FRMAC Laboratory Analysis Rad Responder Enhancements Requirements

FEMA-NIRT FY19 Project 3.4

Prepared for Chainbridge Technologies by:

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Contents

Introduction

This document will describe the requirements for improvements to the Rad Responder platform to meet the needs of FRMAC Lab Analysis and other users of the sample control and lab analysis modules. The report is broken down into specific sections and organized by the specific deliverables under the FY19 FEMA-NIRT project. This report describes requirements that go beyond what was originally funded under the FY19 FEMA-NIRT project since auxiliary funding is being used on top of FEMA-NIRT funding through the DOE eFRMAC working group. This document describes all the lab analysis requirements for FRMAC Lab Analysis operations. Under each section the reader will find specific user "stories" or use-cases along with specific and technical requirements for each feature. Mock ups and data models will be provided as needed.

Symbology

This document contains several flow diagrams that explain the workflow and status triggering. In general, the following shapes are used to describe the following system attributes:

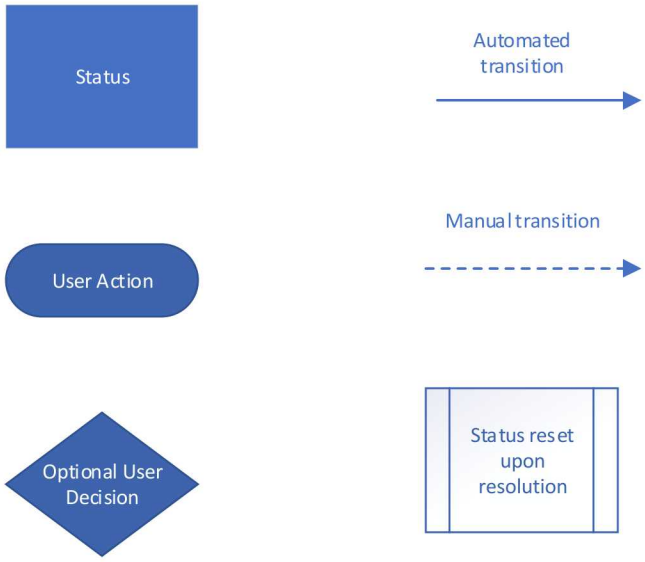

Figure 1: Symbology description

The status is the core of the workflow and relates to a setting of a status field in RR. The User action describes what the user must do in the process to advance the status to the next step. The optional user decision is something that can be done at any time in the workflow. An automated transition is one that occurs as a result of another action in the system. The manual transition is one done through a status transition utility and for the sole purpose of updating the status. The status reset upon resolution occurs when the user performs an action and the status is reset to what it was before the optional user decision occurred.

Sample and Result Mapping

The sample map view will primarily be used as a tool to search for samples, identify samples that need to be exported together for some sort of data product. This mapping tool would help mission planners choose where to collect more samples.

In most situations, samples will be collected in clusters. Several different types of samples will be collected at a given point along with field measurements and each of those samples will be analyzed for several different analytes, perhaps even up to 30 - 40 analytes per sample can be expected in many scenarios. Thus, showing all available data on a map will be very hard to render and lag on the server. It will be important to improve the map view filtering capability to toggle on and off sample types, and specific analytes to improve system performance and human-readability.

Sample mapping

At the core, users will want a quick way to display, filter, and extract all data from samples (including sample results) for a region of space using the existing drawing tools. The sample mapping view will be a good tool for the data user to locate and extract data in the context of the event to answer specific stakeholder questions.

Use Cases:

- Assessment scientist – Asked to provide a stakeholder a list of drinking water samples collected in a specific county. Needs a quick way to down-select drinking water samples and export a list of samples and their relevant status and available data for a given region of space.
- Assessment scientist – Asked to review all the available data for samples and measurements collected in a specific region so that incident command can make a decision on relocation. Needs a quick way to lasso a region of space, apply filters to measurement and sample types and extract all relevant data from the database for these objects to have a holistic data set to work with.

Result Mapping

The results mapping view will primarily be used to visualize sample results, help identify sample results of interest and outliers, quickly see what results have exceeded the Analytical Action Levels (AAL) identified in the mixture and allow the user to export the data for further analysis.

Results will be queried based on the question being asked by the user and will vary widely and unpredictably so it will be important to have tools built in to filter down data into manageable chunks to view and export. The available filters should include the following and allow multiple filters to be applied at once:

- Sample status
- Result status
- Sample type
- Analyte (nuclide)

- Less than MDA/MDC?
- Assessed?

Once filtered, the sample information and all available result information shall be exportable into the standard flat data format specified later in this report.

Color coding

General map view: Within a sample result cluster, color code based on the highest severity (i.e. if any analytes are above AAL, it is red; if any are above the measured critical level, yellow; or green otherwise)

Using specific region of a map (a drawing):

- First, ask user to call up a saved drawing, or provide link to create a new one
- Ask user to choose an existing mixture and provide link to mixture creation
- Ask user to choose the sample type filter – display all sample types that are available in all the samples selected in the drawing region
    - Filter data by sample type
- Ask user to choose the analyte – display all analytes with results for the down-selected data set
    - Filter data by analyte
- Normalize sample analyte results and mixture AAL values so they are comparable
    - Convert all radioactivity values to Bq
    - Convert all volumes to mL
    - Convert all masses to g
- Determine color-coding for normalized analyte results
    - Red – result greater than or equal to analyte AAL
        - No available analyte AAL in mixture: grey with dotted outline
    - Yellow – result between measured critical level and AAL – Needs to be able to be toggled on/off. Some maps may only require the Red/Green designation
    - Green - result less than measured critical level
- Display thresholds and filters on screen with map key so users can easily screen-shot the page.
- After calculations, allow user to change the mixture (AAL's) the analyte results are compared against.
- Allow user to export the filtered data from this region defaulting to the selected analyte.
    - Include checkbox to toggle the export of all analytes for the selected samples
- Have outlier detection algorithm and flag results (with purple/magenta icon) that are suspected outliers in a given drawing region, with a user adjustable threshold that defaults to 3.
    - All sample analyte results (x) are assessed using a z-score based on the uncertainty weighted average (μ) and the standard deviation (σ) to give:

      $$z = \frac{x - \mu}{\sigma}$$

      The equations for the uncertainty weighted average and standard deviation are found in Appendix I – Equations.

Currently the results are displayed on the map all at once as a flask icon (Figure 2.). This is unnecessary and we recommend removing the flask icons from the map since all the data is contained in the expanded sample type icon. The use of full color vs. grey to indicate having or not having results is a good practice and should be continued. (see Figure 3)

