.

3.3.3.2 Precipitation Sampling

Advice: Precipitation sampling should be evaluated for its utility in meeting the ERAMS objectives as compared to the benefits of diverting those resources to enhancing drinking water sampling.

NAREL should clarify how data on radionuclides in precipitation would be useful in nuclear emergency response assessments or later dose assessments. Precipitation has been demonstrated to be an effective indicator of ground deposition from localized fallout, (e.g., releases from the Hanford Reservation in the 1940s, the Nuclear Test Site in the 1950s, fallout from Chinese testing of nuclear devices in the 1970s and 1980s, and the Chernobyl reactor accident in 1986). Rainfall is the main vector for radionuclides moving from air to the ground. However, NAREL should evaluate the utility of precipitation data against the advantages of diverting those resources into taking more drinking water samples, especially from surface water systems. If NAREL believes that precipitation data are useful, this could be made clearer by implementing the suggestion for a written plan on how, and within what time frame(s), dose assessments would be conducted, based on ERAMS data (Section 3.4.4).

3.3.3.3 Air Sampling

Advice: NAREL should thoroughly review the performance requirements for air particulate samplers and include these requirements in the specifications submitted to commercial vendors.

NAREL should be cautious in acquiring commercial samplers. Based on the personal experience of members of the RAC, they should not be viewed as a panacea. Commercial samplers are not necessarily reliable nor is their performance always up to the standards specified by the manufacturer. NAREL should consult with the individuals responsible for air particulate monitoring at nuclear facilities to obtain practical evaluations of sampler performance.

NAREL should institute a periodic sampler testing program to measure reliability.

Advice: NAREL should consider adding gross alpha analysis to the air particulate sampling program.

The Committee was somewhat surprised that no gross alpha analysis is contemplated for the air particulate matter sampling program. The RAC acknowledges the difficulties in detecting short-range alpha particles emitted from solid media; however, some additional sample preparation steps may permit such analyses at

modest additional cost. Although an argument can be made that this measurement is not quantitative due to variable impaction in the filter and self absorption in the mass of material collected on the filter, it is still a reasonable qualitative indicator. In systems with which the RAC has had experience, significant differences between gross alpha results in the general environment and those near an elemental phosphorus plant, which emits natural ^{210}Po, were routinely noted (US AEC, 1974). In addition, considering the concern over the ^{238}Pu radioisotope thermal generators (RTGs) such as those launched recently in the Cassini spacecraft, a gross alpha capability for nuclear emergency response assessments and a baseline would seem to be timely.

3.3.3.4 Environmental Gamma Radiation Measurement

Advice: NAREL should evaluate the technical basis for the number of real-time gamma radiation monitoring stations proposed in comparison with other strategies for assessing ambient gamma radiation levels.

Although the Committee supports the intent of the real-time gamma radiation monitoring plan, it is concerned that the number of stations proposed may not be sufficient to provide much useful information. A plume from a radionuclide-releasing event could well miss all of the stations on its first pass, especially if it originated inside the U.S. The Committee is well aware that such stations would be expensive and that even the optimistic budget cannot provide for many real-time gamma monitors. NAREL should improve its technical justification for the number of stations requested or consider using the proposed budget for more useful strategies. NAREL should also consider reinstituting the environmental thermoluminescent dosimeter (TLD) system, or implementing a state-of-the-art TLD or Electret Ionization Chamber (EIC) system (Kotrappa, 1992) to supplement the planned pressurized ionization chamber (PIC) network. These integrating systems are cost-effective and can be operated at locations without electrical power.

3.3.4 Resource Priorities

Advice: NAREL should work to ensure that there is a proper balance in the budget between capital acquisition and the needs of operations and maintenance.

In a recent visit to Los Alamos, a member of the RAC noted that several of the Neighborhood Environmental Watch Network (NEWNET) stations had not operated properly for periods of time and was told that there were insufficient resources to keep them repaired and calibrated. The resources required for acquisition and maintenance of expensive monitoring stations for ERAMS should be carefully considered by NAREL, particularly in regard to new air samplers and PICs.

