IMS QAPP:

Quality Assurance Project Plan For the Use of Existing Data from the International Monitoring System Radionuclide Monitoring Network Under the Comprehensive Nuclear-Test-Ban Treaty Organization [A1][1]

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[1] Notations in brackets are QAPP elements as described in the EPA *Guidance for Quality Assurance Project Plans (EPA QA/G-5)*, EPA/240/R-02/009, December 2002, Table 1.

IMS QAPP

Approval Page [A1]

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IMS QAPP

Revision History [A2]

Rev.	DCN	Responsible Official	Date
0	IMS QAPP	Kathryn K. Snead	August 1, 2014
1	IMS QAPP	Wagnus D. Prioleau	May 13, 2024

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QAPP Identifying Information

The US Environmental Protection Agency (EPA) developed the Quality Assurance Project Plan (QAPP) as a tool for project managers and planners to document the type and quality of data needed to make environmental decisions and to describe the methods for collecting and assessing those data. The QAPP is a part of EPA's mandatory Quality Program.

This *Quality Assurance Project Plan for the Use of Existing Data from the International Monitoring System Radionuclide Monitoring Network under the Comprehensive Nuclear-Test-Ban Treaty Organization* (short title: *IMS QAPP*) has been prepared in accordance with:

- EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, March 2001; and
- EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, December 2002.

This *IMS QAPP* is a generic QAPP and describes the quality objectives and references the supporting documents of the International Monitoring System (IMS) Radionuclide Monitoring Network under the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). This QAPP also outlines the review, evaluation of usability, and reporting of the IMS data by EPA's Office of Radiation and Indoor Air (ORIA) as part of its larger project of using environmental data from the EPA's RadNet air monitoring network to:

- Characterize background concentrations of naturally occurring radionuclides at additional locations in the US and its territories; and
- Respond to an airborne release from a radiological incident by:
  - Characterizing (detecting, identifying, and quantifying) the source of the release;
  - Modeling atmospheric fate and transport of the radioactive material; and
  - Performing exposure pathway modeling, dose assessments, and risk assessments.

The IMS Radionuclide Monitoring Network under the CTBTO consists of a global network of radionuclide monitoring stations and radionuclide laboratories. The radionuclide monitoring stations are designed to measure minute concentrations of radioactive fission products in the air. The US, as a Member State of CTBTO, operates eleven radionuclide particulate stations; four of these stations also have noble gas samplers; in addition, Pacific Northwest National Laboratory (PNNL) is an IMS radionuclide laboratory. Data is collected and analyzed at the International Data Centre (IDC) in Vienna, Austria. The data is distributed to all Member States of the CTBTO in both raw and analyzed form. The US National Data Center (US NDC) is housed in the Air Force Technical Applications Center (AFTAC) which is subordinate to the 16th Air Force (Air Forces Cyber). The US NDC disseminates data from the US stations to the EPA.

Based on EPA's review of the IMS assessment and quality assurance program as detailed in this QAPP, EPA has determined that the IMS data meets EPA's quality requirements for use of the data as a supplement to the RadNet system. By supplementing the RadNet system with the IMS US-operated radionuclide stations, EPA will be able to leverage additional US assets for more comprehensive monitoring and assessment of airborne radionuclides. This will also allow EPA to extend fixed monitoring coverage to include the IMS stations located in the US Territories in the Pacific Ocean.

Distribution List [A3]

This QAPP and supporting documents will initially be emailed to the distribution list given below. The QAPP will then be maintained by the project manager with copies available upon request. All users are responsible for ensuring that they have the most recent version prior to using the QAPP.

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A. Project Management

A.1 Project Organization and Schedule [A4]

The key Office of Radiation and Indoor Air (ORIA) personnel responsible for the implementation of this QAPP are limited to those individuals who will use the IMS data in conjunction with the RadNet data and to those individuals who are responsible for quality concerns during the use of the data. The key ORIA personnel are identified here by their titles:

- Director, Center for Radiological Emergency Management (CREM)
- EPA representatives on the Advisory Team for Environment, Food, and Health (A-Team)
- Headquarters (HQ) Emergency Operations Center (EOC) Science Team
- HQ EOC Environmental Unit
- Radiological Emergency Response Team (RERT) Response Leads
- RadNet Program Managers
- Radiation Protection Division (RPD), National Analytical Radiation Environmental Laboratory (NAREL), and National Center for Radiation Field Operations (NCRFO) QA Coordinators
- Regional Radiation Advisors

Sections A.1.1 to A.1.8 identify the roles and responsibilities for each of the key positions responsible for implementing the IMS data management activities identified in this QAPP. No additional training requirements or certifications beyond those necessary to fulfill the position requirements are necessary to review and use the IMS data. [A8]

A.1.1 Director, CREM

During EPA's response to a radiological emergency incident that includes an airborne release of radioactive material, the CREM Director would be responsible for managing ORIA's operations and staff working in a variety of Incident Command System (ICS) positions and for closely communicating with senior leadership on data observations from EPA sources as well as data from other federal partners. For all radiological emergency responses that include an airborne release of radioactive material, the CREM Director would need to ensure the successful exchange of radiation data, including IMS data, among the ten EPA Regions and with involved federal partners and state agencies.

The CREM Director will designate an IMS QAPP Project Manager who ensures annual review of this QAPP. The IMS QAPP Project Manager also maintains the official approved QAPP and ensures that the team has the current version in accordance with the distribution list instructions. The IMS QAPP Project Manager will conduct a quarterly IMS acquisition report check and document the results, coordinate with the US NDC for missing reports, should any be identified, and communicate with the US NDC at least annually for system updates.

A.1.2 EPA representatives on the A-Team

EPA provides representatives to the interagency A-Team. The A-Team is a radiological emergency response group tasked with providing protective action recommendations to state and local governments on behalf of its member agencies. In addition to the EPA, the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), and the US Department of Agriculture (USDA) are permanent members of the A-Team. Other agencies may be invited to participate in A-Team activities.

EPA representatives on the A-Team may use RadNet and IMS data to develop their advice in matters related to environmental assessments required for developing recommendations for protective actions.

A.1.3 HQ EOC Science Team

Depending on the size and technical complexity of an incident, the Agency may establish a Science Team at the HQ EOC. The Science Team brings together subject matter experts to address science issues related to the incident. Although ORIA will likely contribute many of the Science Team personnel for a radiological emergency, members with subject matter expertise may come from Program Offices and Regions across the Agency. Depending on the event's significance, a scientific support coordinator or Science Team may also be asked to support the federal response more broadly through interagency communication. Science Team personnel may also provide technical advice and review of public information products.

ORIA representatives on the Science Team may use RadNet and IMS data to answer science queries related to the incident.

A.1.4 HQ EOC Environmental Unit

The HQ EOC Environmental Unit collects, reviews, and interprets regional environmental information and data. In addition, the Environmental Unit coordinates with the Public Information Officers and other technical specialists (e.g., Office of General Counsel, HQ EOC Science Team) to prepare environmental information for posting on the EPA website, press releases, and other reports. Finally, the Environmental Unit provides published technical guidance, policy, and directives for assisting field personnel, where needed. The Environmental Unit Leader completes Incident Command System Environmental Unit Leader training provided by the Agency before taking on this role in the HQ EOC.

EPA representatives on the Environmental Unit may perform comparisons between RadNet data and IMS data during an incident for independent corroboration of RadNet results. The Environmental Unit will only utilize RadNet for posting to the EPA's website, press releases, and other public information products.

A.1.5 RERT Response Leads

RERT Response Leads are integral in the early phases of EPA's response to a radiological incident. As part of the RERT Coordination Team, RERT Response Leads make recommendations to ORIA for RERT activation and coordinate deployment into the field. Refer to the RERT ConOps Plan for more details.

RERT Response Leads may utilize RadNet and IMS monitoring data to analyze gaps in monitoring coverage and make recommendations for additional air sampling equipment, performing direct measurements, or taking environmental samples using field teams.

A.1.6 RadNet Monitoring Program Managers

The RadNet Fixed Monitoring Program is currently located at NAREL, with 140 fixed air monitors operating continuously throughout the United States and its territories. The Program Managers are responsible for the review and distribution of all RadNet Fixed Monitoring data including the near-real-time data.

The Program Managers may assess comparisons between RadNet data and IMS data as supplemental information in determining RadNet station performance.

A.1.7 RPD, NAREL, and NCRFO QA Coordinators

The RPD, NAREL, and NCRFO QA Coordinators oversee any quality concerns that may occur during the project activities and provide oversight and guidance through QA measures to ensure that the activities are consistent with Agency and Laboratory Quality System requirements. They are independent from the CREM team and laboratory and field operations center personnel.

A.1.8 Regional Radiation Advisors

The Regional Radiation Advisors provide in-office radiological technical advice to the EPA On-Scene Coordinators and other regional personnel as needed and provide regional radiation program functions in the context of RERT response. They will brief their regional personnel on the use of the IMS data and/or RadNet data by the HQ EOC Science Team during responses. Regional Radiation Advisors also provide radiological technical assistance to regional management, coordinate with affected and non-affected federal, state and local radiation programs, coordinate regional radiation resources, if applicable, and work directly with the Regional Response Center during emergencies to provide radiation advice and assistance.

The ORIA personnel listed above will be able to access IMS data from MS Outlook® by accessing the e-mail account, IMSData@epa.gov, to which the US NDC will send Reviewed Radionuclide Reports as they are generated, approximately one per day per US-based station. Once the data are received, the ORIA personnel will review the sample data to determine whether they are to be used to characterize background concentrations of naturally occurring radionuclides or to characterize airborne radionuclides released as a result of a radiological incident according to the procedures in Sections D.1 and D.2.

An *IMS QAPP* specific organizational chart is provided in Figure 1.

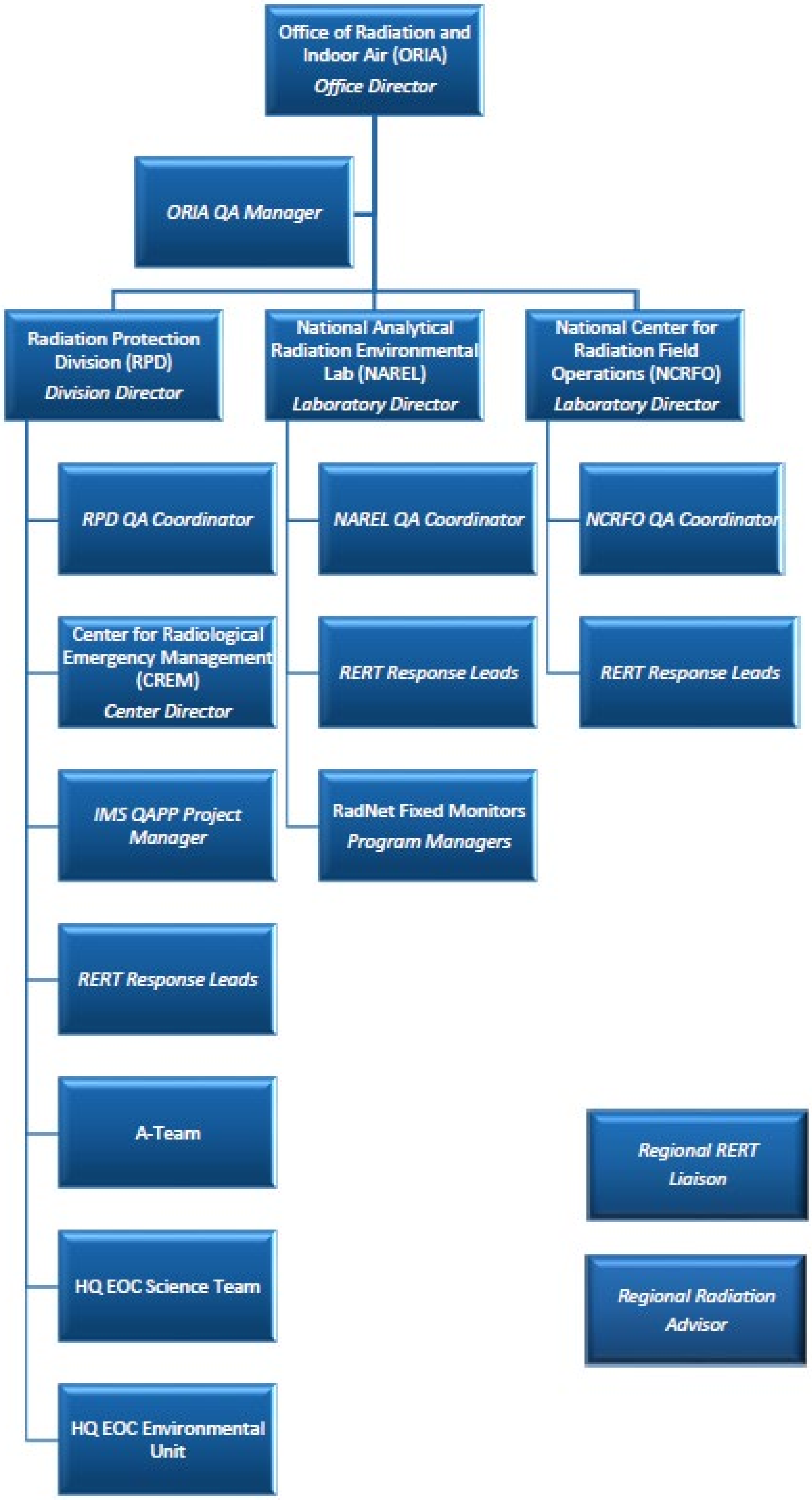


Figure 1: ***IMS QAPP*** **Specific Organizational Chart**

A.2 Project Overview, Intended Data Uses, and Background [A5, A6]

Based on EPA's review of the IMS assessment and quality assurance program as detailed in this QAPP, EPA has determined that the IMS data meets EPA's quality requirements for use of the data as a supplement to the RadNet system.