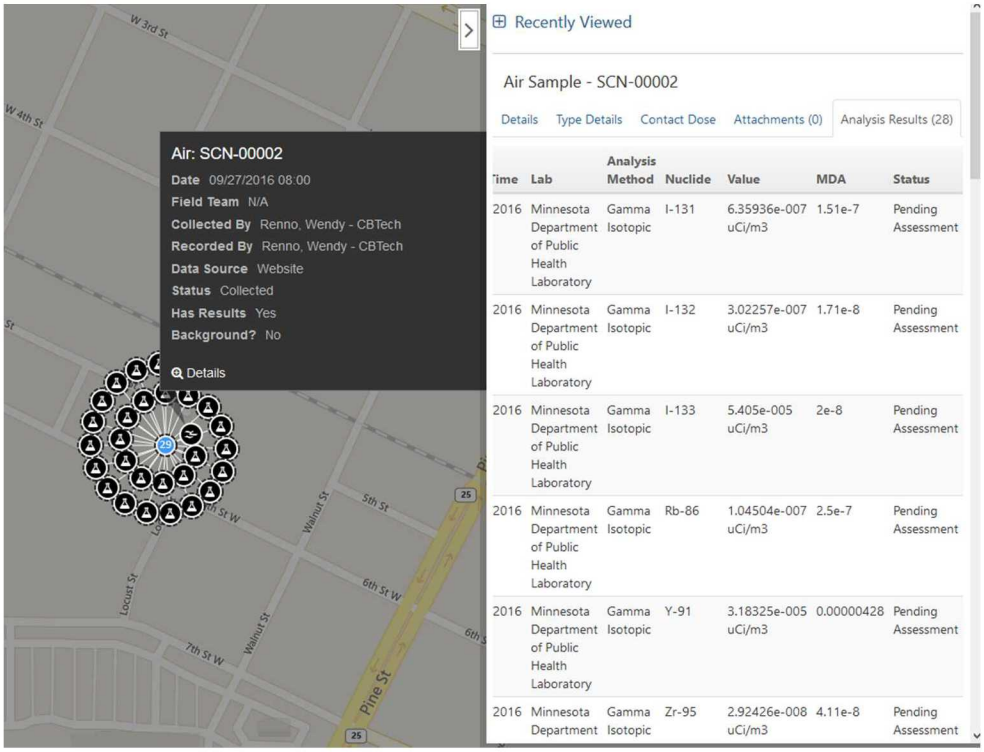

Figure 2: Current RR sample result mapping tool

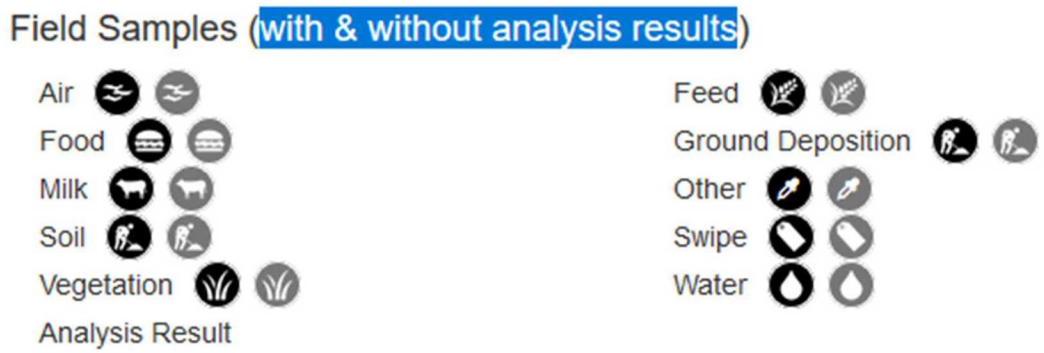

Figure 3: Current use of shading to indicate status (best practice)

Miscellaneous usability notes:

- Drawing view control “go to drawing” should zoom so that drawing fills 90% of the screen but all vertices are on screen.

- User should be presented with option to view and download (via full-data flattened file) all data enclosed in a shape including measurements, samples, and sample results. A single excel file with separate tabs for each data type would be convenient.
- In an active drawing, the expanded details should show all the data types within that shape with drill-down available.

Data Export Format

In general, the Rad Responder data export format must mimic the advanced data export format in RAMS as described in Appendix III: RAMS Advanced Data Export Format. The map can be a visual way to filter down data for the master export.

- Measurement type, Result, uncertainty, and unit should be separate data elements on exported surveys from the mapping tool. Include other data elements like instrument, probe, owner, etc. in flattened data file. Users will want as much information as possible and will be able to filter out what they don't want very easily in excel. As a rule of thumb: Export all the data in separate columns/fields.

	A	B	C	D	E	F	G	H	I	J	K
1	Name	Type	Latitude	Longitude	Location	Timestamp	Team	Personnel	Data	Url	
2	Survey - Gamma - 11 uRem/hr	Survey	44.440867	-73.156886	POINT(-73.156886 44.440867)	7/11/2019 18:26		Mann, Littia	ID:	https://www.rad	
3	Survey - Gamma - 8 uRem/hr	Survey	44.464282	-72.686248	POINT(-72.686248 44.464282)	7/8/2019 17:31		Mann, Littia	ID:	https://www.rad	
4	Survey - Gamma - 10 uRem/hr	Survey	44.221553	-72.790155	POINT(-72.790155 44.221553)	6/17/2019 11:11		Mann, Littia	ID:	https://www.rad	
5	Survey - Gamma - 9 uRem/hr	Survey	44.203788	-72.506656	POINT(-72.506656 44.203788)	6/3/2019 15:34		Mann, Littia	ID:	https://www.rad	
6	Survey - Gamma - 10 uRem/hr	Survey	44.498052	-73.184133	POINT(-73.184133 44.498052)	5/30/2019 17:27		Mann, Littia	ID:	https://www.rad	
7	Survey - Gamma - 9 uR/hr	Survey	44.461101	-73.159235	POINT(-73.159235 44.461101)	5/6/2019 21:32		Oneill, Francis	ID:	https://www.rad	
8	Survey - Gamma - 11 uR/hr	Survey	44.479499	-73.213968	POINT(-73.213968 44.479499)	5/3/2019 18:01		Oneill, Francis	ID:	https://www.rad	
9	Survey - Beta-Gamma - 20 uR/hr	Survey	44.479556	-73.213851	POINT(-73.213851 44.479556)	4/17/2019 15:26		Oneill, Francis	ID:	https://www.rad	
10	Survey - Gamma - 4 uR/hr	Survey	44.479774	-73.21431	POINT(-73.214310 44.479774)	4/16/2019 19:20		Irwin, William	ID:	https://www.rad	
11	Survey - Gamma - 15 uR/hr	Survey	44.479774	-73.21431	POINT(-73.214310 44.479774)	4/16/2019 19:18		Irwin, William	ID:	https://www.rad	

Figure 4: Current data export from mapping tool. Need to break out data elements and include as many fields as possible without combining them (see Name field above)

Sample Tracking Workflow

Accurate and efficient sample tracking is essential to the operations of Lab Analysis as they need to be able to identify the location and status of any sample at any time and they need to be able to provide metrics to stakeholders in situation reports. A workflow is defined that allows for the tracking of all samples through the process from collection through disposal. This section will describe how RR needs to support this workflow.

Sample Workflow Statuses

- **Collected** – Autogenerate when a sample is first created in the system via web interface or tablet application. Indicate that the sample has not yet been delivered to the hotline.
- **Received** – Trigger by a sample control specialist at the hotline when samples arrive and are checked for consistency and packaging/collection practice compliance. **Note:** Create a utility that makes this manual status update as easy as possible when several samples show

up at the hotline at once. Consider the use of barcode scanners to set the status of samples in bulk.

- **Hold** – Indicate that something is wrong with the sample and that it is being put aside. Auto populate when an NCF is initiated and tagged to the sample. When the NCF is resolved, have the system ask the user what next status the sample should get (choices should be: Received or Not Usable).
- **Not Usable** –Trigger through the resolution of an NCF. Indicate that a sample will not be carried through the process. Store these not usable samples in a special location so they can be addressed later.
- **Sent to Lab** – Auto populate when a sample is attached to an ARF that has had the "Ship" button pressed. Indicate that a sample has left the custody of FRMAC and is now either on its way to the lab or at the lab.
- **Returned** – Trigger by a sample control specialist when samples are returned from the laboratory. Typically done on an ARF-by-ARF basis. **Note:** Create a utility that will allow you to update the status for an ARF of samples
- **Disposed** – Indicate that a sample has been disposed of; this is a manual promotion from any of the statuses above. **Note:** Create a utility to update this status in bulk using a barcode scanner or manual entry of SCN or ARF number.