3.4 Charge #3: Ensuring the Usefulness of the Data

Will the proposed changes to the system's current data dissemination and data evaluation practices increase the data's usefulness to governmental agencies, the scientific community, and the public? Are there any other interpretation issues and/or practices that should be addressed?

Response: The reconfigured ERAMS includes provisions for data dissemination that will increase the visibility of the data to the public as well as governmental agencies and the scientific community. However, the RAC believes that more can be done to fulfill the ERAMS objective of "informing the general public and public officials about levels of radiation in the environment" and enhancing the quality of the data.

3.4.1 Data Quality Objectives (DQO).

Advice: NAREL should use the DQO approach systematically and up-front in the design of its reconfigured ERAMS, including all aspects of sample analysis, such as analytical detection limits, uncertainties, quality control measures, and action levels.

DQO are mentioned briefly on pages 42 and 44 of the NAREL document (NAREL, 1997) document. Implementing this advice probably involves a reorganization of the format of the reviewed document, with little change to its content.

3.4.2 Lower Detection Limits.

Advice: The RAC strongly supports the proposal to analyze samples periodically using more sensitive techniques and encourages the use of the Currie method for estimating minimum detectable activities.

More sensitive analytical techniques, as described on page 33 of the reconfiguration document (NAREL, 1997), would serve several purposes:

a) They would provide greater confidence in results reported at or near the detection limits of less-sensitive techniques;

b) They would permit the calculation of background doses to serve as a basis against which to compare any increased dose resulting from a nuclear event. When the reported exposure or concentration is zero, then the implied background dose is also zero (although, of course, such is not really the case). Consequently, if a nuclear event gave rise to detectable radioactivity, then the entire dose would be attributed to the event since the apparent background dose was zero. This conclusion could be quite misleading if the true background was only slightly below the detection limit, while the radioactivity resulting from the event was only slightly above it; and

c) Non-zero data are necessary in order to identify trends.

ERAMS should use the Currie method (Currie, 1968) for estimating minimum detectable activities and concentrations instead of using 3 standard deviations as was done in the sample *Environmental Data Reports* 74 and 75 (EDR) (NAREL, 1994a; 1994b) provided to the RAC. (Based on information received from NAREL, the Currie method has been implemented since publication of Volume 75 of EDR.)

3.4.3 Uncertainty Estimates

Advice: All ERAMS data should be reported with uncertainty limits.

Some, but not all, categories of data are already reported with uncertainty limits in the ERAMS' quarterly journal*, Environmental Radiation Data*. A statement should be published together with each data set as to any other significant sources of uncertainty, in addition to analytical counting statistics, that would not be reflected in the reported uncertainty limits.

3.4.4 Dose Levels

Advice: NAREL should calculate dose levels from concentration data to lend perspective to the monitoring results.

Reporting dose levels calculated from radionuclide concentrations resulting from release events is important because the estimated dose places a specific radionuclide measurement in perspective. On the other hand, the dose can vary widely because of assumptions made concerning intake pathways and amounts, and target populations. Hence, the assumptions underlying the dose calculations should be clearly stated.

It is assumed that doses would not be assessed for individuals in the population but rather for specific segments of the population. These segments should be identified. A written plan should be developed to describe how, and within what time frame(s), dose assessments would be conducted, based on ERAMS data. To the extent feasible, NAREL should consider reporting approximate dose levels corresponding to its current and extended detection limits. Underlying assumptions for these dose levels should also be clearly stated.

3.4.5 Statistical Analyses and Trend Evaluation

Advice: Statistical summaries and analyses should be designed to address ERAMS objectives.