A.2.1 Overview and Intended Data Uses

Overview of the IMS Radionuclide Monitoring Network

The IMS Radionuclide Monitoring Network under the CTBTO consists of a global network of radionuclide monitoring stations and radionuclide laboratories. The radionuclide monitoring stations are essential to determine if an explosion detected by the seismic, hydro-acoustic, and infrasound stations is due to a nuclear event or not. The United States, as a Member State of CTBTO, operates eleven radionuclide particulate stations; four of these stations also have noble gas samplers. Radionuclide reports produced by the US-operated radionuclide stations are reported to the US NDC. The US NDC then provides these reports directly to selected ORIA personnel via email.

The IMS radionuclide monitoring stations are designed to measure minute quantities of radioactive material that are indicative of a nuclear explosion (i.e., fission products). For example, the baseline sensitivity is approximately 2.7×10^{-4} to 8.1×10^{-4} picocuries per cubic meter (pCi/m^3) or 10 to 30 microbecquerels per cubic meter (μBq/m^3) for barium-140 (Ba-140). The results of the analysis are not available until 48 – 72 hours after the beginning of sample collection due to a decay period and counting of the sample. The IMS stations do not have real-time measurement capability.

Overview of the EPA RadNet Air Monitoring Network

The RadNet air monitoring network operated by EPA consists of 140 fixed air monitoring stations throughout the country and US territories.

The primary mission of the RadNet air monitoring system is to provide timely, scientifically sound data on airborne releases of radionuclides to the environment and information to decision makers and the public regarding radiation protection recommendations. It accomplishes this mission by:

- Providing data for radiological emergency response assessments in support of homeland security and other responders to radiological accidents and incidents;
- Informing public officials and the general public of the impacts resulting from major radiological incidents/accidents and on ambient levels of radiation in the environment; and
- Providing data on baseline levels of radioactivity concentrations in air.

Table 1 provides an overview of the objectives and data uses for the RadNet air monitoring network as presented in *Expansion and Upgrade of the RadNet Air Monitoring Network, Volume 1 of 2, Conceptual Plan and Implementation Process*, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, March 30, 2012, Version 1. The objectives are presented in sequential phases reflecting the chronological progress of a radiological incident and the status of the system from routine to emergency, and back to routine conditions.

Table 1: Overview of Objectives and Data Uses for the RadNet Air Monitoring Network

Incident Phase	Fixed Monitor Objectives and Data Uses
Ongoing operations/ pre-incident	Establish Baseline • Information • Trends • Increases from incidents Maintain Readiness • Continuous operation
Early Phase (0-4 days post incident)	Provide data for atmospheric dispersion modelers who • Verify model output or adjust model input, especially for longer distance transport • Assist decision makers and scientists with the model outputs Provide data to assist in evaluating National Impact
Intermediate Phase (up to 1 year post incident)	Provide data for atmospheric dispersion modelers who • Continue to verify model output or adjust model input, especially for longer distance transport Provide data to assist in refining National Impact • Determine overall data trends • Assist in determining additional sampling needs
Late Phase (after 1 year post incident)	Provide data for scientists who perform trend analyses to • Verify return to normal levels • Establish new baselines

It is unlikely that the data from a RadNet fixed air monitoring station would be used, by themselves, to recommend a protective action in the event of a radiological incident. However, the required sensitivity, quality, and timeliness of data for making protective action decisions was established as a design objective for the RadNet fixed system. For example, the minimum detectable concentration (MDC) for the fixed monitor system is a small fraction of that needed to result in a dose large enough to meet or exceed a protective action guide. For Ba-140, the calculated MDC is 52 pCi/m^3 for the near-real-time beta/ gamma detectors for a one-hour collection.

A much more sensitive analysis may be performed at NAREL. Filters are sent to NAREL usually every three to four days. If the gross beta measurement of the filter exceeds 1 pCi/m^3 (3.7×10^4 $\mu Bq/m^3$), a high-purity germanium detector is used to analyze the gamma spectrum. At the discretion of the NAREL Laboratory Director, filters may be analyzed using the high-purity germanium detector system even if the gross beta measurements are below 1 pCi/m^3.

<u>Intended Data Use of the IMS Radionuclide Monitoring Network</u>

By supplementing the RadNet system with the IMS US-operated radionuclide stations, EPA will be able to leverage additional US assets for more comprehensive monitoring and assessment of airborne radionuclides. This will also allow EPA to extend fixed monitoring coverage to include the IMS stations located in the US Territories in the Pacific Ocean. Table 2 provides a summary of the potential uses of IMS data based on the radionuclides detected.

Table 2: Uses of the IMS Data based on the Radionuclides Detected

Radionuclides Detected	Potential Uses of IMS Data
Be-7, K-40, uranium and thorium decay chain radionuclides, and long-lived anthropogenic radionuclides resulting from above-ground testing.	Characterize concentrations of naturally occurring radionuclides at additional locations in the US and its territories.
Fission products, activation products, and other anthropogenic radionuclides.	Respond to an airborne release from a radiological incident by: • Characterizing (detecting, identifying, and quantifying) the source of the release; • Modeling atmospheric fate and transport of the radioactive material; • Performing exposure pathway modeling, dose assessments, and risk assessments; and • Performing direct measurements or taking environmental samples using field teams.

ORIA personnel will use the radionuclide analysis data from the US-operated IMS radionuclide stations solely to supplement the information obtained from the EPA's RadNet air monitoring network. **Under the auspices of this generic QAPP, no protective actions will be recommended, and no other operational decisions will be made solely on the basis of IMS data.**

A.2.2 Background [A5, A6]

<u>The IMS Radionuclide Monitoring Network</u>
The IMS Radionuclide Monitoring Network under the CTBTO consists of a global network of 80 radionuclide monitoring stations and 16 radionuclide laboratories. In order to ensure good operation of the monitoring system, common protocols, software, formats and reporting requirements are used throughout the IMS. A total of 80 stations throughout the world have been certified for radionuclide particulate monitoring while 39 stations have also been certified for radioactive noble gas monitoring. The United States operates eleven (11) radionuclide particulate monitoring stations; four (4) of these stations also have radioactive noble gas samplers.

The US-operated radionuclide monitoring stations are located at the sites listed below. The US-operated radionuclide laboratory is in Richland, WA, at the Pacific Northwest National Laboratory (PNNL). The United States Particulate Monitoring Station (USP) designation is for United States operated particulate stations while the United States Xenon (Noble Gas) Monitoring Station (USX) designation is for the United States operated noble gas stations:

- USP70 – Sacramento, California
- USP71 – Sand Point, Alaska
- USP72 – Melbourne, Florida
- USP73 – Palmer Station, Antarctica
- USP74, USX74 – Ashland, Kansas
- USP75, USX75 – Charlottesville, Virginia
- USP76 – Eielson Air Force Base (Salchaket), Alaska
- USP77, USX77 – Wake Island

- USP78 – Midway Island
- USP79, USX79 – Oahu, Hawaii
- USP80 – Andersen Air Force Base (Upi), Guam

A radionuclide particulate monitoring station contains an air sampler, detection equipment, computers and a communication setup. Air is forced through a filter, which retains more than 85% of all particles that reach it. Filters are replaced daily. The used filter is first allowed to decay for a period of 24 hours and then measured for another 24 hours in the detection device at the monitoring station. The result is a gamma ray spectrum that is sent to the IDC in Vienna for further analysis.

In noble gas monitoring systems, air is pumped into a charcoal-containing purification device where xenon is isolated. Contaminants of different kinds, such as dust, water vapor and other chemical elements are eliminated. The resulting air contains higher concentrations of xenon, both in its stable and unstable (i.e. radioactive) forms. The radioactivity of the isolated and concentrated xenon is measured, and the resulting spectrum is sent to the IDC for further analysis.

Data sent by the radionuclide stations to the IDC include gamma radiation spectra, meteorological information, and state-of-health information. State-of-health data provides information on the station's operational status and the quality of the raw monitoring data it transmits.

Support is provided by the radionuclide laboratories, which conduct sample analyses if and when necessary. Their main function is to provide independent analysis of particulate samples suspected of containing radionuclides that may have been produced by a nuclear explosion, and to conduct routine analyses for quality control of a station's air sample measurements.

The AFTAC is home to the US NDC. The US NDC receives data from the IDC and provides it to other national authorities and the scientific community. The US NDC sends Reviewed Radionuclide Reports to the e-mail address, IMSData@epa.gov, as they are generated, approximately one per day per US-based station. Appendix B is an example of a Reviewed Radionuclide Report.

In some cases, following a specific incident, the US NDC may provide more detailed data directly to EPA from both the US-operated stations and IMS stations from other Member States that have been released for wider distribution by the Technical Secretariat of the CTBTO. These data are available for use by the government agencies of the Member State, but they are not for public release. The CREM Director may request these reports from the US NDC; the reports will be received via email. Appendix C is an example of a Detailed IMS Review Radionuclide Report.

In some cases, following a radiological event, the US NDC may also prepare trending reports (usually in the form of Microsoft Excel spreadsheets) or summary reports (usually in the form of Adobe Portable Document Format (PDF) files) and provide them to EPA via email. See Appendix D for an example of a trending report.

The EPA RadNet Air Monitoring Network

EPA operates a nationwide radiation monitoring system known as RadNet. The RadNet system includes sampling stations for air, drinking water and precipitation to determine levels of radioactivity in the environment. RadNet has 140 permanently installed air monitors located across all 50 states and in Puerto Rico. The RadNet air monitoring stations collect particulate air samples on a filter using a high-volume sampler and provide near-real-time beta and gamma count rates for those filters; noble gas samples are not taken as a part of the RadNet system. On a regular basis, typically weekly or bi-weekly, the station operator collects the air filter and sends it to NAREL (in Montgomery, Alabama) for additional analyses that are more sensitive than the near-real-time analysis of the filters and are not affected by the ambient background radiation at the sample location. Laboratory analyses include a gross beta analysis, performed on each air filter, followed by a gamma scan if the beta activity is greater than 1 pCi/m^3.

The fixed RadNet air particulate samples provide baseline data on background levels of gross beta radioactivity in the environment and can detect elevated concentrations of manmade radionuclides released to the atmosphere following a radiological incident. Beginning in 2016, gamma exposure rate instrumentation was added to the RadNet air monitoring stations so that ambient radiation levels in the vicinity of the stations could be determined. As of January 2024, all but 36 stations include gamma exposure rate instrumentation.

Both near-real-time data and laboratory analysis data of the filters are available to the public on the internet after going through NAREL's quality assurance process. Near-real-time data from the fixed air monitoring stations and laboratory analyses of filters are available at https://www.epa.gov/radnet/near-real-time-and-laboratory-data-state .

NAREL's Quality Assurance Manual for the RadNet system is incorporated by reference: *National Analytical Radiation Environmental Laboratory RadNet Real-Time Fixed Air Monitoring Program Quality Assurance Manual, QA/QAM-8, Revision 0, Reapproval Date April 24, 2023.*

Figure 2 shows the location of the fixed RadNet air monitoring stations and the US-operated IMS radionuclide stations.