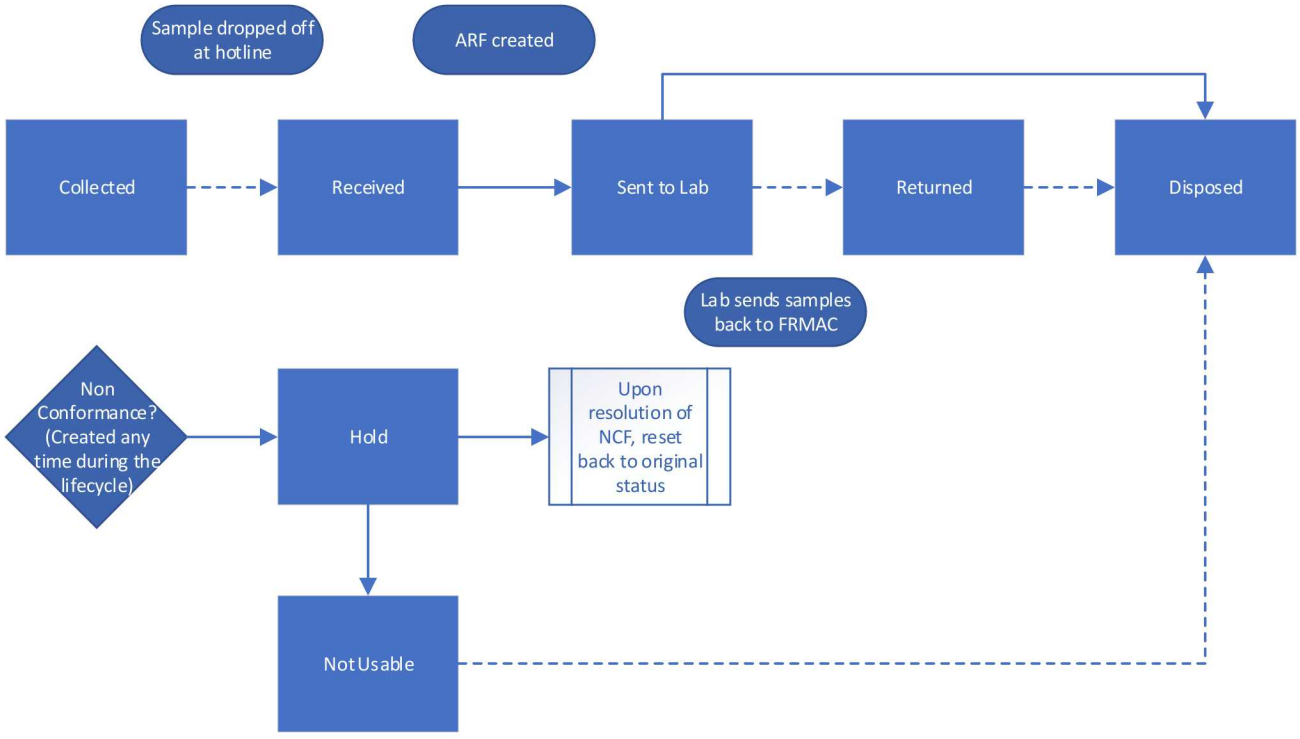

Figure 5. Sample status lifecycle

Use Cases:

- Sample collector – Needs to collect a sample, label it with a pre-printed or printed on demand label, record when and where it came from, add pictures and other ancillary info and drop off the sample with sample control for processing. This includes chain of custody transfer.
- Sample Control – Needs to accept custody of samples electronically (chain of custody) from collectors at a sample dropoff location (hotline). Needs to record sample mass/size that cannot be recorded in the field. Needs to record sample contact dose rate at the hotline (not the field dose rate). Needs to identify where the sample can be stored and move them to storage.
- Deputy LA manager/Sample Control – Identify and locate samples in storage that need to be grouped on an analysis request form.
- Deputy LA manager/Sample Control – Identify and locate samples that have been flagged as having some issues (non-conformance)
- Deputy LA manager/Sample Control – Needs to update the status of an individual sample or a bulk list of samples
- Shipping Specialist – identify samples in transit and be able to find associated courier tracking numbers as applicable.
- Deputy LA manager/Sample Control – Provide metrics on how many samples are being collected but not yet dropped off, number of samples in storage, number of samples on ARFs but not shipped yet, number of samples in transit, number of samples at the labs, number of samples returned from the lab, number of samples disposed, number of samples with completed analysis, number of samples with completed and assessed results, number of samples with issues requiring resolution, and number of unusable samples.

Track sample physical location

Laboratory Analysis personnel need a way to track sample locations in addition to a sample's physical location. The physical locations should be:

- **Transit - Hotline** – Auto trigger when a sample is created.
- **Storage** – Auto trigger when a sample is promoted from Collected to Received.
- **Transit – Laboratory –** Auto trigger when a sample is on an ARF and that ARF has been marked "Shipped"

Note: Ensure that the courier tracking number field on the ARF is viewable on the sample table.

- **"Laboratory Name"** – Auto populate with the name of the laboratory the ARF is associated with and that the sample is attached to. For samples attached to multiple ARFs, have this reflect the laboratory with the latest shipment date.
- **Transit – Return -** triggered manually when the user pulls up an ARF and marks samples for return from lab.
- **Disposed** – Auto trigger when a sample status is set to "Disposed."

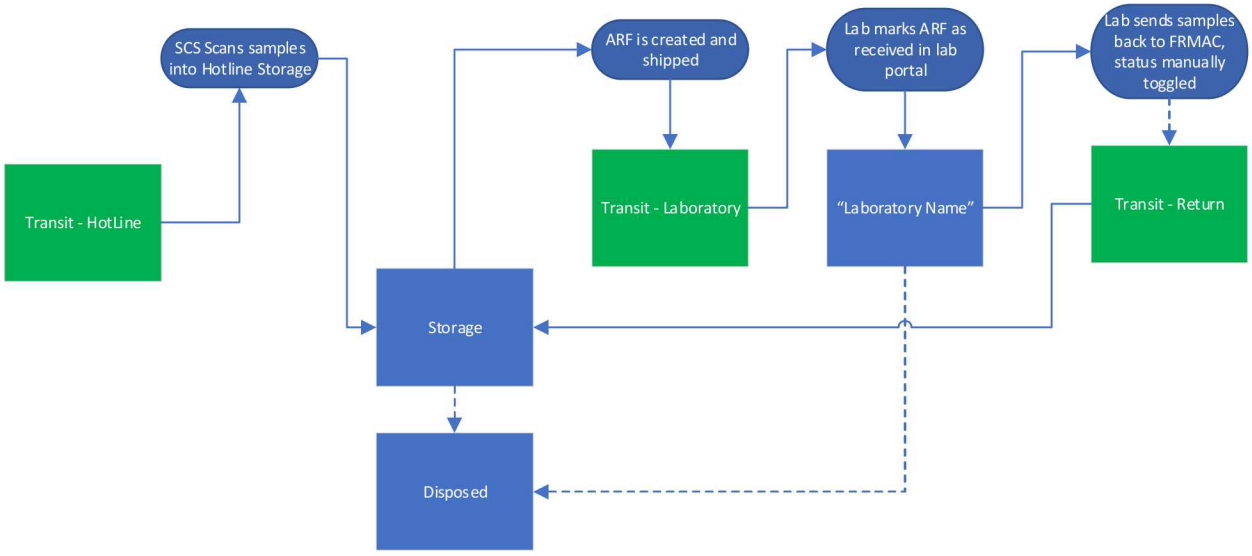

Figure 6. Sample location Lifecycle

Override of sample physical location

The Lab Analysis user need to be able to update the physical location *en mass* in the following views:

- Sample Details view
- Sample List view
- ARF Details view

Use Cases:

- Sample Control - A group of samples were returned from the lab and the user needs to indicate that they were disposed
- Laboratory- A group of samples were disposed of by the lab and the lab needs to communicate that they have disposed of the samples.
- Sample Control - A shift change occurs, and incident command need to know where a set of high priority sample are located.

Update SCF to for status and location history

In a sample detail view, there needs to be a section detailing the status and location history for the sample sorted by date and time. Include who initiated the action that caused the status change. When data is exported, only the **current** status, date/time, and name will be exported.

Use cases:

- Sample Control – A sample is under scrutiny, and the user needs to determine the status history of the sample to support explanation of anomalous result.

- Assessment/Sample control – A result is determined to be and outlier and assessment wants to determine if there were any issues with the sample that may have led to the anomalous result.

Analysis Request Form Workflow

ARF status tracking is needed in RadResponder to allow users to provide situational awareness to stakeholders and to keep track of large response operations.

- **Created –** Auto trigger when ARF is first saved.
- **Sent to Lab** – Trigger when the "Ship" button is pressed on the ARF but no results have been uploaded for any of the requested analytes yet.
- **Received by Lab** - triggered through the portal when the Lab received data, or by lab analysis when the lab notifies sample control of receipt of the samples.
- **Awaiting Reply** – triggered through the Lab portal when there is an unresolved question.
- **Hold** – Triggered by NCF creation on the ARF, or any of the samples on the ARF, or any the results on any of the samples on the ARF.
- **Unreviewed Results** – First trigger when results are uploaded to the system that have not yet been marked as reviewed (when data is available to review). When all results that have been uploaded are reviewed, have the status toggle to Complete. When new results are entered, have the status switch back to Unreviewed Results.
- **Results Reviewed** – First trigger when all uploaded results are marked as reviewed. Have the status cycle back to Unreviewed Results when new results show up in the system that are not yet reviewed. Have the final state be Complete when all results are reported and reviewed.
- **Not Useable –** All the sample are marked as not useable from an NCF.