NAREL should develop a proposed set of statistical parameters and specific hypotheses to be tested and should prepare a draft report for peer review, applying these statistical tools to its current data base. Some suggestions are:

a) provide statistical summaries on a regional, as well as national, scale;

b) provide statistical summaries on a seasonal, as well as annual, scale since seasonal variations would occur for radionuclides with a significant inventory in the stratosphere because of an annual spring breakthrough to the troposphere; and

c) compare U.S. situation to worldwide trends.

3.4.6 Trend Evaluation

Advice: NAREL should analyze the monitoring results for trends on a sampling site basis. Data can then be grouped on a logical basis to improve robustness.

The RAC encourages NAREL to develop trend analyses of the laboratory analyses and resultant data they publish. These trend analyses should be reported in a format readily understandable to the general public. A good example of this approach is the Indicators of Stress and diagrams used in the Report Highlights, *STATE OF THE GREAT LAKES - 1997* (SOLEC, 1997a), prepared from information gathered for and discussed during the November 1996 State of the Lakes Ecosystem Conference (SOLEC, 1996; SOLEC, 1997a; 1997b).

In its discussions with the RAC, NAREL proposed to evaluate trends by aggregating data nationally and examining the changes over time. While national aggregation of data will probably work for nuclides such as ^{90}Sr in milk, it could obscure regional differences in other cases. It may be better to examine trends on a sample site basis and then aggregate data that exhibit similar trends, thus improving robustness. Aggregating data with different trends could simply obscure possibly meaningful local or regional trends. However, the data need to be grouped on a logical basis in order to have sufficient power to detect trends. Trend analysis may also be useful in determining when the frequency of monitoring for radionuclides whose levels have been well defined should be reduced as discussed in Section 3.3.2., as well as providing design flexibility as discussed in Section 4.3.1.

3.4.7 Dissemination of ERAMS Data and Public Outreach

The RAC strongly supports all efforts to disseminate the ERAMS data and to design documents to meet the needs of a wider audience, especially by electronic means such as the Internet.

Advice: NAREL should enhance its public outreach by active participation in professional societies, further indexing its web pages in Internet search engines, and providing links to the web sites of other agencies with radiological monitoring programs.

NAREL has, laudably, included plans for enhancing the utility of ERAMS products to outside users, e.g., by improving the formatting and content of the Environmental Radiation Data (ERD) reports and placing data on the Internet. NAREL should consider establishing a map-based database accessible on the Internet that guides the user in accessing the radiation data available for the geographic area of interest. The environmental database established and maintained by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a good example of such a map-based system. More public outreach may still be necessary. The ERD page on the Internet showed only 243 visits through mid April 1998, many of which may be from people who already knew about the database. NAREL may need to make itself better known by further indexing its pages in search engines and publicizing via the Health Physics Society, the American Nuclear Society, and other organizations and journals featuring interests in environmental radiation data. The RAC recommends that NAREL personnel become more active in professional societies in order to build a stronger user constituency, to serve as a vehicle for data dissemination, and to increase interaction between NAREL staff and environmental radiation professionals.

NAREL/ERAMS reports should discuss the relationship of ERAMS to the radiological monitoring programs of other Federal Agencies (USGS, Department of Defense, Department of Energy, Nuclear Regulatory Commission, Department of Agriculture, and US Customs). The ERAMS web site should provide links to the web sites of those agencies for access to their information.

While the above recommendations may help in disseminating the information to a larger audience, it is somewhat unrealistic to expect much broadly based enthusiasm for the ERAMS program data unless there is an event resulting in release of radionuclides. NAREL should develop a plan to publicize the availability of its data and of its interpretation of those data when a nuclear event occurs. The data should be publicized even if the event does not result in measurable increases in activity concentrations in environmental media or increases in direct gamma radiation levels.