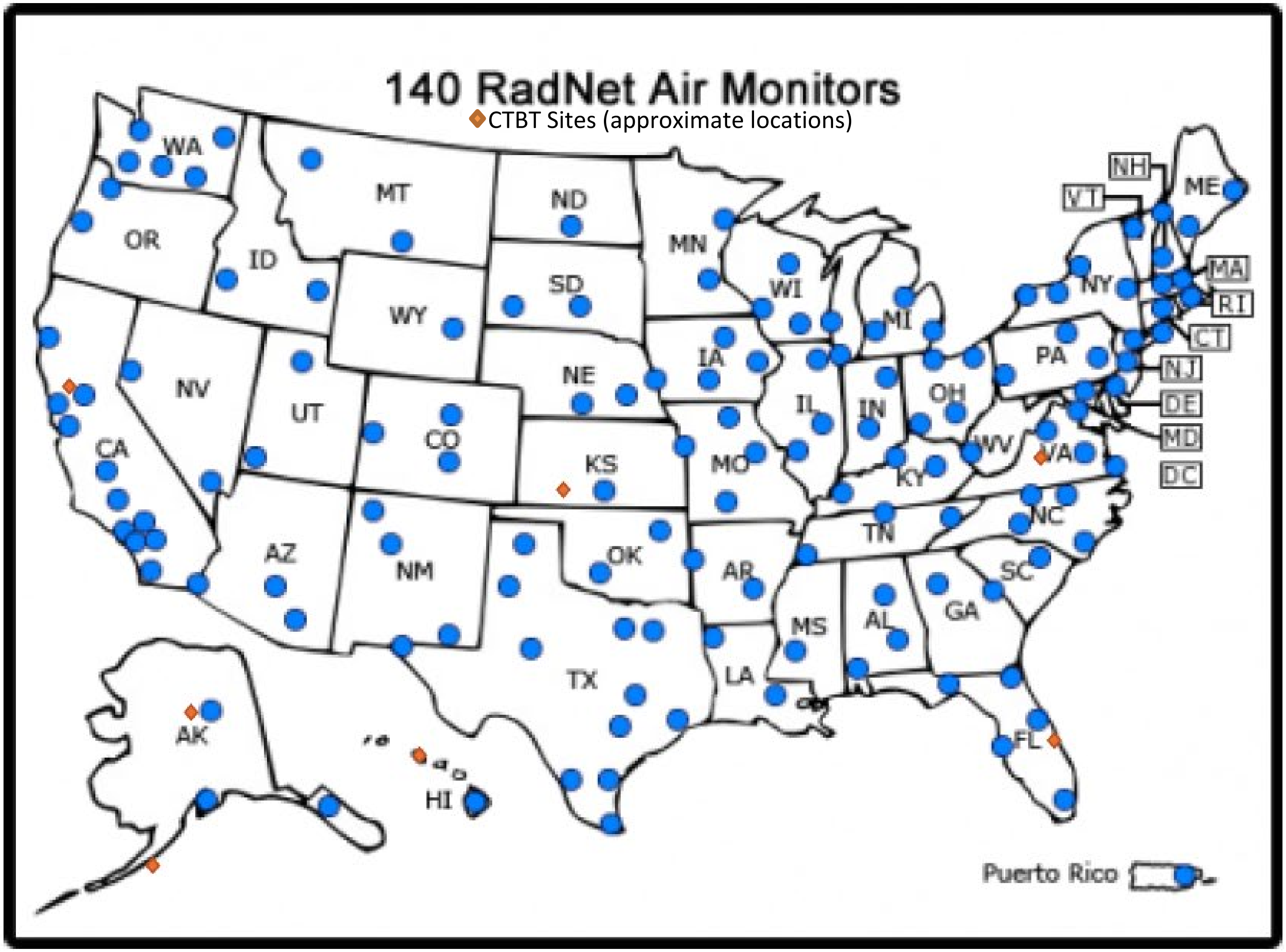


Figure 2: RadNet and US-Operated IMS Air Monitoring Stations
(CTBTO IMS Sites on Wake Island, Midway Island, Guam, and Palmer Station are not shown)

A.3 Quality Objectives and Performance Criteria [A7]

Performance criteria for the IMS Radionuclide Monitoring System are given in the *Operational Manual for Radionuclide Monitoring and the International Exchange of Radionuclide Data, Draft*, CTBT/WGB/TL-11, 17/18/Rev. 5, 10 December 2010. Appendix I of the CTBTO document lists minimum requirements for the monitoring station specifications. These are given in Tables 3 and 4. Additional details are provided in Section B, Data Generation and Acquisition, of the document.

Table 3: Minimum Requirements for IMS Particulate Monitoring Station Specifications

Characteristics	Minimum Requirements
System	Manual or automated
Airflow	500 m^3/hour
Collection time [a]	24 hours
Decay time [b]	≤ 24 hours
Measurement time [c]	≥ 20 hours
Time before reporting	≤ 3 days
Reporting frequency	Daily
Filter	Adequate composition for compaction, dissolution and analysis
Particulate collection efficiency	For filter: ≥ 80% at d = 0.2 micrometers (µm) Global [d]: ≥ 60% at d = 10 µm
Measurement mode	High purity germanium high resolution gamma ray spectrometry
High purity germanium relative efficiency	≥ 40%
High purity germanium resolution	< 2.5 kilo-electron volts (keV) at 1332 keV
Baseline sensitivity [e, f]	2.7×10^{-4} to 8.1×10^{-4} pCi/m^3 (10 to 30 µBq/m^3) for Ba-140
Calibration range	88 to 1836 keV
Data format for gamma spectra and auxiliary data	Radionuclide Monitoring System format [g]
State of health	Status data transmitted to International Data Centre
Communication	Two-way
Auxiliary data	Meteorological data, flow rate measurement data every 10 min
Data availability	≥ 95%
Downtime [h]	≤ 7 consecutive days ≤ 15 days annually

[a] Time specifications allow for an uncertainty of 10%, except for the reporting time parameter.
[b] This value can be reduced to a minimum of 6 hours, if other stations or techniques detect a suspicious event.
[c] This value allows for authentication measurements for manual systems.
[d] This global value includes the 80% filter efficiency and the collection efficiency of the incoming air circuitry.
[e] The upper limit is intended for high background areas.
[f] Certification procedures to be defined for baseline sensitivities (a posteriori minimum detectable concentrations) as well as the efficiency. Sample preparation losses should not affect baseline sensitivities.
[g] This format should make provision for auxiliary data, authentication data and state of health data.
[h] Provision should be made for spare parts in particular areas where periodicity of transportation facilities is more than 7 days.

Table 4: Minimum Requirements for Noble Gas Monitoring Station Specifications

Characteristics	Minimum Requirements
Airflow	0.4 m^3/hour
Total volume of sample	10 m^3
Collection time	≤ 24 hours
Measurement time	≤ 24 hours
Time before reporting	≤ 48 hours
Reporting frequency	Daily
Isotopes measured	Xe-131m, Xe-133, Xe-133m, Xe-135
Measurement mode [a]	Beta-gamma coincidence or high-resolution gamma ray spectrometry
Minimum detectable concentration [b]	2.7×10^{-2} pCi/m^3 (1 mBq/m^3) for Xe-133
State of health	Status data transmitted to International Data Centre
Communication	Two-way
Data availability [c]	At least 95%
Downtime	≤ 7 consecutive days ≤ 15 days annually

[a] Calibrations need to be defined.
[b] Minimum detectable concentrations for the other isotopes are not defined here since they critically depend on the detection system used.
[c] This is a goal to be reached.

The RadNet quality objectives and performance criteria are specified in *Expansion and Upgrade of the RadNet Air Monitoring Network, Volume 1 of 2, Conceptual Plan and Implementation Process*, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, March 30, 2012, Version 1.

B. IMS Data Generation and Acquisition [B1-B10]

The following information throughout Section B about the IMS Radionuclide Monitoring System is summarized from Chapter 3, Technical Requirements for Radionuclides Stations, and Chapter 4, Operational Requirements, of the *Operational Manual for Radionuclide Monitoring and the International Exchange of Radionuclide Data, Draft,* CTBT/WGB/TL-11, 17/18/Rev. 5, 10 December 2010.

B.1 IMS Sampling Tasks, Documentation, Handling, Tracking, and Chain-of-Custody

B.1.1 Particulate Sampling [B1, B2, B3]

Particulate sampling equipment consists of a high volume, low pressure-drop air pump that moves air from the atmosphere through a filter to remove a large amount of particles from the airstream. The equipment also has a device to measure the amount of air that is passed through the filter. In addition, the particulate equipment also contains a high purity germanium gamma ray spectrometer to identify and quantify the radionuclides collected on the filter; this spectrometer may be at another location or may be part of an integrated system.

Sample collection at a particulate monitoring station takes place over a 24-hour period (plus or minus 10%). At each station, a time schedule for filter changes is established following consultation between the station operator and the Technical Secretariat (located in Vienna, Austria); the time schedule is recorded in the station specific documentation.

Sample handling and preparation depend on the type of measurement configuration and degree of automation at the station. Samples are handled in such a way as to prevent contamination of the filter material and components of the system, to prevent cross-contamination between samples, and to maintain identity of the samples. Measured filters are stored in a secure place; and unused filter material are stored securely in a clean environment.

Each filter is assigned and labeled with a bar code to uniquely identify the sample. This identifier is used throughout the measurement and analysis. A record is kept for all samples, including the identifier, any relevant operational parameters and observations.

All procedures for sample collection, including schedules, sample collection and handling, personnel requirements and materials, are detailed in station specific documentation.

A system of sample control and chain-of-custody records is in place to record information related to the sample collection, preparation, analysis, and disposition. The format of these records is established by the CTBTO Technical Secretariat. For samples that are transported from the location of the air sampler for analysis at an off-site country facility, procedures are established that specify that the transfer takes place within 24 hours following the end of the collection period, that specify the contracts with couriers guarantee this requirement, and that security and sample identification and integrity are maintained. Detailed records of the shipment of samples are maintained by the station. Receipt records at the measurement facility also include the requirement for authorized personnel to sign for the acceptance of samples.

B.1.2 Noble Gas Sampling [B1, B2, B3]

Noble gas systems collect xenon from the air, separate it from other components in the air, perform a nuclear count, determine the quantity of the xenon gas, and store the gas in containers that can be retrieved for later analysis. The subsequent analysis is performed in a laboratory as part of a noble gas quality assurance program. Noble gas equipment consists of a high-pressure compressor and other components that move air from the atmosphere through a series of traps that selectively remove and purify xenon from the airstream. The equipment also has a device to measure the amount of xenon that is collected by the system. In addition, the noble gas equipment contains a nuclear detection system, either a high purity germanium or a beta-gamma spectrometer that selectively determines the amount of xenon activity in the sample.

To maintain a 100% duty cycle, so that plumes that may cross a station are not missed, the noble gas sampling system continually collects samples and, in a batch process, performs the separations and analysis. The air sampling period for noble gas monitoring does not exceed 24 hours. The schedule for sampling is established in consultation with the CTBTO Technical Secretariat.

Samples are handled in such a way as to prevent contamination of the components of the system, to prevent cross-contamination between samples, and to maintain identity of the samples. All procedures for sample collection, including schedules, sample collection and handling, personnel requirements and materials, are detailed in station specific documentation.

After collection, the sample is processed in order to extract the xenon. The time for processing is minimized to ensure a time before reporting of less than or equal to 48 hours. The processed sample is transferred to the measurement system. If the noble gas detection system has several measurement cells, each cell is uniquely identified. After measurement, the noble gas samples are collected into separate sample archive containers that are uniquely identified and are detachable from the noble gas system so that they can be sent to radionuclide laboratories for quality control purposes or for further analysis.

A system of sample control and chain-of-custody records is in place to record information related to the sample collection, preparation, analysis, and disposition. The format of these records is established by the CTBTO Technical Secretariat. For samples that are transported from the location of the air sampler for analysis at an off-site country facility, procedures are established that specify that the transfer takes place to minimize the time required so that the overall reporting specification (i.e., within 48 hours following the start of sample collection) is met, that the contracts with couriers guarantee this requirement, and that security and sample identification and integrity are maintained. Detailed records of the shipment of samples are maintained by the station. Receipt records at the measurement facility also include the requirement for authorized personnel to sign for the acceptance of samples.

B.2 IMS Analytical Tasks

B.2.1 Particulate Samples [B4]

All particulate samples are allowed to decay for a period of no more than 24 hours following the end of collection to reduce the levels of natural radioactivity. If a suspicious event has been detected at other radionuclide stations or by other technologies, the CTBTO Technical Secretariat may direct that the decay time be reduced to facilitate investigation of the event.

Normally, a filter sample is compressed into a smaller volume to improve measurement sensitivity and to ensure the sample is in a standardized measurement geometry. The sample is measured using a high-resolution gamma ray spectrometer with a high purity germanium detector that meets the minimum specification as given in Table 3. The detector crystal and sample are housed in lead shielding to reduce background radiation interference with the measurement. The measurement configuration is standardized for the station so that each sample is measured in the same geometry and a reproducible configuration.

The measurement system is calibrated in accordance with the requirements specified in the station-specific documentation. The calibration must be performed using a calibration source of adequate composition and geometry with a certificate or using a semi-empirical calibration method approved at the time of the station certification or station revalidation. Detectors for radiation measurements are calibrated during the installation of the system, following major replacement of detector components, or upon request by the Technical Secretariat.

The measurement time for routine samples is the maximum compatible with the minimum requirements. The sample measurement time allows for an additional measurement of a check source for quality control purposes. A full pulse height spectrum is acquired over the range of at least 70 keV to 2.0 mega-electron volts (MeV) with a minimum of 4096 channels.