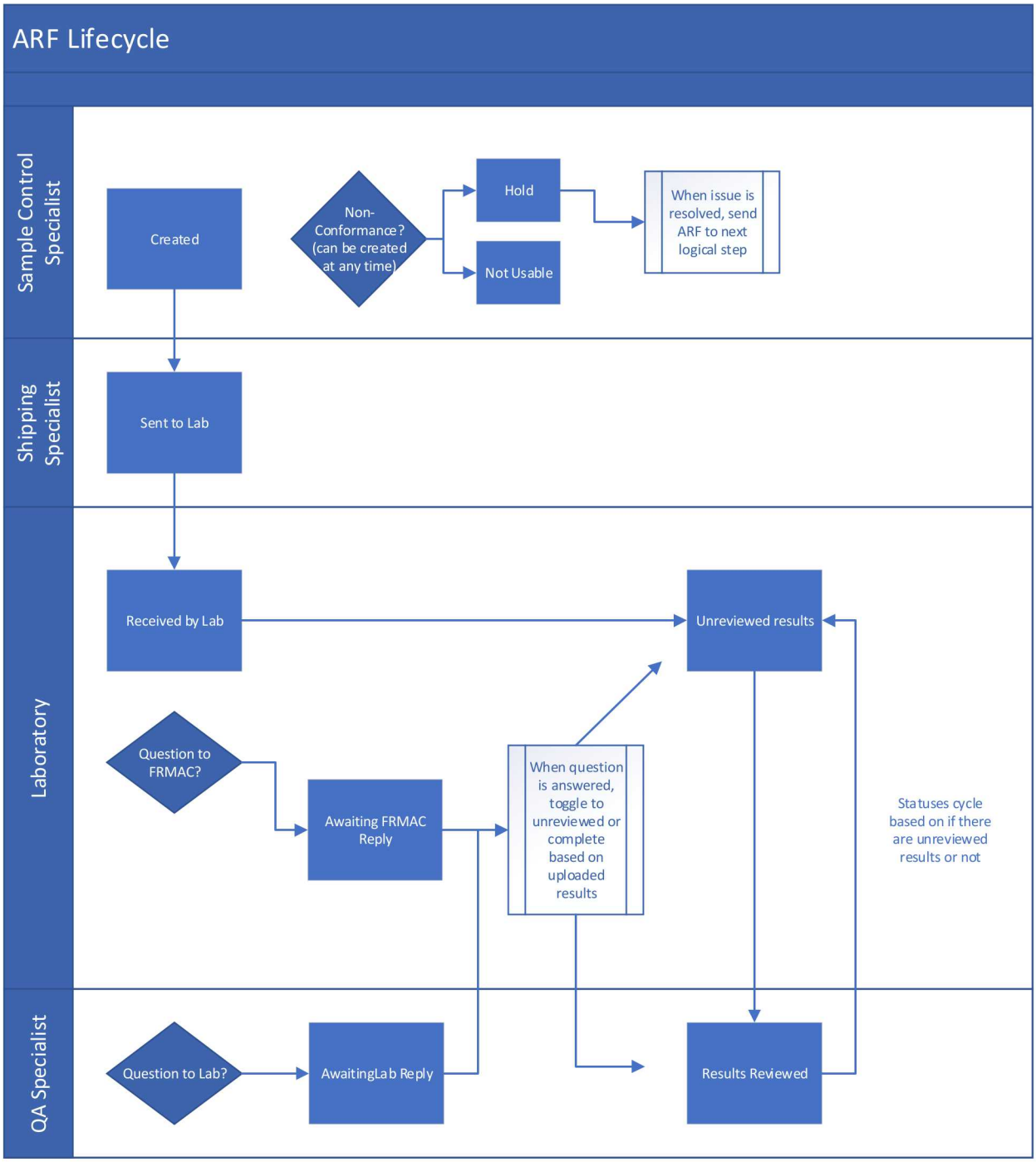

Figure 7. Analysis request form status lifecycle

Note: Status cycles between unreviewed results and complete as results are uploaded for an ARF.

Use cases:

- Deputy Lab Manager – A shift change is occurring and the deputy lab manager needs a quick status of where the ARFs are at so that she can assign QA specialists to data review and shipping specialists to preparing shipments.
- CMHT Lab Manager – Stakeholders want a snapshot of where all analysis is at for the entire event, CMHT Lab Manager is tasked with tallying up the number of ARFs at each laboratory and what the analysis status is.
- QA Specialist – Tasked with monitoring the lab access portal for unanswered questions and needs a way to see what ARFs are pending a response.

Updates to Analysis Request Form report

Several updates are needed on the Analysis Request Form report format to support the new information available as a result of these upgrades. A mockup of the report can be found in the appendix III: **ANALYSIS REQUEST FORM MOCKUP.**

Non-conformance form

The Non-Conformance Form (NCF) needs to track problems with samples, Analysis Request Forms (ARFs), analytical results, measurements, spectra, etc.

The NCF must:

- be tracked uniquely in the system
- be categorized as an issue with a sample, an issue with an ARF, or an issue with sample analyte result
- May also be initiated and not tied to a sample, ARF, or result set; this would just be a generic NCF that would be used for documentation purposes (see use cases).
- be tagged to all the data elements (samples, ARFs, and results) and be accessible in the view when looking at those elements
- track who initiated the NCF, what the issue was, who corrected the issue, what was done to correct the issue, and what the date and time was when the NCF was initiated
- have a view or dashboard that can be used to monitor NCFs and to open, edit, and resolve them
- initiate, resolve, or have more than one NCF associated per sample or per ARF

Use Cases:

- Sample Control Specialist – finds an issue wrong with a sample at the hotline, cannot resolve it immediately but needs to move on to the next samples; needs to ask for assistance from management
- Sample Control Specialist – Samples arrive at the hotline from the public with no information or sample IDs. FRMAC accepts the samples but does not wish to enter them in the system yet pending guidance from leadership. An NCF must be initiated to describe the issue so it does not

get lost in the chaos. This NCF would not tie in with any sample, ARF, or result in the system and is simply an informational, generic NCF.

- Shipping Specialist – marks an ARF as complete, prints it, puts it in the box with the samples and ships it off to the lab; latter he realizes that the ARF was not tied to the correct mixture; Makes changes to the ARF in RR but the lab will have a hardcopy (which is now the COC) that is not correct. Needs to correct this issue and send the lab a new ARF to use for instructions.
- QA Specialist – finds an issue in reviewing an ARF's data package; needs to flag the data as suspect and come back to it later when she has more time;
- LA manager – gets asked about a data set that has been "rejected". Data users need to know more details why since these were high priority samples.