As U.S. citizens, we should be pleased to live in an area for which ERAMS reports have shown that our environmental exposure to anthropogenic sources of radiation is practically nil. However, this finding should not lead to a sense of complacency and a concomitant reduction in EPA's commitment to continued operation of ERAMS. The RAC commends NAREL for its proposed approach for maintaining and continually improving the baseline data provided by ERAMS. In addition, the RAC recommends that the "good news" generated by the ERAMS program deserves greater

visibility with the public, with public officials, and with scientists who may not be familiar with the scope and breadth of the data or of the program. Such enhanced visibility can be achieved through better interactions with radiation protection societies and other societies such as the American Nuclear Society. An outreach program to make the public aware of this excellent program could include presentations to local groups such as Lions and Rotary clubs, Chambers of Commerce, the League of Women Voters, schools, and other community organizations.

3.4.8 Cooperative Sampling Efforts

Advice: NAREL should investigate the cost-effectiveness of sharing samples with other EPA monitoring programs.

The samples that NAREL collects may well contain non-radioactive substances of interest to other parts of the Agency. If sample collection is a significant part of the sampling and analysis cost for those other programs, sharing the samples may increase the value of the ERAMS program to the nation. Conversely, samples from other parts of the Agency might expand ERAMS coverage if analytical cost is not dominant. The Committee recognizes that NAREL is aware of these possibilities and intends to pursue them. Somewhat more specificity is desirable in the plan.

3.4.9 International Cooperation

Advice: EPA/NAREL should develop close working relationships with other North American countries, especially Canada and Mexico, seeking to develop environmental radiological profiles and trends.

These relationships would be consistent with the nation's international environmental commitments, such as those discussed in the SOLEC '96 report (SOLEC 1997a; 1997b).

4.0 ADDITIONAL ADVICE

The following comments and recommendations are not directly related to the three elements of the charge to the RAC. They have been included here to provide additional information that the RAC believes would strengthen the ERAMS program.

4.1 Radiation Data Center

Advice: The RAC strongly supports NAREL's concept of a National Environmental Radiation Data Center (NERDC) and recommends that NAREL prepare a proposal to develop such a center in phases, with specific actions corresponding to different funding scenarios, similar to the approach used for the ERAMS reconfiguration plan.

The proposed incorporation of data from the States, Department of Energy (DOE), U.S. Nuclear Regulatory Commission (NRC), and other agencies into the ERAMS data base is excellent. However, the process for building, maintaining, and sharing this database needs to be established. In order to assess the comparability of radiation data from different sources and to minimize the potential for misusing data, a critical task for the data center to undertake will be documentation of the data objectives, sample collection and analytical protocols, and quality controls used by other agencies. NAREL may want to consider bringing this topic before the RAC for a consultation or advisory.

The RAC suggests that the NERDC could be started with real-time PIC data. These data are already available electronically from many sources, and there should be little issue of data comparability because calibration of these instruments is a relatively straightforward process.

ERAMS documentation should include a summary of other radiation monitoring systems around the world. ERAMS has been very useful in documenting the extent of radiological fallout related to accidents. The system was "booted up" as a result of information first obtained from systems in Europe. Therefore, there is a clear and very useful relationship between ERAMS and other systems.

4.2 Standard Procedures for Environmental Sampling

Advice: EPA should establish and promote standard procedures for environmental sampling and analyses in the ERAMS program.

EPA should establish and promote standard procedures for environmental sampling and analyses in the ERAMS program, recognizing that the Multi-Agency

Radiation Laboratory Analytical Procedures (MARLAP), which is currently being formulated, will provide consensus guidance for federal agencies.

4.3 Periodic Reviews

Advice: The RAC strongly supports the concept of periodic reviews of ERAMS to assess what aspects may need enhancement and what aspects may not be cost-effective.

These future reviews of ERAMS should start from a zero base program, as is being done currently, and consider options relative to an ideal radiological environmental monitoring/surveillance program.

4.3.1 ERAMS Design Flexibility

Advice: Periodic reevaluation of the design should be built into ERAMS so that the system can respond to new challenges, improvements in analytical technology, and changes in population distribution, and can terminate, or place on a less frequent schedule, the monitoring for radionuclides whose levels have been sufficiently well defined and that show no temporal trends.