Detector background measurements are performed for the detector without a filter and with a blank filter. The background is determined prior to commencement of operations as part of the certification of the stations; further background measurements are carried out following detector repair or replacement, or any changes to the shielding, or in the event of suspected contamination. Blank filter spectra and background spectra which are part of normal station operations are not considered in assessing station downtime.

Under routine conditions, there are five situations in which a sample may be sent to a certified laboratory by the CTBTO Technical Secretariat:

1. As part of the QA program;
2. For backup of station operations;
3. Because a particulate sample filter was identified as having multiple anthropogenic nuclides with at least one of them being a fission product;
4. Because an expert technical analysis was requested by a State Party; or
5. Because an analysis was initiated by the CTBTO Technical Secretariat.

If a particulate sample is sent for laboratory analysis, the sample will normally be split into two parts following the procedures outlined in the station specific documentation. Sample chain-of-custody procedures are followed as given in the station specific documentation.

B.2.2 Noble Gas Samples [B4]

The measurement time for noble gas samples does not exceed 24 hours and commences as soon as possible after the end of sample collection. Noble gas samples are measured using either a high purity germanium or a beta-gamma spectrometer. All of the noble gas stations operated by the United States utilize a beta-gamma coincidence system.

Detector background measurements are performed for an empty detector chamber. The background is determined prior to commencement of operations as part of the certification of the stations; further background measurements are carried out following detector repair or replacement, or any changes to the shielding, or in the event of suspected contamination. For beta-gamma coincidence systems, the detector background is determined in the coincident mode. If the beta-gamma system has a significant memory effect (because of diffusion of xenon into the walls of the beta detector), a gas background measurement is done prior to each sample measurement. Specifications for determining the background and for analyzing the samples are outlined in the station specific documentation.

The measurement system is calibrated in accordance with the requirements specified in the station-specific documentation. The calibration must be performed using a calibration source of adequate composition and geometry with a certificate or using a semi-empirical calibration method approved at the time of the station certification or station revalidation. The calibration procedure is such that it does not affect the subsequent sample analysis. Detectors for radiation measurements are calibrated during the installation of the system, following major replacement of detector components, or upon request by the Technical Secretariat.

All gas samples, unless required for further analysis at radionuclide laboratories, are retained for 3 days (or 10 days, if requested by the Technical Secretariat) at the measurement site.

B.3 IMS Quality Control [B5, B6, B7]

The Technical Secretariat runs a quality control program for samples measured in IMS stations on a periodic and ongoing basis. Samples collected during normal operations are sent from stations to certified laboratories on a periodic basis to verify system calibrations as part of this program. On the basis of the laboratory results, the Technical Secretariat may initiate a request for corrective actions.

Station operators also carry out quality control programs with the following elements:
- Management of technical documentation (including operation and maintenance procedures and equipment manuals);
- Daily station state of health monitoring; and

- Periodic instrumentation calibration and background checks (in particular, daily checks of the radiation detector calibration and, at least, semi-annual background checks).

The daily operation at a particulate station includes counting a mixed radionuclide source to check the energy and resolution calibration of the detection system. Trends of the count rate of the source may be used as an indication of the stability of the detector and electronics. Any deterioration in data quality identified is immediately communicated to the Technical Secretariat and actions are undertaken to seek a solution(s) to the problem.

All spectral data, sample collection times, total sample volumes, and flow rate data are reviewed by the station operator and within the CTBTO Technical Secretariat for internal consistency. Criteria are established for the quality of the analysis of spectral data covering gamma peak detection, peak quantification, nuclide identification, and nuclide quantification. Any questions arising at the Technical Secretariat are communicated immediately to the station either directly, via the US NDC, or via an appropriate communication node for investigation by station personnel.

Procedures are in place at the stations to implement requests from the CTBTO Technical Secretariat to carry out system recalibration or to investigate possible problems with the equipment. Any maintenance required to correct a defect is carried out promptly in accordance with station procedures that have been approved by the CTBTO Technical Secretariat and, where appropriate, follow manufacturers' specifications.

The required state of health information (sensors and instruments that provide information on the operational status of the sample collection and measurement systems) is checked at least once every 24 hours by the station operator. Problem Reports are used by station personnel to identify to the CTBTO Technical Secretariat any inconsistency noted in the state of health information.

The station operator maintains a detailed daily record of all relevant operation and maintenance activities taking place at the station including:

- The type of maintenance or repair;
- Personnel performing the work;
- References to the approved procedure; and
- Any additional comments or observations.

Station maintenance records are retained for at least 12 months and are to be made available at any time during that period for inspection by the CTBTO Technical Secretariat.

As part of the quality control program for the IMS, each Radionuclide Monitoring Station submits the following reports to the CTBTO Technical Secretariat:

- Monthly Reports are submitted that summarize the activities during one calendar month.
- Problem Reports are submitted whenever there is a problem with the station; including those problems that have already been solved by the station operator.
- Outage Requests are submitted when the station operator plans an outage at the station.

- Configuration Change Requests are submitted by the station operator, at least 20 days prior to the changes, for changes in any equipment in the list of configuration items given below:
    - Site survey report;
    - Certification documentation;
    - Description of the site facilities and infrastructure;
    - Brief description of the station equipment;
    - Detailed specifications of all station equipment;
    - Inventory of equipment, spare parts and components;
    - Equipment maintenance protocols and schedules;
    - Procedures for instrument calibration;
    - Operation and maintenance manuals provided by manufacturers of equipment;
    - Description of communication system;
    - Station specific list of configuration items;
    - Information on station consumables, including identification and supplier;
    - Protocols for all station operations; and
    - List of personnel responsible for station operation and maintenance, including contact telephone numbers.
- Configuration Change notifications are submitted after the changes are made.
- Summary Reports are submitted to the CTBTO Technical Secretariat every 12 months.

B.4 IMS Data Management [B10]

Sample spectral data are transmitted to the IDC no later than 72 hours following commencement of the collection of each particulate sample or within 48 hours following commencement of the collection of each noble gas sample. Other data types, state of health, flow, etc., are transmitted at the same time or on an agreed, more frequent schedule. Schedules are included in the station specific documentation. All data are also archived at the collection site in electronic form for at least two months so that it can be retransmitted to the CTBTO Technical Secretariat, if requested.

Data are transmitted in accordance with the approved IMS protocol.

Data availability is computed regularly by the Technical Secretariat. Should the availability begin to fall, the Technical Secretariat communicates with the station operator to begin an investigation of the cause(s). The station operator and US NDC may also compute data availability using the same procedures as the Technical Secretariat.

The data acquisition system of the radionuclide station comprises the electronics, data loggers, computer equipment, and software to receive the various analog or digital signals from the measurement detector; state of health sensors, such as the flow rate meter of the air sampler; and other supplementary instrumentation, including meteorological equipment. The data acquisition system is used:

1. To convert analog signals to digital form, where necessary;
2. To combine the data into the required formats;
3. To provide for authentication of the data;

4. To transmit the data to the IDC via the Global Communications Infrastructure (GCI); and
5. To store the data at the station.

Station documentation includes details of all anti-tampering systems and authentication systems. The information systems of the station must be protected from inadvertent or malicious modification or damage. Measures to prevent corruption of data at the station include restriction of access to station facilities and equipment housings and protection of key items of equipment with locks and, where appropriate, tamper-proof seals. Access is restricted to authorized station personnel only. Computer systems are password protected.

Data surety is provided by tamper detection of the equipment enclosures and authentication of the data. Controls or measures are implemented at a number of stages to ensure that station operations are carried out in accordance with IMS procedures. These controls are designed to protect the system from accidental or deliberate actions that would result in manipulation and/or corruption of the data produced at the station.

The US NDC receives continuous data feeds from the IDC via the Global Communications Infrastructure (GCI) for all US-operated radionuclide stations. These data are analyzed and archived indefinitely for future analysis and to fulfill requests from national authorities and the scientific community.

The US NDC will send Reviewed Radionuclide Reports to the e-mail address, IMSData@epa.gov, as they are generated, approximately one per day per US-based station. The CREM Director will ensure that the e-mail box is added to their regular MS Outlook® inbox for all EPA personnel with a need to access reports. During a radiological incident, the US NDC may provide ORIA personnel with more detailed or trending reports from IMS stations operated by both the US and other Member States (when the reports are released from the Technical Secretariat). These reports will be requested by the CREM Director.

Examples of the IMS reports are contained in Appendices B, C, and D.

C. Assessment [C1, C2]

The IMS QAPP Project Manager will conduct a quarterly IMS acquisition report check and document the results, coordinate with the US NDC for missing reports, should any be identified, and communicate with the US NDC at least annually for system updates. The IMS QAPP Project Manager also maintains the official approved QAPP and ensures that the team has the current version in accordance with the distribution list instructions.

In addition, if an incident occurs, the IMS QAPP Program Manager will assess the more detailed or trending IMS report acquisition process. Furthermore, the IMS QAPP Program Manager will assess the review and use of the IMS data to determine whether they follow the protocols and limitations set forth in the QAPP. Any concerns will be documented and discussed directly with the Director, CREM. Any necessary corrective actions will be monitored by the IMS QAPP Program Manager.

D. Review, Evaluation of Usability, and Reporting [A9, C2, D1 – D3]

D.1 Review [C2, D1, D2]

The US NDC sends Reviewed Radionuclide Reports to the e-mail address, IMSData@epa.gov, as they are generated, approximately one per day per US-based station. Only data that is provided directly by the US NDC as a Reviewed Radionuclide Report may be considered by users on the IMS QAPP distribution list. If this is not the case, users should notify the CREM Director immediately of the problem and discontinue consideration of the data.

Users will review the Radionuclide Reports as discussed in Table 2 to characterize background concentrations of naturally occurring radionuclides or to characterize airborne radionuclides released as a result of a radiological incident.

During non-incident periods, if more than one week has elapsed since Reviewed Radionuclide reports have been sent to the IMSData@epa.gov e-mail address, Users should contact the IMS QAPP Program Manager, who will then contact the US NDC to try to determine the reason data have not been sent. Following a radiological incident, if more than one week has elapsed since data have been sent to the IMSData@epa.gov e-mail address, Users should contact the IMS Program Manager, who will then contact the US NDC to try to determine the reason data have not been sent. Since IMS data will not be used, by themselves, to make decisions, an inability to recover missing data will not adversely impact how EPA characterizes background levels of radioactivity or responds to a radiological incident.

D.2 Evaluation of Usability [D2, D3]

Based on EPA's review of the IMS assessment and quality assurance program as detailed in this QAPP, EPA has determined that the IMS data meet EPA's quality requirements for use of the data to supplement the RadNet system.

Each IMS radionuclide station is designed to collect particulate air samples at an extremely high volumetric rate (>500 m^3/hr) and employs a high-purity germanium detector to detect the gamma radiation emitted from radionuclides collected on a large filter membrane. It is this combination of high sampling rate, large filter, and sensitive gamma ray detector that allows IMS operators to detect, identify, and quantify extremely small concentrations of naturally occurring and manmade radionuclides in air. Based on a technical review of selected US IMS data collected during the Fukushima Nuclear Power Plant accident, EPA determined that the detection limits of the IMS monitoring system for all radionuclides analyzed were several orders of magnitude lower than comparable levels achieved by RadNet fixed monitors, both for real-time and laboratory measurements. Therefore, it is not unexpected that an IMS sample may indicate the presence of a radionuclide and a comparably located RadNet monitor may not indicate positive activity. If, however, the IMS sample indicates a concentration that would normally exceed the RadNet MDC, then a further investigation may be necessary to resolve the difference.

EPA intends to use the IMS data in two ways. If the IMS sample only contains naturally occurring radionuclides (such as beryllium-7 (Be-7), potassium-40 (K-40), or radionuclides from the uranium or thorium decay chains) or long-lived anthropogenic isotopes that were generated by above ground testing, then the data may be used to characterize concentrations of naturally occurring radionuclides at additional locations in the US and its territories.

If, however, the IMS sample contains any other radionuclides (such as, fission or activation products, or other man-made radionuclides), then the sample may be used during EPA's evaluation of a possible radiological incident. Possible uses for the IMS data when responding to an airborne release from a radiological incident are:

- Characterizing (detect, identify, and quantify) the source of the release;
- Modeling atmospheric fate and transport of the radioactive material;
- Performing exposure pathway modeling, dose assessments, and risk assessments; and
- Siting other air sampling equipment, performing direct measurements, or taking environmental samples using field teams.

D.3 Reporting [A9, D3]

Since the IMS sample data will not be used in isolation, special reports with just the IMS data are not necessary. Any report generated that includes IMS data will note that they have been used and include an explanation of their use and conclusions based on their use. In the event of a nuclear emergency, ORIA will consult with the State Department before releasing IMS Data to the public. IMS data that are from non-US-operated stations may not be released to the public nor used in a report that is released to the public.

Appendix A: References, Acronyms, SI Prefixes, Units and Special Symbols, and Chemical Symbols

References

EPA Quality Assurance Project Plan References

EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, March 2001.

EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, December 2002.