Lifecycle

The non-conformance form (NCF) must be given a status so they can be tracked in the system. The status field will also be used as a filter on the NCF view. The statuses should be:

- **NCF Created** – User starts an NCF and is not ready to mark complete because of missing information
- **NCF Awaiting Review** – The NCF is ready to be investigated so steps can be taken to resolve the issue.
- **NCF Resolved** – Appropriate steps have been taken and documented on the NCF to resolve the issues or mark the sample or ARF

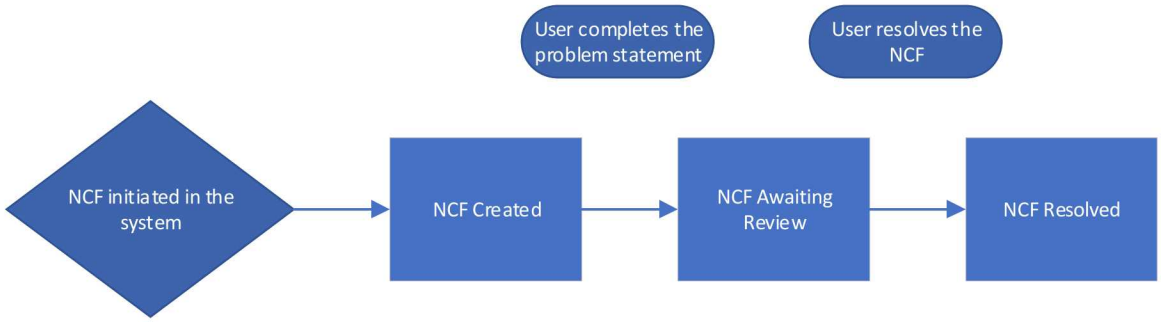

Figure 8: Non-conformance form lifecycle

Association

The NCF should have a common format but be flexible enough to be associated with:

- Samples – Common issues: not enough sample, sample package broken or leaking, not properly labeled, information incorrect
- Analysis Request Forms
    - The analysis request itself – Common issues: ARF was given to the lab with the wrong information/samples
    - Sample Results – Common Issues: Results do not meet analysis requirements such as count time or detection limit, Results incomplete,

- A feature to tag the NCF under the ARF to specific sample and analytes instead of just writing it in the text

Note: this is not to be used as the data verification form. Just a way to communicate serious problems that may have resolutions. QA problems that need to be noted on data but not necessarily fixed are noted on the data verification form (DVF).

- Analyte Results

Tracking

NCFs will be monitored by sample control management in a table view that shows all the open NCFs and some of the information contained within. The user should be able to drill down into the NCF, enter the resolution, mark it as resolved and print the pdf report if needed. The heart of this dashboard is the NCF status. The created NCFs should show up at the top, then the complete NCFs and then the resolved NCFs.

Updating

When an NCF is initiated for a Sample, an ARF, or its results, the status of these elements should be auto-triggered to "hold" indicating that some user action is required to resolve the non-conformance issue. When the user resolves an NCF, this will include a decision to update the status to the original status prior to the creation of the NCF or deem the item "Not-Usable" in the case of a sample/ARF or "Rejected" in the case of a result.

Report Design

A PDF report should be created that displays the identifying information, the issue description, and the resolution information along with the creator, date/time created, the resolver and the date/time resolved so that users can download and use the reports in the data review process. The form should be printable whenever the NCF record view is called up and look like the mocked-up version found in Appendix II: Rad Responder Non-Conformance form report.

Sample result review workflow/FRMAC data assessor role

Sample results are typically reviewed by two parties. Lab Analysis reviews the results for their validity and data quality from the laboratory performance perspective. Checks are made against the analytical request and internal laboratory QC measures are evaluated. Once approved, an Assessment Scientist (FRMAC Data Assessor) will review the data in the context of the entire response and compare the results against other measurements made in the same general area and time for consistency and feasibility. This is best done using a map or GIS tool and is currently done outside RR. However, the flagging of the data must go back into Rad Responder so that product scientists, the individuals making maps and data products know that the data has been reviewed and assessed. This second tier of review can also be the review that determines if the data can be shared outside the FRMAC per orders from the FRMAC director.

The current implementation of this in RR is simply the “Assessed” field which we interpret as the first check made by lab analysis. We propose renaming this status to match what is currently in RAMS as “QA Review”. The next tier of review, often referred to as the validation step, is done by an assessment scientist and should be called FRMAC Assessment. At a minimum, FRMAC needs these two tiers.

To make this system more flexible and adaptable to users’ needs, we recommend that a flexible user-configurable tiered review construct be developed in a second phase. This way, users can create as many tiers and name them as they wish for their data. Finally, one of the tiers can be flagged that when marked accepted, will trigger the system to allow the data to be viewable by those partner organizations with the “View data” privilege. This will allow the organization to develop their own custom data sharing plan and implement it in RR. This will make the system more usable state-to-state as data sharing requirements change.

Items that need to be developed to support phase 1 (two tiered FRMAC review):

- Need to duplicate the data review module that currently exists in RAMS under the ARF view. This has proven to be very useful and user-friendly in recent drills and exercises. See **ARF-BASED DATA REVIEW UTILITY**
- Need a data verification form that the QA specialist can fill out for an ARF to describe any issues identified during the review. This can look identical to the one used in RAMS. The form should be accessible on the ARF (and spectra) See Appendix III: **ARF-BASED DATA REVIEW** Utility

The result review utility that exists currently in RAMS under the ARF is well liked by the community so far. It should be replicated in RR and extend to quantitative spectra as well.

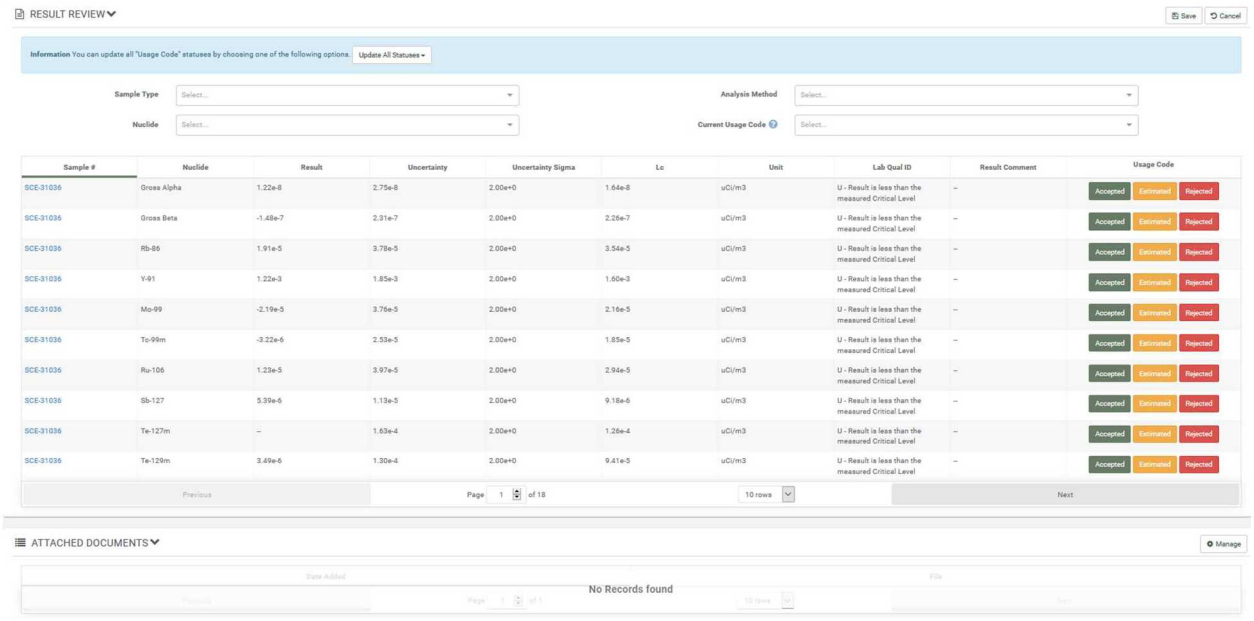

Figure 16: Screenshot of existing RAMS data review utility to be duplicated in RR under the ARF view

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- Need way to use mapping utility and table to bulk assess sample results. Assessing samples point-by-point will not be used (see Figure 10). The assessor will want to bulk assess by ARF or by sampling location via mapping tool. When approving by ARF, these assessment tools should be accessible through the ARF screen and apply to all samples/results attached to the ARF. See **ARF-BASED DATA REVIEW UTILITY**
- The Data Sharing Review status will most likely be applied ARF-by-ARF or using a set of filters system wide to bulk approve data.
- At each step, the user will be prompted for an optional comment when marking as anything but Approved.
- When data is exported the most recent review status is printed to the results including the user and date/time stamp.