The NAREL plan generally provides a good rationale for its design choices. The plan would be further improved if it also discussed "stopping rules." These are statements of conditions under which NAREL might consider discontinuing or reducing the frequency of collection of samples for a certain matrix or medium, discontinuing analysis for a specific radionuclide, or abandoning a station.

The stopping rules could be based on failure to detect an analyte over a period of time, levels routinely well below any risk-based action level, or stability of results (indicating that little new information is being generated). Any resources freed through these decisions could then be diverted to more productive activities. It must be noted, however, that most of the anthropogenic radionuclides will be below detection limits of standard methods under normal circumstances. There is nothing wrong with measuring a long string of high quality "zeros" in media and at locations that would be affected by an accident, should one occur. The readiness capability could be impaired or lost if sample collection and analyses were stopped. It is reasonable, however, to consider rules for increasing and decreasing the frequency of sample collection and analyses, putting certain functions on standby, restarting, and shifting emphasis.

4.4 Process for Implementing Reconfigured ERAMS

Advice: The time scale and process for implementing the reconfigured ERAMS should be described in greater detail.

. If budgetary constraints force a reduction in sampling frequency to the extent that ERAMS can no longer meet its basic objectives, then NAREL should describe how that data gap will be addressed.

4.5 Prioritization Based on Available Funding

Advice: NAREL should define a “state-of-the-art” monitoring system and then compare each system proposed under the different funding levels described in the reconfiguration document (NAREL, 1997) to this system.

The reconfiguration plans include prioritization according to the available funding: zero additional resources, some additional resources, and optimized additional resources. The RAC suggests that NAREL develop and verbalize a "grand view" of what could constitute a "state-of-the-art" monitoring system, and then compare each system envisioned by the different funding levels to this ideal system.

ORIA should also evaluate the cost-benefit aspects of aerial gamma radiation surveys. If this activity is deemed to be consistent with the ERAMS mission, its cost-effectiveness should be evaluated in the context of available resources and other activities necessary to meet the ERAMS objectives.

4.6 Termination of NRC Monitoring Contracts with States

Advice: The NRC has terminated contracts with 34 states for radiation monitoring around nuclear facilities. NAREL should evaluate the effect this loss of funding for state programs might have on the ERAMS sample collection networks that are staffed by state employees.

REFERENCES CITED

Broadway, J. A., J. M. Smith, D. L. Norwood, and C. R. Porter. 1988. *Estimates of radiation dose and health risks to the United States population following the Chernobyl nuclear plant accident.* Health Physics 55, No. 3. p. 533.

Currie, L. A. 1968. *Limits for qualitative detection and quantitative determination.* Anal. Chem. 40. .p. 586.

Kotrappa, P., T. Brubaker, J. C. Dempsey, and L. R. Stieff. 1992. *Electret ion chamber system for measurement of environmental radon and environmental gamma radiation.* Rad. Prot. Dos. 45 (1- 4 Supp). P 107.

NAREL. 1994a. Environmental Radiation Data Report 74: April-June 1993, U.S. EPA, ORIA, NAREL, EPA 402-R-93-093, August 1994.

NAREL. 1994b. Environmental Radiation Data Report 75: July-September 1993, U.S. EPA, ORIA, NAREL, EPA 402-R-93-094, August 1994.

NAREL. 1997. National Air and Radiation Environmental Laboratory (NAREL). *Reconfiguration Design for The Environmental Radiation Ambient Monitoring System*. United States Environmental Protection Agency (U.S. EPA), Office of Radiation and Indoor Air (ORIA). November.

SAB. 1996. *Advisory on Environmental Radiation Ambient Monitoring System (ERAMS)*, U.S. EPA, Science Advisory Board (SAB), Radiation Advisory Committee (RAC), Washington, DC EPA-SAB-RAC-ADV-96-003, April.