RadNet References

Expansion and Upgrade of the RadNet Air Monitoring Network, Volume 1 of 2, Conceptual Plan and Implementation Process. Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, March 30, 2012, Version 1.

RadNet Real-Time Fixed Air Monitoring Program Quality Assurance Manual. National Analytical Radiation Environmental Laboratory, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Revision 0, Reapproval April 24, 2023.

IMS References

Operational Manual for Radionuclide Monitoring and the International Exchange of Radionuclide Data, DRAFT. Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization. CTBT/WGB/TL-11, 17/18/Rev. 5. December 10, 2010.

Acronyms

AFTAC	Air Force Technical Applications Center
ARR	Automated Radionuclide Report
A-Team	Advisory Team for Environment, Food, and Health
CDC	Centers for Disease Control and Prevention
CIO	Chief Information Officer
CREM	Center for Radiological Emergency Management
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FWHM	Full Width at Half Maximum (Height)
GCI	Global Communications Infrastructure
HQ	Headquarters
ICS	Incident Command System
ID	Identification Designation
IDC	International Data Center
IMS	International Monitoring System
MDC	Minimum Detectable Concentration
NAREL	National Analytical Radiation Environmental Laboratory
NCRFO	National Center for Radiation Field Operations
ORIA	Office of Radiation and Indoor Air
PDF	Adobe Portable Document Format
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RERT	Radiological Emergency Response Team
RPD	Radiation Protection Division
RRR	Reviewed Radionuclide Report
US	United States
USDA	United States Department of Agriculture
US NDC	United States National Data Center
USP	United States Particulate Monitoring Station
USX	United States Xenon (Noble Gas) Monitoring Station

SI Prefixes

k	kilo (10^3)
M	mega (10^6)
μ	micro (10^{-6})
m	milli (10^{-3})
n	nano (10^{-9})
p	pico (10^{-12})

Units and Special Symbols

Bq	becquerel
Ci	curie
keV	kilo-electron volts
m^3	cubic meter
MeV	mega-electron volts
⌀	Particle diameter

Chemical Symbols

Ac	Actinium
Ba	Barium
Be	Beryllium
Bi	Bismuth
Ce	Cerium
Cs	Cesium
I	Iodine
K	Potassium
Mo	Molybdenum
Nb	Niobium
Pa	Protactinium
Pb	Lead
Ra	Radium
Ru	Ruthenium
Tc	Technetium
Te	Tellurium
Th	Thorium
Tl	Thallium
U	Uranium
Xe	Xenon
Zr	Zirconium

Appendix B: Example of IMS Reviewed Radionuclide Report Distributed to EPA

BEGIN IMS2.0
MSG_TYPE DATA
MSG_ID 890471 CTBT_IDC
PROD_ID 643 890471
DATA_TYPE LOG
Info - 48488754 - Job 120841409: job status has changed to: RUNNING Info - 48488754 - The product RRR has been generated in 0 minutes, 0 seconds and 7 milliseconds Info - 48488754 - You have 3755538.97KB left out of your daily 4194304.00KB quota DATA_TYPE RRR

IDC GENERATED REPORT
REVIEWED RADIONUCLIDE REPORT
Particulate Version

Creation Date: 2024/01/29 15:23:00
Sample Arrival Time: 2024/01/27 12:35:38
Time difference from receipt of raw data to report creation: 50 hours

SAMPLE INFORMATION ==

Station ID: USP72 Detector ID: USP72_002
Authenticated: YES

Station Location: Melbourne, FL, USA.
Detector Description: Detector #2 in Melbourne, FL, USA.

Sample ID: 7600405 Sample Geometry: M4
Sample Quantity: 23127.69 m3 Sample Type: Particulate

Collection Start: 2024/01/24 13:09 Sampling Time: 23.95 hours
Collection Stop: 2024/01/25 13:05 Decay Time: 24.05 hours
Acquisition Start: 2024/01/26 13:09 Acquisition Time: 23.43 hours
Acquisition Stop: 2024/01/27 12:34 Avg Flow Rate: 965.67 m3/hr

Collection Station Comments:
Barcode ID: 7200022331
GAIN_COARSE: 8, GAIN_FINE: 0.774, SHAP_RISE: 12, SHAP_FLAT: 1.2
HIGH_VOLTAGE: 4800, PZ_ENA: 3840
This data generated by RASA Linux Control Software Version 6.10

Replaced MCA 2017/03/15
Canberra 10930 90.1mm L x 75.2 mm D, Cert 5000 V HV 4800, Rise Time 12.0, Flat 1.2, Initial T -187 TP Cert, -0.66, TP Actual -0.64
DSPec50 13295253, Calibrated with NPL X160539

IDC Analysis General Comments:
IDC 2024/01/29 15:23:00

MEASUREMENT CATEGORIZATION ==

Categorization Legend

Level 1 = Typical Background Rad. Meas.
Level 2 = Anomalous Background Rad. Meas.
Level 3 = Typical Anthropogenic Rad. Meas.
Level 4 = Anomalous Anthropogenic Rad. Meas.
Level 5 = Mult. Anomalous Anthropogenic Rad. Meas.

Spectrum Category (1) -- Typical Background Rad. Meas.

ACTIVITY SUMMARY ===

NATURAL RADIOACTIVITY:

Nuclides Identified and not Quantified:

BI-214, PB-207M, PB-214, RA-224, TH-234

Nuclides Quantified:

Nuclide	Half-Life	Conc(uBq/m3)	RelErr(%)	Activ(uBq)	RelErr(%)
BE-7	53.290 D	2.75E+03	3.02	6.24E+07	3.02
PB-212F	10.64 H	2.79E+03	3.32	6.83E+06	3.32

ACTIVATION-PRODUCT RADIOACTIVITY:

Nuclide	Half-Life	Conc(uBq/m3)	RelErr(%)	Activ(uBq)	RelErr(%)	Coincidence

None Found

FISSION-PRODUCT RADIOACTIVITY:

Nuclide	Half-Life	Conc(uBq/m3)	RelErr(%)	Activ(uBq)	RelErr(%)	Coincidence

None Found

MINIMUM DETECTABLE CONCENTRATION FOR KEY NUCLIDES ======================

Nuclide	Half-Life	MDC(uBq/m3)	MDA(uBq)
BA-140	12.752 D	1.03E+01	2.19E+05
CE-143	1.377 D	1.55E+01	1.70E+05
CS-134	2.062 Y	2.95E+00	6.81E+04
CS-136	13.160 D	3.25E+00	6.94E+04
CS-137	30.100 Y	2.73E+00	6.31E+04
I-131	8.040 D	3.45E+00	7.02E+04
I-133	20.87 H	1.19E+01	8.57E+04
MO-99	2.748 D	3.25E+01	5.16E+05
NB-95	34.970 D	2.48E+00	5.58E+04
RU-103	39.260 D	2.51E+00	5.66E+04
TE-132	3.204 D	4.34E+00	7.27E+04
ZR-95	64.020 D	4.49E+00	1.02E+05
ZR-97	16.900 H	1.67E+01	9.16E+04

PEAK SEARCH RESULTS ==

65 peaks found in spectrum by automated peak search.
60 peaks associated with nuclides by automated processing.
5 peaks not associated with nuclides by automated processing.
92 percent of peaks were associated with nuclides.

Note: "*" indicates that a peak was a component of a multiplet.

Energy (keV)	Centroid	Width	FWHM (keV)	Eff (%)	Area	Bkgnd (%)	RelErr (%)	Nuclide	Nts
46.84	141.16	3	1.11	1.80	952.69	96.67	7.15	PB-210	
63.56	191.88	3	1.13	4.54	1474.06	99.91	5.63	TH-234	
72.64	219.44	3	1.14	5.60	2607.44	61.50	3.26	PB-212F	
75.18	227.14	3	1.14	5.82	5044.28	42.01	2.05	PB-212F	
75.18	227.14	3	1.14	5.82	5044.28	42.01	2.05	PB-214	
77.40	233.88	3	1.14	6.01	2703.45	13.22	3.38	PB-212F	
84.87	256.56	3	1.15	6.53	1810.11	81.96	4.77	PB-212F	
87.42	264.30	3	1.15	6.69	1631.47	27.52	5.24	PB-212F	
90.10	272.40	4	1.15	6.85	542.84	15.80	14.56	PB-212F	
92.89	280.90	4	1.16	6.95	4190.90	94.63	2.31	TH-234	
98.72	298.58	4	1.16	7.15	272.85	74.68	27.76		1
113.30	342.81	4	1.18	7.47	298.15	58.87	25.64	TH-234	
143.91	435.69	4	1.21	7.57	428.58	115.81	17.46	U-235	
185.81	562.86	4	1.25	7.22	2367.93	101.46	3.52	U-235	

198.36	600.92	4	1.26	7.04	291.69	96.92	22.84	GE-71M
205.57	622.80	4	1.27	6.93	216.81	89.95	30.18	U-235
238.63	723.12	4	1.30	6.52	10009.88	16.91	1.17	PB-212F
241.46	731.71	4	1.31	6.48	246.79	64.51	24.61	PB-214
241.46	731.71	4	1.31	6.48	246.79	64.51	24.61	RA-224
270.46	819.72	4	1.33	6.10	202.33	68.63	27.82	AC-228
277.38	840.71	4	1.34	6.03	505.38	19.34	11.51	PB-212F
295.18	894.74	4	1.36	5.81	389.01	75.41	14.76	PB-214
300.04	909.48	4	1.36	5.76	564.78	20.18	10.41	PB-212F
338.26	1025.46	4	1.40	5.36	486.72	86.78	10.62	2
352.03	1067.23	4	1.41	5.23	624.16	86.21	8.40	PB-214
462.51	1402.48	5	1.51	4.47	265.38	47.35	15.51	PB-214
477.63	1448.37	5	1.52	4.39	24146.53	0.92	0.66	BE-7
510.89	1549.31	5	1.55	4.23	5422.43	59.68	1.38	3
569.75	1727.92	5	1.60	3.97	123.68	0.00	28.47	PB-207M
583.17	1768.64	5	1.61	3.91	4309.22	22.54	1.69	PB-212F
609.41	1848.27	5	1.63	3.81	794.22	90.22	5.48	BI-214
727.35	2206.18	5	1.73	3.44	1010.92	26.36	4.37	PB-212F
766.10	2323.78	5	1.76	3.35	135.03	102.03	23.67	PA-234M
785.65	2383.09	5	1.77	3.30	149.08	50.75	21.05	PB-212F
794.72	2410.62	5	1.78	3.28	188.51	65.99	16.61	PB-212F
802.53	2434.32	5	1.79	3.27	108.87	65.11	27.07	PB-206
835.75	2535.14	5	1.81	3.19	96.38	0.00	31.23	PB-212F
860.51	2610.28	6	1.83	3.13	661.78	24.41	5.78	PB-212F
911.22	2764.16	6	1.87	3.02	890.85	98.67	4.56	AC-228
934.30	2834.20	6	1.89	2.98	100.90	0.00	27.77	BI-214
964.78	2926.71	6	1.91	2.93	119.61	134.27	23.93	AC-228
968.93	2939.29	6	1.91	2.93	590.37	96.26	6.02	AC-228
1001.03	3036.72	6	1.94	2.88	325.03	98.45	9.67	PA-234M
1078.83	3272.80	6	1.99	2.76	98.41	0.00	28.02	PB-212F
1094.00	3318.84	6	2.01	2.73	100.94	0.00	26.37	PB-212F
1120.29	3398.65	6	2.03	2.70	432.26	82.28	7.53	BI-214
1238.24	3756.61	6	2.11	2.55	149.45	98.79	18.42	BI-214
1378.01	4180.81	7	2.21	2.39	128.32	79.03	18.29	BI-214
1385.39	4203.21	7	2.22	2.38	80.05	0.00	27.49	BI-214
1401.37	4251.70	7	2.23	2.37	94.24	46.18	23.56	BI-214
1407.94	4271.65	7	2.23	2.36	88.25	81.32	24.86	BI-214
1460.83	4432.18	7	2.27	2.31	4939.82	98.50	1.47	K-40
1509.62	4580.26	7	2.30	2.27	75.00	69.76	26.88	BI-214
1587.72	4817.28	7	2.36	2.18	240.62	54.35	8.94	4
1592.31	4831.23	7	2.36	2.17	147.26	38.34	14.62	PB-212F
1620.84	4917.82	7	2.38	2.14	199.67	29.18	11.22	PB-212F
1630.69	4947.71	7	2.38	2.13	91.82	72.76	21.67	5
1729.48	5247.58	7	2.45	2.06	121.75	81.12	16.37	BI-214
1764.50	5353.86	8	2.47	2.04	607.88	88.81	4.77	BI-214
1847.37	5605.41	8	2.53	1.98	59.84	132.64	30.60	BI-214