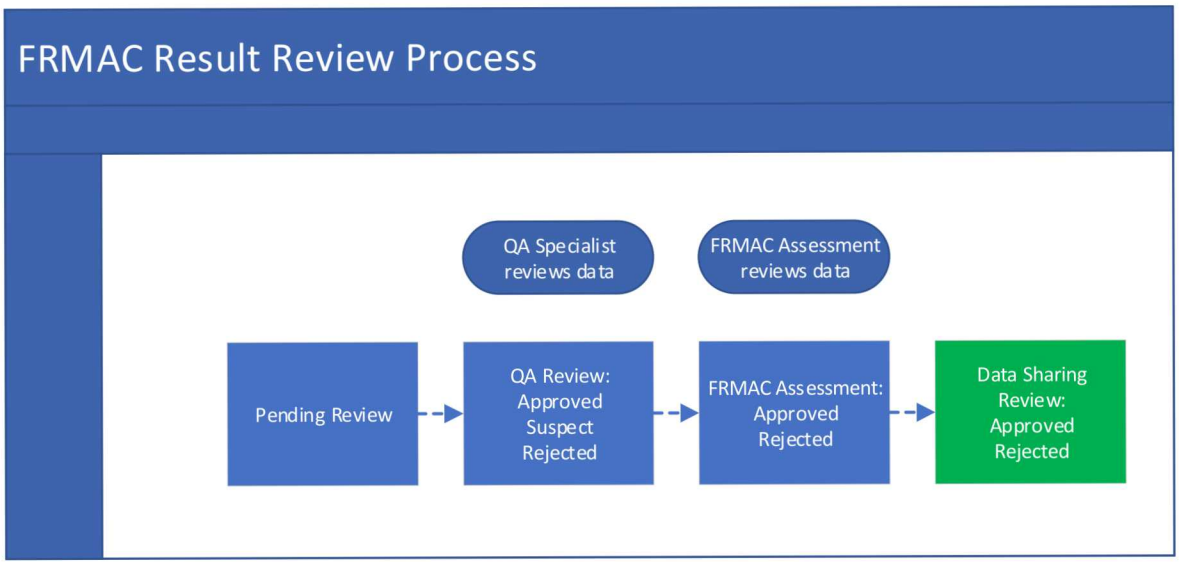


Figure 9: FRMAC Result Review Process. In this flow, the Result Sharing Review is the status that toggles data that can be viewable by partner orgs.

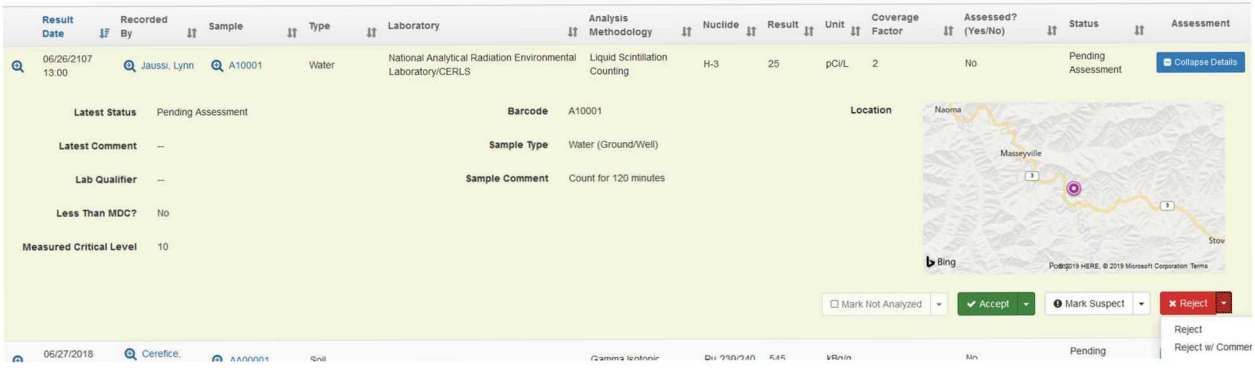


Figure 10: Current state of data assessment in Rad Responder

A second phase of this development will be to make the workflow described above editable for an organization, allowing them to add or remove any of the steps and flag which one will make data viewable by partner organizations.

Use Cases:

- FRMAC QA Reviewer (Lab Analysis) – Receives a batch of data from a lab for an ARF. Wishes to look up the ARF in the lab access portal and retrieve the files, review them, look for mistakes and errors, and document findings. Wishes to take the EDD file and import it to Rad Responder and mark it as reviewed (accepted, rejected, suspect) so the FRMAC Assessor can review it or ignore it and mark it invalid.
- FRMAC Assessor: Wishes to locate samples and measurements taken in a region of space and time and compare them for consistency, feasibility, and general product usability. Wishes to easily export this data, use their tools to analyze it, and communicate validity back to Rad Responder for future use.

Mixtures

Bulk import capability

When a mixture changes, the users must be able to upload AAL's for the new mixture. The AAL's are generated using Turbo FRMAC. The system should allow for the bulk import of an AAL set from a .CSV or excel format. Upon upload, the user should still be able to make minor edits in RadResponder prior to activating the mixture.

The mixture import format should have the following format. Be sure to include ALL possible sample types that might have a different AAL.

Table 1: AAL table for the mixture; the anchor analyte for gamma spec is Am-241, the anchor for LSC is Sr-90, there is no anchor for Gas Proportional Counting so the user will need to enter a count time in the analysis requirements table

Nuclide	*Air*	*Ground Deposition*	*Drinking Water*	*Swipe*	*Etc…*	*Analysis Method*	*Anchor Analyte*
Reporting Units	***uCi/m3***	***uCi/m2***	***pCi/L***	***Dpm/100cm2***			
Cs-137	1.2e-4	1.7e-4	Etc.	Etc.	Etc.	Gamma Spectroscopy	False
Am-241	1.2e-5	1.7e-5	Etc.	Etc.	Etc.	Gamma Spectroscopy	True
Sr-90	2.4e-3	2.4e-3	Etc.	Etc.	Etc.	Liquid Scintillation Counting	True
Gross Alpha	Etc.	Etc.	Etc.	Etc.	Etc.	Gas Proportional Counter	False
Gross Beta	Etc.	Etc.	Etc.	Etc.	Etc.	Gas Proportional Counter	False
…							

In general, values are not required in the table. For each analysis method an "Anchor Analyte" can be defined. This tells the system what values to drop into the analysis requirements table. Only one anchor analyte is needed for each unique analysis method. If no anchor analyte is defined, the user will need to type in a count time in the sensitivity requirements table.

Table 2: Analysis Requirements table; gathers info from the AAL table and allows user to override and/or enter count times; this table builds out for all active sample types for the event.

		Sensitivity Requirements				
		Air		**Ground Deposition**		**Etc…**
Analyte	**Method**	**Measured Critical Level Less Than:**	**Count time**	**Measured Critical Level Less Than:**	**Count time**	**Etc…**
Am-241	Alpha Spectroscopy	= (LC/AAL ratio) * (AAL)	--	= (LC/AAL ratio) * (AAL)	--	**Etc…**
Am-241	Gamma Spectroscopy	--	100 min	--	100 min	**Etc…**
Gross Alpha	Gas Proportional Counting	--	10 min	--	10 min	
Sr-90	Liquid Scintillation Counting	= (LC/AAL ratio) * (AAL)	--	= (LC/AAL ratio) * (AAL)	--	

On the ARF that is attached to this mixture, the sensitivity requirement (measured Lc or count time) for each unique requested analysis will be pulled from this table and printed on the ARF in the header info.

Then, the list of requested analytes will print in a table. Updates to the ARF report are needed to support this functionality. See **ANALYSIS REQUEST FORM MOCKUP**

Use Cases:

- Lab Manager/Assessment Scientist – Analysis of data shows the initial mixture AAL/L_c's require updating. The assessment scientist runs Turbo FRMA to generate a new set of many AAL's; they need to quickly add the newly generated AAL's to a new mixture to share with the users.
- Assessment Scientist – Used several references to create an AAL set and ran Turbo FRMAC several times and wishes to store information on the assumptions and methods that were used to generate the mixture in Rad Responder.

Mixture needs to have a comment field that allows quite a lot of text and a place to upload multiple documents to store with the mixture for future reference.

Default mixture setting for states

Laboratory Analysis is in the process of generating default mixtures for different event types. These defaults can be used as an initial condition when very little or no data is available to evaluate the mixture to be able to instruct labs on the detection limits that must be meet for their analysis. Upon event creation, a default mixture can be chosen to activate and made available for edit in the mixture module and for use in the ARF module.