SOLEC. 1997a. State of the Lakes Environmental Conference (SOLEC), Environment Canada and U.S. EPA, *State of the Great Lakes: 1997a - Report Highlights,* Environment Canada and U.S. Environmental Protection Agency, 21 pages.

SOLEC. 1997b. State of the Lakes Environmental Conference (SOLEC), Environment Canada and U.S. EPA,*State of the Great Lakes: 1997b - The Year of the Nearshore,* Environment Canada (ISBN 0-662-26003-1; Catalogue N. En. 40-11/35-1997E), U.S. Environmental Protection Agency (EPA 905-R-97-013), 76 pages.

U.S. AEC. 1974. United States Atomic Energy Commission (U.S. AEC), Idaho National Engineering Laboratory 1973 Environmental Monitoring Program Report, Idaho Operations Office, United States Atomic Energy Commission, Idaho Falls, Idaho.

APPENDIX A - GLOSSARY OF TERMS AND ACRONYMS

AEC	- Atomic Energy Commission (U.S. AEC)
Ci	- Curie (unit of radioactivity)
^{137}Cs	- Cesium 137, a radioactive isotope of cesium
DOE	- Department of Energy (U.S. DOE)
DQO	- Data Quality Objectives
EDR	- Environmental Data Reports
EIC	- Electret Ionization Chamber
EML	- Environmental Measurements Laboratory
EPA	- U.S. Environmental Protection Agency (U.S. EPA)
^{152}Eu	- Europium-152, a radioactive isotope of europium
ERAMS	- Environmental Radiation Ambient Monitoring System
ERAMS I	- First ERAMS (I) Advisory by the U.S. EPA/SAB/RAC
ERAMS II	- Second ERAMS (II)Advisory by the U.S. EPA/SAB/RAC
ERD	- Environmental Radiation Data
^{3}H	- Hydrogen-3 (tritium), a radioactive isotope of hydrogen
^{129}I	- Iodine-129, a radioactive isotope of iodine
^{131}I	- Iodine-131, a radioactive isotope of iodine
^{85}Kr	- Krypton-85, a radioactive isotope of krypton
LANL	- Los Alamos National Laboratory
MARLAP	- Multi-Agency Radiation Laboratory Analytical Procedures (Manual)
MARSSIM	- Multi-Agency Radiation Survey and Site Investigation Manual
NADP/NTN	- National Atmospheric Deposition Program/National Trends Network
NAREL	- National Air and Radiation Environmental Laboratory (U.S. EPA)
^{147}Nd	- Neodymium -147, a radioactive isotope of neodymium
NERDC	- National Environmental Radiation Data Center
NEWNET	- Neighborhood Environmental Watch Network
NRC	- U.S. Nuclear Regulatory Commission (U.S. NRC)
ORIA	- Office of Radiation and Indoor Air (U.S. EPA)
^{210}Pb	- Lead-210, a radioactive isotope of lead
Po	- Polonium, as an element (Po), or as an isotope (e.g., ^{210}Po, ^{214}Po)
PIC	- Pressurized Ionization Chamber
Pu	- Plutonium, as an element (Pu) or as an isotope (e.g., ^{239}Pu, ^{240}Pu)
RAC	- Radiation Advisory Committee (U.S. EPA/SAB/RAC)
^{222}Rn	- Radon, as an element (Rn), or as an isotope (e.g., Radon-222)
RTGs	- Radioisotope Thermal Generators
SAB	- Science Advisory Board (U.S. EPA/SAB)
SOLEC	- State of the (Great) Lakes Environmental Conference
^{90}Sr	- Strontium-90, a radioactive isotope of strontium
TLD	- Thermoluminescent Dosimeter
TMI	- Three-Mile Island (Nuclear Generating Station)
U	- Uranium, as an element (U), or as an isotope (e.g., ^{234}U, ^{235}U, ^{238}U)
US	- United States
USA	- United States of America
USCG	- United States Coast Guard
USGS	- United States Geological Survey

USSR - Union of Soviet Socialist Republics

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