2103.65	6383.38	8	2.70	1.79	298.76	57.52	7.71	PB-212F	
2118.15	6427.38	8	2.71	1.79	53.47	77.73	32.50	BI-214	
2204.22	6688.66	8	2.76	1.75	203.10	96.22	10.61	BI-214	
2447.63	7427.65	9	2.92	1.64	68.40	87.79	23.99	BI-214	
2614.53	7934.41	9	3.02	1.59	3447.49	54.86	1.74	PB-212F	
2687.48	8155.90	9	3.07	1.58	37.69	0.00	30.25	PB-212F	
70.17	211.94	3	1.13	5.36	245.81	0.00	6.38	PB-212F	6

SPECTRAL-REGION-OF-INTEREST (SROI) EDITING ============================

Nuclide ID Changes:
Average Concentration Differences: none
Nuclides Entering:

Name	Average Conc (uBq/m3)	RelErr (%)
BE-7	2752.82	3.02
BI-214	2.32	86.86
PB-207M	1.62	28.62
PB-212F	2794.19	3.32
PB-214	2.39	91.53
RA-224	25.59	98.51
TH-234	40.86	65.95

Nuclides Leaving: none

PEAK SEARCH NOTES ===

NOTE 1:
Date Entered: 2024/01/29 15:19:37
Analyst: IDC
Pa-234m

===

NOTE 2:
Date Entered: 2024/01/29 15:20:28
Analyst: IDC
AC-228

===

NOTE 3:
Date Entered: 2024/01/29 15:19:37
Analyst: IDC
Annihilation

==

NOTE 4:
Date Entered: 2024/01/29 15:20:14
Analyst: IDC
AC-228

==

NOTE 5:
Date Entered: 2024/01/29 15:20:00
Analyst: IDC
AC-228

==

NOTE 6:
Date Entered: 2024/01/29 15:20:39
Analyst: IDC
This peak was inserted to correct a perceived missed-peak error in automatic processing (based on a nominal risk level of 0.001 per cent)

Date Entered: 2024/01/29 15:20:46
Analyst: IDC
PB-212F nuclide identity provided during review

==

PROCESSING PARAMETERS ==

Risk level K: 4.26489
Baseline algorithm: Smoothing / Lawn Mowers
Nucl Id Detectability Threshold: 0.2
Energy Id Tolerance: 0.8 + 0 * FWHM
Background subtraction: YES
Background spectrum ID: 6595612
Background data type: blank
Background acquisition start: 2022/02/20 13:08
Background acquisition time: 71.43 hours
IRF for Pb-212F: YES

CALIBRATION PARAMETERS ==

SAreaThreshold: 100

Confidence level: 95
ECR updated: YES
RER updated: YES
Used ECR: CMD
Used RER: CMD

DATA TIMELINESS AND AVAILABILITY FLAGS =================================

Previous Sample Present? YES
Collection time within 24 hours +/- 10%? YES
Acquisition time >= 20 hours? YES
Decay time <= 24 hours? YES
Sample received within 72 hours of collect start? YES

DATA QUALITY FLAGS ==

Name	Pass/Fail	Value	Test
Ba140_MDC	PASS	10.2679	<30
K40_LocationDifference	PASS	0.0112305	<3*std deviation
Be7_FWHM	PASS	1.51913	<1.7
FlowRate	PASS	965.666	>500

EVENT SCREENING FLAGS ==

Activation Products present in this spectrum No

Only one fission product in spectrum No

2 or more fission products in spectrum No

Cs-137 present in spectrum No

CALIBRATION EQUATIONS ==

Energy vs. Channel

E(c) = 0.3249 + 0.3295*c - 1.725E-09*c^2 - 9.419E-13*c^3

E = energy (keV)
c = channel number

Resolution vs. Energy

FWHM(E) = SQRT(1.12+0.00236*E+2.69e-07*E^2)

FWHM = Full Width Half Max (keV)
E = energy (keV)

Efficiency vs. Energy

VGSL pairs

Energy	Efficiency	Uncertainty
40	0.00844	9.08e-05
50	0.0246	0.00041
60	0.041	0.000912
70	0.0538	0.00141
80	0.0623	0.0018
90	0.0685	0.00206
100	0.0719	0.00221
110	0.0743	0.00228
120	0.0756	0.0023
130	0.0762	0.00228
140	0.0761	0.00225
150	0.0752	0.0022
160	0.0747	0.00215
170	0.0737	0.0021
180	0.0727	0.00205
190	0.0718	0.002
200	0.0701	0.00195
210	0.0686	0.0019
220	0.0675	0.00186
230	0.0661	0.00182
240	0.0651	0.00179
250	0.0634	0.00175
260	0.0622	0.00172
270	0.061	0.00169
280	0.06	0.00166
290	0.0586	0.00163
300	0.0576	0.0016
310	0.0564	0.00158
410	0.0478	0.00139
510	0.0423	0.00124
610	0.0381	0.00112
710	0.0349	0.00102
810	0.0325	0.000928
910	0.0302	0.000847
1010	0.0287	0.000778

1110	0.0271	0.000719
1210	0.0259	0.00067
1310	0.0245	0.000628
1410	0.0236	0.000594
1510	0.0227	0.000567
1610	0.0215	0.000544
1710	0.0207	0.000527
1810	0.0201	0.000516
1910	0.0192	0.000508
2010	0.0187	0.000504
2110	0.0179	0.000505
2210	0.0175	0.00051
2310	0.0168	0.000517
2410	0.0165	0.000529

FIELD OF REGARD ===

https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fswp.ctbto.org%2FFOR%2FUSP72%2F2024%2F01%2F26&data=05%7C02%7CIMSdata%40epa.gov%7C79970714f19f4c71abbb08dc20e18c01%7C88b378b367484867acf976aacbeca6a7%7C0%7C0%7C638421400283508948%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=3YrqQSnaZi5XhOrWTz%2BvXPjBW1lDBTsVgnIFWTC7EY4%3D&reserved=0

STOP

Appendix C: Example of Detailed IMS Reviewed Radionuclide Report During Response to Fukushima Accident

EXAMPLE #1

```
BEGIN IMS1.0
MSG_TYPE DATA
MSG_ID 51264108 CTBT_IDC
PROD_ID 1001 117502
DATA_TYPE RRR IMS2.0
                    IDC GENERATED REPORT
                  REVIEWED RADIONUCLIDE REPORT
                     Particulate Version

              Creation Date: 2011/03/27 00:59:48
          Sample Arrival Time: 2011/03/26 18:19:14
   Time difference from receipt of raw data to report creation: 6 hours

SAMPLE INFORMATION
==========================================================

Station ID:       USP75          Detector ID:      USP75_003
Authenticated:      NO

Station Location: Charlottesville, VA, USA
Detector Description: Detector #3 in Charlottesville, VA, USA

Sample ID:         1507225        Sample Geometry:    M4
Sample Quantity:     24232.14 m3      Sample Type:       Particulate


Collection Start:   2011/03/23 18:49    Sampling Time:       24.00 hours
Collection Stop:    2011/03/24 18:49    Decay Time:          24.00 hours
Acquisition Start:  2011/03/25 18:49    Acquisition Time:     23.42 hours
Acquisition Stop:   2011/03/26 18:15    Avg Flow Rate:      1009.67 m3/hr

Collection Station Comments:
Barcode ID: 7500007210
RASA SOFTWARE VERSION 3.3.1
Ortec 46-TP32108A   92.8mm L x 75.9mm D
Many Lines Decayed away from Source NPL X06186
CTBTO Requested new added lines 2010/11/26
```

IDC Analysis General Comments:
IDC 2011/03/27 00:59:43

IDC 2011/03/27 00:54:33
Confirmed as level 5 due to the presence of activation and fission products.
Spilio Spiliopoulos, Chief MDA.

IDC 2011/03/27 00:54:24
The spectrum is confirmed as Level 5 due to detection of nuclides Cs-134 (604.8 keV, DT=34.0), Cs-136 (818.5 keV, DT=5.6),Cs-137 (661.7 keV, DT=6.98), I-131 (364.4 keV, DT=121.8), I-132 (667,7 keV, DT=11.0), Te-132 (228.4 keV, DT=9.0).

IDC 2011/03/26 18:19:34

MEASUREMENT CATEGORIZATION
===

Categorization Legend

Level 1 = Typical Background Rad. Meas.
Level 2 = Anomalous Background Rad. Meas.
Level 3 = Typical Anthropogenic Rad. Meas.
Level 4 = Anomalous Anthropogenic Rad. Meas.
Level 5 = Mult. Anomalous Anthropogenic Rad. Meas.

Spectrum Category (5) -- Mult. Anomalous Anthropogenic Rad. Meas.

Categorization Summary:

Name	Category	Categorization Comment
----	--------	----------------------
CS-134	4	Not Regularly Measured
CS-136	4	Not Regularly Measured
CS-137	4	Not Regularly Measured
I-131	3	Within Statistical Range
I-132	2	Not Regularly Measured
TE-132	4	Not Regularly Measured

ACTIVITY SUMMARY
==

NATURAL RADIOACTIVITY:

Nuclides Identified and not Quantified:

AC-228, BI-214, K-40, PA-234M, PB-214, RA-226, TH-234, U-235

Nuclides Quantified:

Nuclide	Half-Life	Conc(uBq/m3)	%%RelErr	Notes
BE-7	53.29 D	2E+03	5.86	
PB-212F	10.64 H	2.6E+04	6.72	

ACTIVATION-PRODUCT RADIOACTIVITY:

CS-134	2.062 Y	61	3.45

FISSION-PRODUCT RADIOACTIVITY:

CS-136	13.16 D	7.9	8.02
CS-137	30.1 Y	75	2.17
I-131	8.04 D	3.3E+02	7.26
I-132	9.99899 Y	17	4.55
TE-132	3.204 D	32	8.93

MINIMUM DETECTABLE CONCENTRATION FOR KEY NUCLIDES
======================

Nuclide	Half-Life	MDC(uBq/m3)
BA-140	12.752 D	10.57
CE-143	1.37662 D	16.96
CS-134	2.062 Y	2.69
CS-136	13.16 D	2.42
CS-137	30.1 Y	2.89
I-131	8.04 D	4.05
I-133	20.8 H	12.34
MO-99	2.7475 D	30.64
NB-95	34.97 D	2.68
RU-103	39.26 D	2.64
TE-132	3.204 D	5.43
ZR-95	64.02 D	4.19
ZR-97	16.9 H	15.87

PEAK SEARCH RESULTS
==

74 peaks found in spectrum by automated peak search.
67 peaks associated with nuclides by automated processing.
7 peaks not associated with nuclides by automated processing.
91 percent of peaks were associated with nuclides.

Note: "*" indicates that a peak was a component of a multiplet.

Energy	Centroid	Width	FWHM	%%Eff	Net Area	%%RelErr	Nuclide	Nts
72.77	221.53 *	26	1.07	2.11	1646.54	5.16	PB-212F	
74.79	227.63 *	26	1.07	2.32	9268.58	1.35	PB-212F	
74.79	227.63 *	26	1.07	2.32	9268.58	1.35	PB-214	
77.04	234.47 *	26	1.08	2.56	11921.16	1.16	PB-212F	
77.04	234.47 *	26	1.08	2.56	11921.16	1.16	PB-214	
84.70	257.70 *	37	1.17	3.34	1502.33	5.63	PB-212F	
87.13	265.08 *	37	1.18	3.58	5968.36	1.89	PB-212F	
87.13	265.08 *	37	1.18	3.58	5968.36	1.89	PB-214	
89.87	273.37 *	37	1.18	3.83	1757.90	4.84	PB-212F	
89.87	273.37 *	37	1.18	3.83	1757.90	4.84	PB-214	
92.59	281.62 *	37	1.19	4.07	1501.54	5.66	TH-234	1
115.15	350.04	14	1.09	5.52	783.50	11.11	PB-212F	
163.36	496.22	10	0.66	6.33	198.74	31.41	U-235	2
185.76	564.13	14	1.15	6.25	1672.67	5.36	RA-226	
228.33	693.24	15	1.09	5.87	2184.36	3.95	PB-212F	
228.33	693.24	15	1.09	5.87	2184.36	3.95	TE-132	
238.63	724.48	15	1.14	5.77	71698.12	0.39	PB-212F	
252.51	766.56	11	1.07	5.64	338.67	17.61	PB-212F	
277.35	841.88	12	1.16	5.40	3162.67	2.61	PB-212F	
284.26	862.86 *	27	1.19	5.34	1899.74	3.88	I-131	
288.10	874.50 *	27	1.20	5.30	601.89	9.41	PB-212F	
295.21	896.05	16	0.46	5.24	187.18	22.34	PB-214	
300.09	910.84	16	1.20	5.20	4761.09	1.91	PB-212F	
327.94	995.29	12	1.04	4.97	203.76	26.13	AC-228	
327.94	995.29	12	1.04	4.97	203.76	26.13	PB-212F	
338.31	1026.76 *	21	1.43	4.89	389.22	13.78	AC-228	
340.70	1034.01 *	21	1.43	4.87	440.06	12.40	CS-136	
351.95	1068.11	16	1.18	4.78	626.06	9.19	PB-212F	
351.95	1068.11	16	1.18	4.78	626.06	9.19	PB-214	
364.44	1106.00	16	1.22	4.70	21418.00	0.73	I-131	
452.80	1373.97	14	1.46	4.15	509.40	9.95	PB-212F	
459.46	1394.15	11	0.69	4.12	87.27	37.23	TE-129	3