Use Case:

- Lab Manager/Assessment Scientist – an event has occurred but there is little to no information about the source term available. Early samples need to be analyzed but leadership does not know the nuclide ratios to base required detection limits on.

Templates

The system should allow users to upload and save their own default AALs that show up for any user in their organization. The saved mixture templates should be editable and persist in the system beyond the even they were created in.

Use Case:

- State REP official – A NPP drill is run in a state and a set of AALs are developed. The state wishes to save this information for future use.

Miscellaneous Items

ARF Bulk import capability

This is a standard import file format that will create ARFs and sample records, attach samples to ARFs, and associate mixtures with them for the purposes of quickly importing simulation data to Rad Responder. May be a multi-tiered import format (several tabs on a sheet). Needs to update with data structure as it changes with further upgrades. May take the form of an API but a flat data import will make this more useable by more people. Start with the exercise data upload template used in RAMS and adopt it to Rad Responder.

Use Cases:

- Laboratory – A drill is in the planning stages and the controllers want to simulate many samples and attach them to ARF's so the laboratories can begin analyzing samples at start-of-exercise.
- Shipping specialist - preparing shipments of samples at start of exercise.

API for sample info and sample results

An API is required for the import and export of event data and sample result to other advanced CM applications (TurboFRMAC, AVID framework, NARAC, etc.). The manual transfer of data from RadResponder to these applications will consume valuable resources that are better spent on generating data products.

The API must allow for the export of **ALL** data fields of **ALL** types for samples and their results. Must include uploaded documents as well. A very well documented user manual and data dictionary is mandatory.

Use Cases:

- Analysis Laboratory – Has API import/export capabilities in the laboratory information management system and wishes to connect it to Rad Responder to expedite the upload of sample result data
- Dose Assessment scientist – has a health physics tool that performs advanced data analysis and wishes to tie it to Rad Responder for automated data transfer
- GIS Scientist – Wishes to connect an advanced GIS tool to use Rad Responder as a data source
- IAEA Leadership – Wishes to import Rad Responder data into their international nuclear incident response database
- FRMAC Gamma Spectroscopist – wishes to import results for several dozen in-situ spectra she analyzed but does not want to type in the numbers by hand
- FRMAC CMRT field teams – wish to use tablet software to push data to Rad Responder for sample collection

- FRMAC CMRT/AMS/Instrument Vendors – new spectral data platforms are developed and developers wish to seamlessly push data to Rad Responder in real-time

Portal for Lab personnel

Laboratories contracted with a FRMAC will need to be able to communicate with Lab Analysis personnel with a standardized and robust tool. All the sample results will come from the laboratories; thus, a large amount of data moves between the laboratories and Lab Analysis. All the analyses require extensive instructions and back-and-forth communication to clarify needs and limitations.

Responders are typically federal contractors and employees that may not have access to work email (email must be accessed through VPN connection which will not be available on deployment computers) and use of personal email to move data is prohibited. There may be no way to transfer files and other information to the laboratories. The simplest solution is to use RadResponder as an intermediary between FRMAC and the Laboratories. The laboratory personnel require a portal that allows them to view and interact with the ARFs they have received, but not view sensitive information such as sampling locations, event data (AAL's), and other laboratories' results. The Labs should be able to:

- mark an ARF as received (this propagates to the samples on the ARF),
- view the ARF and PDF report,
- upload EDD and any analysis report files of any type (e.g. .pdf, .docx, .xlsx, .txt, .csv, .jpeg/gif/tiff/png, .xml, .spec, .cnf, .tar, .zip, .7z, etc.)
- receive notification of changes to a received or shipped ARF,
- receive request for further information from FRMAC, and
- receive notification that the ARF is accepted and compete.

FRMAC Lab Analysis QA specialist is responsible for reviewing the laboratory results received, ensuring the full completion of analysis instructions, reviewing the results for their validity and data quality from the laboratory performance perspective, ensuring the analytical result report values match the EDD. The specialist reviews results ARF-by-ARF and documents on a data verification form (see Sample result review workflow/FRMAC data assessor role). The QA specialist will make administrative changes to the EDD as necessary, upload it with the result files to database, and mark it as reviewed.

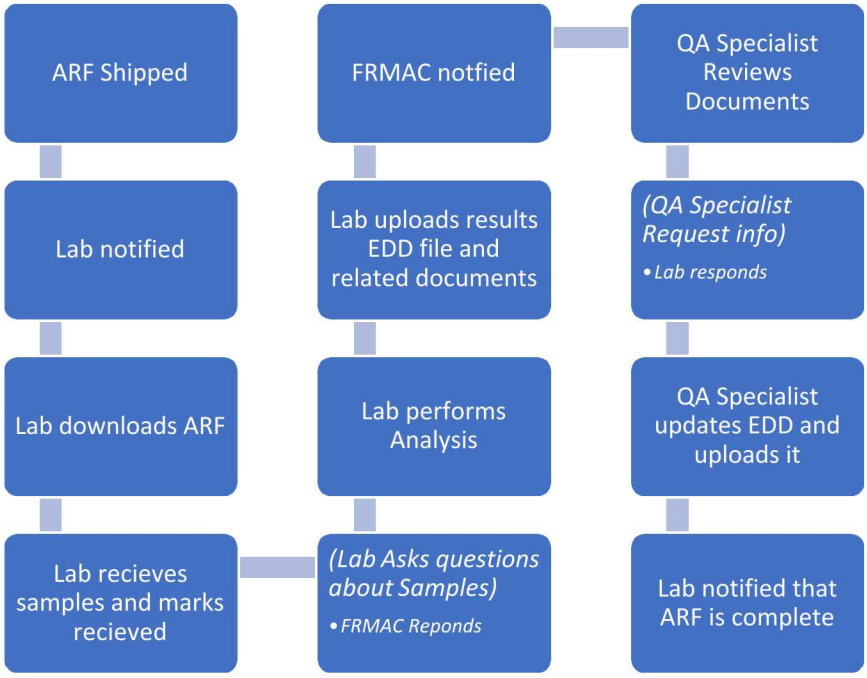


Figure 11: Laboratory Data Reporting Process Workflow

Use Cases:

- Laboratory – asked to provide analysis of an ARF of samples. Creates reports and electronic data deliverable (EDD) files; wants to send results back to customer but does not have a valid email address; wishes to upload the files to a website so that any one of the people in the customer's group can look at them.
- Laboratory – has many large PDFs of analysis reports that are too large to attach to an email
- Sample Control – Needs to download files from lab, review them, and then upload the electronic results to RR but does not have access to email through the borrowed computer they are using.
- Sample Control – Needs to reject an EDD and ask the lab to make edits to their results prior to import into RR
- Sample Control – Needs to verify that packages were received by the 10 laboratories supporting the response but does not have time to call each one or put in the tracking code for each one.
- Laboratory – Receives a package of samples but notices some samples are missing, needs to contact the sample control personnel to raise the issue prior to proceeding.
- QA Specialist: Reviews a labs EDD file and finds some simple syntax errors that do not affect the data. QA specialist makes edits and imports the edited files. QA specialist now needs to store this edited file alongside the original files submitted by the lab with comments.
- Sample control – Sends a completed ARF to a lab via FedEx but wants to get the electronic copies of the files to the lab while they are in transit so the lab can prepare for the requested analysis

- Sample control – sends 10 ARFs to 5 different labs but does not want any of the labs to see what the other labs are receiving for security purposes nor does he want the labs to be able to determine the location of the samples for data integrity and legal defensibility reasons
- Sample control – an analysis is added to a set of samples already in the mail and wishes to update the ARF in RR and send the amended ARF electronically to the lab
- Sample control - **fancy idea** - Wants to capture the barcode using a mobile app on a shipment that contains the tracking number and wants the lab to do the same to show chain of custody was maintained.