477.62	1449.21	17	1.30	4.03	17145.90	0.80	BE-7	
510.82	1549.90	18	1.72	3.86	12128.82	1.00	PB-212F	
522.55	1585.48	13	1.18	3.81	226.60	17.10	I-132	
563.31	1709.11	9	1.39	3.63	322.05	12.29	CS-134	
569.39	1727.53	15	1.38	3.61	619.89	7.33	CS-134	
583.19	1769.40	18	1.39	3.55	29011.71	0.60	PB-212F	
604.72	1834.70 *	32	1.42	3.47	4223.44	1.77	CS-134	
609.36	1848.75 *	32	1.43	3.45	743.31	5.52	BI-214	
630.37	1912.47	16	1.34	3.38	187.10	18.68	I-132	
637.00	1932.60	19	1.43	3.35	1372.24	3.66	I-131	
657.85	1995.81 *	25	1.47	3.28	143.53	19.68	PB-212F	
661.66	2007.39 *	25	1.47	3.27	4231.48	1.72	CS-137	
667.70	2025.68	16	1.35	3.24	1087.12	4.23	I-132	
722.82	2192.86 *	33	1.49	3.07	298.42	10.49	I-131	
727.31	2206.49 *	33	1.49	3.05	6132.80	1.38	I-132	
727.31	2206.49 *	33	1.49	3.05	6132.80	1.38	PB-212F	
742.79	2253.43	14	0.95	3.01	72.99	32.32	BI-214	4
763.26	2315.51	16	1.26	2.95	452.44	7.59	PB-212F	
772.66	2344.04	17	1.47	2.92	812.45	4.95	AC-228	
772.66	2344.04	17	1.47	2.92	812.45	4.95	I-132	
785.52	2383.04	17	1.69	2.88	1007.20	4.23	PB-212F	
795.86	2414.39	19	1.56	2.86	3397.38	1.91	CS-134	
802.17	2433.53	17	1.96	2.84	408.51	8.98	CS-134	
802.17	2433.53	17	1.96	2.84	408.51	8.98	TE-129	5
818.47	2482.97	17	1.17	2.80	403.24	7.83	CS-136	
860.56	2610.64	20	1.56	2.69	3744.09	1.80	PB-212F	
893.40	2710.22	20	1.61	2.61	292.92	10.40	PB-212F	
911.20	2764.22	16	1.67	2.57	495.03	6.95	AC-228	
954.78	2896.39	14	1.49	2.48	108.88	22.11	I-132	
969.01	2939.55	14	1.24	2.45	266.64	10.51	AC-228	
1000.98	3036.51	18	1.86	2.38	215.52	13.32	PA-234M	
1047.83	3178.63	14	1.62	2.29	233.54	12.22	CS-136	
1078.72	3272.33	17	1.55	2.24	330.56	8.76	PB-212F	
1093.97	3318.59	21	1.61	2.21	452.86	6.97	PB-212F	
1120.44	3398.87	17	1.99	2.17	276.31	10.65	BI-214	
1238.17	3756.00	10	1.29	1.99	70.82	29.58	BI-214	
1346.52	4084.64	11	0.99	1.86	47.51	33.60	PB-212F	6
1365.14	4141.13	11	1.46	1.84	129.63	16.44	CS-134	
1400.89	4249.59	23	2.97	1.80	263.89	11.22	BI-214	7
1460.81	4431.35	23	1.83	1.74	918.28	3.96	K-40	
1512.84	4589.18	13	1.57	1.70	215.61	10.65	PB-212F	
1587.91	4816.92 *	30	1.86	1.64	40.78	40.23	AC-228	8
1592.61	4831.16 *	30	1.86	1.63	379.38	7.41	PB-212F	
1612.83	4892.52	13	0.48	1.62	27.01	16.61		9

1620.74	4916.52	20	2.02	1.61	961.63	3.85	PB-212F	
1764.55	5352.79	21	1.79	1.52	331.09	7.93	BI-214	
1911.18	5797.65	11	0.93	1.46	35.19	35.93		10
2103.54	6381.26	26	2.97	1.40	1420.27	3.16	PB-212F	
2204.43	6687.38	17	2.79	1.38	217.17	11.23	BI-214	
2614.53	7931.78	28	2.41	1.40	13287.48	0.88	PB-212F	
176.81	537.01	12	1.06	6.30	356.35	5.30	CS-136	11
1167.30	3541.01	18	1.71	2.10	78.06	11.32	CS-134	12

SPECTRAL-REGION-OF-INTEREST (SROI) EDITING ==============================

PEAKS ADDED:

Energy	Centroid	Width	FWHM	%%EFF	Net Area	%%RelErr
176.81	537.01	12	1.06	0.06	356.35	5.30
1167.30	3541.01	18	1.71	0.02	78.06	11.32

PEAKS DELETED: none

SROIs MODIFIED: none

AFTER:

Energy	Centroid	Width	FWHM	%%EFF	Net Area	%%RelErr

Nuclide ID Changes:
Average Concentration Differences: none
Nuclides Entering:

Name	Average Conc	%%RelErr
AC-228	36.58	7.28
BE-7	2035.77	5.86
BI-214	22.89	6.29
CS-134	61.18	3.45
CS-136	7.87	8.02
CS-137	74.53	2.17
I-131	326.49	7.26
I-132	16.64	4.55
K-40	241.94	4.49
PA-234M	751.57	20.33
PB-212F	25876.54	6.72
PB-214	17.06	11.63
RA-226	374.85	8.53
TE-132	31.71	8.93
TH-234	157054323269.39	0.00
U-235	30.75	18.03

Nuclides Leaving: none

PEAK SEARCH NOTES ===

NOTE 1:
Date Entered: 2011/03/27 00:40:14
Analyst: IDC
TH-234 nuclide identity provided during review

===

NOTE 2:
Date Entered: 2011/03/27 00:40:56
Analyst: IDC
U-235 nuclide identity provided during review

===

NOTE 3:
Date Entered: 2011/03/27 00:53:22
Analyst: IDC
This nuclide was removed from the Activity Summary section because in the analyst's judgment the nuclide was not present; some nuclides may be removed because their activity calculations are not meaningful (they are identified, not quantified).

Date Entered: 2011/03/27 00:53:28
Analyst: IDC
False peak detection; Type I error in peak processing.

===

NOTE 4:
Date Entered: 2011/03/26 20:29:03
Analyst: IDC
False peak detection; Type I error in peak processing.

===

NOTE 5:
Date Entered: 2011/03/27 00:53:22
Analyst: IDC

This nuclide was removed from the Activity Summary section because in the analyst's judgment the nuclide was not present; some nuclides may be removed because their activity calculations are not meaningful (they are identified, not quantified).

==

NOTE 6:
Date Entered: 2011/03/26 20:29:03
Analyst: IDC
False peak detection; Type I error in peak processing.

==

NOTE 7:
Date Entered: 2011/03/27 00:45:01
Analyst: IDC
BI-214 nuclide identity provided during review

==

NOTE 8:
Date Entered: 2011/03/26 20:29:03
Analyst: IDC
False peak detection; Type I error in peak processing.

==

NOTE 9:
Date Entered: 2011/03/26 20:29:03
Analyst: IDC
False peak detection; Type I error in peak processing.

==

NOTE 10:
Date Entered: 2011/03/26 20:29:03
Analyst: IDC
False peak detection; Type I error in peak processing.

==

NOTE 11:
Date Entered: 2011/03/27 00:47:09

Analyst: IDC
This peak was inserted to correct a perceived missed-peak error in automatic processing (based on a nominal risk level of 0.001 per cent)

Date Entered: 2011/03/27 00:47:17
Analyst: IDC
CS-136 nuclide identity provided during review

==

NOTE 12:
Date Entered: 2011/03/27 00:47:43
Analyst: IDC
This peak was inserted to correct a perceived missed-peak error in automatic processing (based on a nominal risk level of 0.001 per cent)

Date Entered: 2011/03/27 00:47:52
Analyst: IDC
CS-134 nuclide identity provided during review

==

PROCESSING PARAMETERS
==

Threshold: 3
Peak Start (keV): 42
Peak End (keV): 2700
Left FWHM limit: 2
Right FWHM limit: 2
Multiplet FWHM limit: 4
Fit Singlets: On
Critical-level Test: On
Estimate Peak Widths: On
Baseline Type: STEP
Baseline Channels: 3
Perform Subtraction: Off
Energy Tolerance 0.4
Confidence Threshold 0.25

UPDATE PARAMETERS
==

Use MRP: Yes

Most Recent Prior sample: Yes
Gain Shift (%): 0.1
Zero Shift (Channels): 0.5
Minimum Area: 100
Use Weights: On
Allow Multiplets: On
Force Linear: Off
Lookup Tol Floor (keV): 0.2
Default RER Intercept: 0.5
Default RER Slope: 0.035
Default ECR Slope: 0
Do RER Update: Yes

DATA TIMELINESS AND AVAILABILITY FLAGS ===================================

Previous Sample Present? YES
Collection time within 24 hours +/- 10%? YES
Acquisition time >= 20 hours? YES
Decay time <= 24 hours? YES
Sample received within 72 hours of collect start? YES

DATA QUALITY FLAGS
===

Name	Pass/Fail	Value	Test
Ba140_MDC	PASS	10.5739	<30
K40_LocationDifference	PASS	0.0454102	<3*std deviation
NormalizedGainDifference	PASS	9.78708e-05	<0.0001
Be7_FWHM	PASS	1.29802	<1.7
FlowRate	PASS	1009.67	>500

EVENT SCREENING FLAGS
==

Activation Products present in this spectrum Yes
Number of days since last activation product 0.999398

Only one fission product in spectrum No

2 or more fission products in spectrum Yes
Number of days since 2 or more fission products 0.999398

Cs-137 present in spectrum Yes

Number of times seen in last 30 days 2

CALIBRATION EQUATIONS
===

Energy vs. Channel

E(c) = -0.2839 + 0.3298*c - 1.565E-08*c^2

E = energy (keV)
c = channel number

Resolution vs. Energy

FWHM(E) = 0.66 + 0.03082*SQRT(E)

FWHM = Full Width Half Max (keV)
E = energy (keV)

Efficiency vs. Energy

L(E) = ln(947.8/E)

e(E) = exp { -3.693 + 0.8098*L - 0.1284*L^2
- 0.132*L^3 + 0.1656*L^4 - 0.05703*L^5 }

e = efficiency (counts/gamma)
E = energy (keV)

FIELD OF REGARD ==

http://kuredu.ops.ctbto.org/web-gards/FOR/USP75/2011/084

STOP

<u>EXAMPLE #2</u>

```
BEGIN IMS1.0
MSG_TYPE DATA
MSG_ID 51230275 CTBT_IDC
PROD_ID 1037 116847
DATA_TYPE ARR IMS2.0
                    IDC GENERATED REPORT
                 AUTOMATED RADIONUCLIDE REPORT
                      Particulate Version

                Creation Date: 2011/03/26 01:48:54
            Sample Arrival Time: 2011/03/26 01:48:23
   Time difference from receipt of raw data to report creation: 0 hours

SAMPLE INFORMATION
=========================================================

Station ID:       USP78          Detector ID:      USP78_003
Authenticated:     NO

Station Location: Midway Islands, USA.
Detector Description: Detector #3 in Midway Islands, USA.

Sample ID:          1506746        Sample Geometry:    M4
Sample Quantity:     22966.44 m3      Sample Type:       Particulate


Collection Start:   2011/03/23 02:04    Sampling Time:       24.00 hours
Collection Stop:    2011/03/24 02:04    Decay Time:          24.00 hours
Acquisition Start:  2011/03/25 02:05    Acquisition Time:    23.42 hours
Acquisition Stop:   2011/03/26 01:29    Avg Flow Rate:       956.93 m3/hr

Collection Station Comments:
Barcode ID: 7800004043
RASA SOFTWARE VERSION 3.3.1
Ortec 43-TP41360A 78.2 mm D x 88.1 mm L


IDC Analysis General Comments:
IDC 2011/03/26 01:48:34
```

ACTIVITY SUMMARY
==

NATURAL RADIOACTIVITY:

Nuclides Identified and not Quantified:

BI-214, K-40, PA-234M, RA-226, U-235

Nuclides Quantified:

Nuclide	Half-Life	Conc(uBq/m3)	%%RelErr	Notes
BE-7	53.29 D	6.9E+03	1.50	
PB-212F	10.64 H	9.8E+02	5.92	

ACTIVATION-PRODUCT RADIOACTIVITY:

CS-134	2.062 Y	8.4E+02	1.34

FISSION-PRODUCT RADIOACTIVITY:

CD-115M	44.6 D	4.8E+02	47.69
CS-136	13.16 D	1.2E+02	2.18
CS-137	30.1 Y	1E+03	1.11
I-131	8.04 D	6.6E+03	1.85
I-132	9.99899 Y	2.6E+02	1.68
TC-99M	6.01 H	9.1E+02	21.89
TE-129	9.99899 Y	1.9E+02	11.03
TE-129M	33.6 D	4.1E+02	37.37
TE-132	3.204 D	5.1E+02	4.85

MINIMUM DETECTABLE CONCENTRATION FOR KEY NUCLIDES
========================

Nuclide	Half-Life	MDC(uBq/m3)
BA-140	12.752 D	20.63
CE-143	1.37662 D	35.02
CS-134	2.062 Y	4.36
CS-136	13.16 D	3.96
CS-137	30.1 Y	4.81

I-131	8.04 D	9.80
I-133	20.8 H	23.94
MO-99	2.7475 D	47.27
NB-95	34.97 D	3.98
RU-103	39.26 D	5.12
TE-132	3.204 D	11.63
ZR-95	64.02 D	6.43
ZR-97	16.9 H	24.64

PEAK SEARCH RESULTS
===

82 peaks found in spectrum by automated peak search.
59 peaks associated with nuclides by automated processing.
23 peaks not associated with nuclides by automated processing.
72 percent of peaks were associated with nuclides.

Note: "*" indicates that a peak was a component of a multiplet.

Energy	Centroid	Width	FWHM	%%Eff	Net Area	%%RelErr	Nuclide	Nts
74.98	228.09	13	0.98	1.35	926.99	12.78	PB-212F	
80.19	243.90	13	1.20	1.76	3910.62	3.62	I-131	
92.63	281.64	13	1.33	2.73	2301.75	6.04		
140.54	427.01	21	0.92	4.90	557.96	21.82	TC-99M	
153.24	465.54	12	0.96	5.08	624.36	21.42	CS-136	
177.02	537.66	15	1.52	5.20	3240.18	5.29	PB-212F	
185.88	564.54	13	1.19	5.20	2548.26	5.90	RA-226	
185.88	564.54	13	1.19	5.20	2548.26	5.90	U-235	
228.41	693.58	16	1.34	5.01	28087.94	0.76	PB-212F	
228.41	693.58	16	1.34	5.01	28087.94	0.76	TE-132	
238.71	724.83	16	1.23	4.94	2194.64	5.65	PB-212F	
273.62	830.73	14	1.70	4.71	1309.99	9.71	CS-136	
284.39	863.41	17	1.38	4.64	30477.08	0.68	I-131	
325.84	989.15	16	1.34	4.38	1100.55	9.66		
340.66	1034.11	18	1.49	4.29	3634.53	3.36	CS-136	
352.03	1068.60	17	1.79	4.22	1176.68	9.99	PB-212F	
364.54	1106.54	18	1.44	4.15	360747.78	0.17	I-131	
459.54	1394.75	15	1.46	3.70	1059.48	7.71	TE-129	
477.66	1449.72	19	1.51	3.62	49487.73	0.48	BE-7	
487.59	1479.84	20	1.29	3.58	256.60	24.72	TE-129	
503.02	1526.64 *	41	1.61	3.52	1395.65	5.05		
506.04	1535.83 *	41	1.61	3.51	729.69	8.40	I-132	

511.05	1551.02 *	41	2.39	3.49	3952.24	2.48	PB-212F
522.74	1586.47	19	1.53	3.45	2347.75	3.41	I-132
563.32	1709.58 *	38	1.53	3.30	3849.62	2.17	CS-134
569.38	1727.97 *	38	1.54	3.28	7413.84	1.42	CS-134
583.26	1770.07	17	1.47	3.23	935.45	6.93	PB-212F
604.75	1835.26 *	35	1.61	3.16	49898.88	0.46	CS-134
609.36	1849.26 *	35	1.61	3.15	1413.04	4.23	BI-214
620.72	1883.73	16	0.76	3.11	117.02	31.86	
630.28	1912.71	15	1.54	3.08	1847.50	3.60	I-132
637.05	1933.25 *	38	1.62	3.06	23412.19	0.69	I-131
642.77	1950.60 *	38	1.62	3.05	743.08	6.72	
650.54	1974.19	17	1.67	3.02	362.87	13.81	I-132
661.71	2008.08 *	48	1.65	2.99	49466.68	0.46	CS-137
667.78	2026.50 *	48	1.65	2.97	14457.16	0.88	I-132
670.64	2035.16 *	48	1.65	2.96	851.69	5.48	PB-212F
695.96	2111.97	20	1.55	2.89	647.87	7.16	TE-129M
722.96	2193.89 *	35	1.68	2.82	5428.29	1.54	I-131
727.37	2207.26 *	35	1.68	2.81	885.46	5.08	I-132
727.37	2207.26 *	35	1.68	2.81	885.46	5.08	PB-212F
766.78	2326.82 *	37	1.71	2.71	273.40	13.21	
772.75	2344.95 *	37	1.72	2.69	10130.68	1.07	I-132
780.56	2368.63	17	0.93	2.67	76.73	42.44	
795.96	2415.33 *	41	1.74	2.64	37724.11	0.52	CS-134
802.07	2433.89 *	41	1.75	2.62	3557.95	1.93	CS-134
802.07	2433.89 *	41	1.75	2.62	3557.95	1.93	TE-129
812.43	2465.30 *	40	1.72	2.60	636.59	6.22	
818.60	2484.04 *	40	1.72	2.58	5255.20	1.55	CS-136
860.34	2610.67	14	1.44	2.49	113.64	28.16	PB-212F
911.20	2764.95	20	1.77	2.38	613.42	6.56	
934.49	2835.60	11	0.53	2.34	58.30	31.53	
954.78	2897.15	21	1.77	2.30	1929.99	2.82	I-132
969.11	2940.64	17	1.49	2.27	271.15	11.88	
984.19	2986.39	13	0.91	2.24	78.27	28.49	
1001.11	3037.70	19	1.88	2.21	432.23	8.15	PA-234M
1038.81	3152.08	19	1.89	2.15	357.23	9.77	CS-134
1048.21	3180.60	24	1.87	2.14	3664.98	1.84	CS-136
1120.48	3399.85	25	1.88	2.02	459.24	7.49	BI-214
1136.09	3447.21 *	41	1.51	2.00	265.29	10.85	I-132
1143.62	3470.04 *	41	1.52	1.99	110.34	22.10	I-132
1159.18	3517.24	14	1.90	1.97	201.94	13.74	
1168.04	3544.12 *	36	1.92	1.96	843.96	4.58	CS-134
1173.89	3561.86 *	36	1.92	1.95	435.23	7.27	
1235.53	3748.87	20	1.93	1.87	741.32	5.11	CS-136
1290.26	3914.90 *	40	3.06	1.81	145.02	17.25	CD-115M

1296.16	3932.81 *	40	3.06	1.80	344.28	8.96	
1365.28	4142.51 *	46	2.03	1.73	1384.07	3.07	CS-134
1372.00	4162.89 *	46	2.03	1.72	125.11	17.60	I-132
1388.80	4213.84	16	1.40	1.71	91.40	21.35	
1400.27	4248.66 *	43	2.80	1.70	2281.63	2.36	
1407.34	4270.10 *	43	2.81	1.69	181.25	12.66	
1440.83	4371.69	25	3.02	1.66	527.25	6.04	
1460.93	4432.67	27	2.07	1.64	2005.27	2.43	K-40
1509.40	4579.70	15	1.45	1.61	64.00	24.97	BI-214
1596.37	4843.57	46	2.45	1.55	188.09	11.37	
1728.85	5245.46	28	3.63	1.47	210.43	10.96	
1764.59	5353.89	24	2.30	1.46	579.75	4.85	BI-214
1847.51	5605.43	17	1.90	1.43	67.84	20.97	BI-214
1866.71	5663.69	23	2.48	1.42	156.27	11.59	
1921.17	5828.91	18	2.11	1.41	117.78	13.67	I-132
1969.89	5976.69	21	2.28	1.39	84.41	16.23	
2002.26	6074.90	25	2.77	1.39	139.70	12.55	I-132
2204.37	6688.05	17	2.10	1.37	172.86	10.22	BI-214
2448.14	7427.57	17	2.30	1.40	66.34	18.82	BI-214
2614.72	7932.92	33	2.80	1.44	891.58	3.52	PB-212F

PROCESSING PARAMETERS
===

Threshold: 3
Peak Start (keV): 40
Peak End (keV): 2750
Left FWHM limit: 2
Right FWHM limit: 2
Multiplet FWHM limit: 4
Fit Singlets: On
Critical-level Test: On
Estimate Peak Widths: On
Baseline Type: STEP
Baseline Channels: 3
Perform Subtraction: Off
Energy Tolerance 0.4
Confidence Threshold 0.25

UPDATE PARAMETERS
===

Use MRP: Yes
Most Recent Prior sample: Used
Gain Shift (%): 0.1

Zero Shift (Channels): 0.5
Minimum Area: 100
Use Weights: On
Allow Multiplets: On
Force Linear: Off
Lookup Tol Floor (keV): 0.2
Default RER Intercept: 0.5
Default RER Slope: 0.035
Default ECR Slope: 0
Do RER Update: Yes

DATA TIMELINESS AND AVAILABILITY FLAGS ===================================

Previous Sample Present? YES
Collection time within 24 hours +/- 10%? YES
Acquisition time >= 20 hours? YES
Decay time <= 24 hours? YES
Sample received within 72 hours of collect start? YES

DATA QUALITY FLAGS
==

Name	Pass/Fail	Value	Test
Ba140_MDC	PASS	20.6321	<30
K40_LocationDifference	PASS	0.0756836	<3*std deviation
NormalizedGainDifference	PASS	4.63724e-05	<0.0001
Be7_FWHM	PASS	1.50543	<1.7
FlowRate	PASS	956.935	>500

CALIBRATION EQUATIONS
===

Energy vs. Channel

$$E(c) = -0.2107 + 0.3296*c$$

E = energy (keV)
c = channel number

Resolution vs. Energy

FWHM(E) = 0.66 + 0.03884*SQRT(E)

FWHM = Full Width Half Max (keV)
E = energy (keV)

Efficiency vs. Energy

L(E) = ln(962.0/E)

e(E) = exp { -3.779 + 0.7818*L - 0.1293*L^2
- 0.1773*L^3 + 0.2052*L^4 - 0.06874*L^5 }

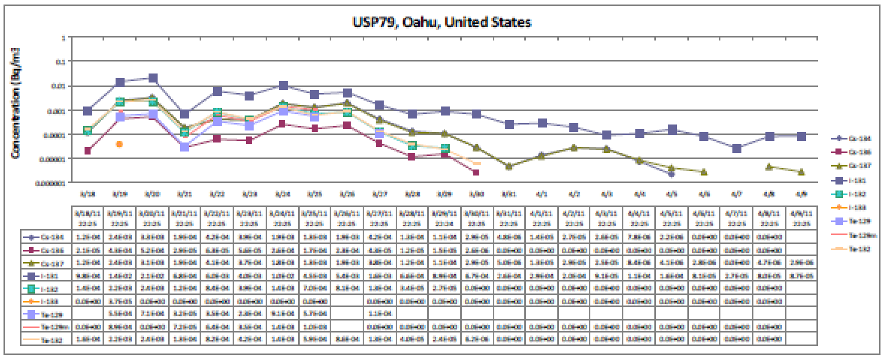
e = efficiency (counts/gamma)
E = energy (keV)

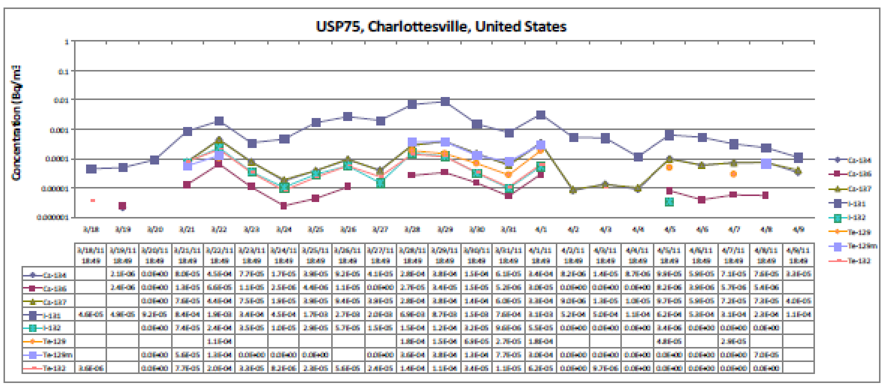
FIELD OF REGARD ==

http://kuredu.ops.ctbto.org/web-gards/FOR/USP78/2011/083

STOP

Appendix D: Example of Trending IMS Reviewed Radionuclide Report During Response to Fukushima Accident





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