Reworking of the Spectra Data Type

Spectra are special types of measurements performed by spectrometers. Spectrometers measure photon radiation over a wide range of energies in what is called a multi-channel analyzer. Several thousand "bins" of data are collected to generate a histogram. Bins that contain more counts than neighboring bins create peaks that correlate to photon energy. The photon energy then correlates to a specific radionuclide. Spectra typically are used to identify the presence of and sometimes quantify the amount of isotopes in the field. Interpreting spectra, especially when there are many radionuclides, is a complicated and highly technical feat usually performed by an expert with specialized software. The equipment varies but spectra will always be used to perform qualitative (nuclide ID and confidence) and/or quantitative (full results like what is collected on a sample result). Some instruments (namely routine monitoring stations) will be configured to generate a set of results directly from the instrument while other, more sensitive and higher resolution instruments (such as the In-Situ detectives) will drop raw spectra and associated metadata into the system for which the FRMAC gamma spectroscopist will download, interpret, and generate results. This latter case will be the most commonly used in an emergency and will be the basis for which the system will need to be designed. The structure for spectra as it exists in RR is nearly adequate but will need some upgrades to align with the current FRMAC conduct of operations.

Spectra workflow

In general, a field team will collect a spectrum in the field using the spectrometer and create a record in RadResponder noting the location, time, and other metadata. The instrument should be a required field since it stores critical information to the analysis of the spectrum. The spectral file and any qualitative (nuclide and confidence) information will be uploaded. For some spectrometers, most notably the In-Situ gamma spectrometers used by the FRMAC, a background spectrum is taken in a nearby "clean" area so that it can be used in the analysis of the contaminated area spectrum. This spectrum needs all the same metadata as the contaminated area spectrum. The contaminated area spectrum must have a utility to tag it to its relevant background. A background will typically apply to several measurements, but a contaminated area spectrum will tie to a single background.

For cases where equipment needs energy adjustment, the field team may need to take a spectrum of a known source and save that to the DB for the analyst to use. The analyst then uses this to adjust the spectrum so that photon energies are aligned properly. This can be called a "calibration spectrum" and

should have the same properties of the background spectrum. The collector will need somewhere to note what source nuclide(s) were used for the calibration measurement.

Once the contaminated area spectra and the background spectra are uploaded, an analyst will go into the system and either use the qualitative data or download the spectrum and any important metadata and background spectra and perform a quantitative analysis. The data provided will match that of a field sample result at that point and the user would toggle the spectral Data Type to "quantitative" and then upload the results. Also, the analyst will have other attachments to upload to the file for backup information. The analyst may choose to do several spectra in bulk so a bulk download/upload capability would be useful. Results will need to be able to be bulk uploaded in the EDD format.

Next, a QA specialist will review the analysis and perform the QA review of the data exactly like a sample result. This will typically be done spectrum-by-spectrum. Add a section to the spectrum to contain the results and QA review step much like what is added to the ARF. Finally, the FRMAC assessor may choose to review the data and assess it against other available data and mark the FRMAC assessment field just like a sample result.

Information to add to the Spectra data type

- Unique identifier – system generated and checked for uniqueness against the event DB
    - Offline use in the mobile app will have a placeholder for this until the sync happens.
- Spectral Austerity – qualitative (default), quantitative (manually switched in system by analyst)
- Tagged Background spectrum – not required but necessary for many types of spectra. Allow tagging to multiple backgrounds but usually only one will be tagged.
- Tagged Calibration spectrum – not required but possibly necessary for detectors that have not been calibrated (many of them). Allow tagging to multiple calibrations but usually only one will be tagged.
- Non-Conformance Form – need the ability to tag a Non-conformance Form to a spectra just like samples and ARFs
- Data Verification Form – Button at top of screen just like on ARF. Optional use for QA reviewer.
- Status:
    - **Collected** – Original status upon record creation
    - **Pending Analysis** – manually transitioned by analyst when spectrum is downloaded for processing
    - **Analyzed** – Auto transitioned when analyst uploads results

    Note: For qualitative spectra, analyst will need to manually transition from collected to Analyzed since no detailed sample results will be placed in the system. This will tell the other analysts that someone has looked at these qualitative data on the spectrum.
    - **Hold, Not Usable** – Auto transitioned through NCF process

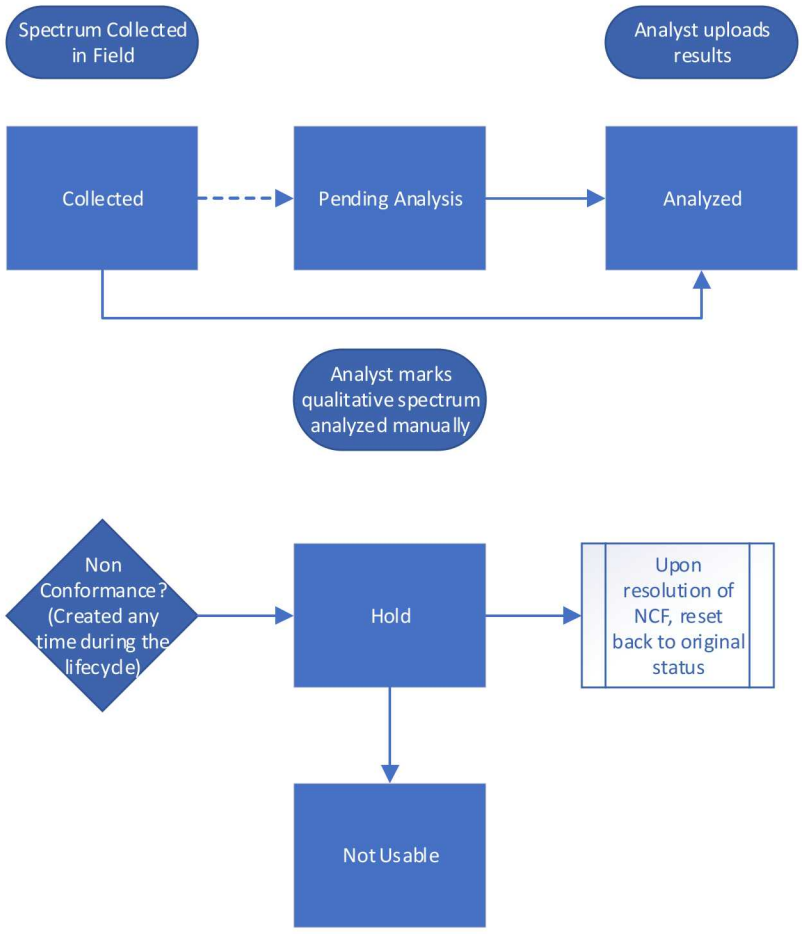


Figure 12: Spectral Status Workflow

- Result review – for quantitative spectra, match review process defined for sample results

SpecFIDLER instrument measurements

The SpecFIDLER is an instrument that reads up two channels of survey data and has a spectrum that can be uploaded to the system. The SpecFIDLER is calibrated to detect Pu and Am isotopes by their x-ray and gamma rays. The output is read out as uCi/m2 per window. Currently SpecFIDLER will need to be entered as surveys with a survey type of "SpecFIDLER". On the Spec FIDLER instruments, the probes will be named after the isotopes the windows are calibrated for. For example, the 17 keV window will be named Pu-238 and the 60 keV window will be named Am-241. The survey measurements will be uploaded to the system as a normal survey would and the field team could also choose to upload the spectrum as an attachment if needed. If further analysis of the spectrum is needed, the gamma spectroscopist could download the spectrum file attachment and create a spectrum in the system for the analysis. This is a rare scenario so building a custom data type for these is unnecessary at this time. Please note that the RAP and DOE Triage communities are still working on standard operating procedures for how to use these instruments and some changes may be needed in the future beyond what is described here.

Lab Portal EDD upload

The Lab portal EDD upload is a requirement for the web access. At a minimum, the lab needs to upload and EDD file, but not necessarily read and imported to the database with data validation like the one the sample result import does. The Lab Analysis QA specialist will review the EDD against the reports sent by the lab and will make administrative changes as necessary, then upload the corrected EDD.

File upload for ARF

User logs into their portal, selects the ARF they wish to submit data to, and uploads files. Simple file upload tool with optional sample tagging tool. This must be implemented as part of the lab access portal or it will not be useful to the responding agency. File types allowed should be at a minimum: .PDF, .DOCX, .XLSX, .TXT, .JPG but should allow any file type if possible. Use maximum file size limit feasible since these types of files are typically large and hard to chop into pieces by the lab.

Use Case:

- Laboratory – wishes to upload analytical reports alongside their electronic data to provide a complete data package to the responders. This may include reports, procedures, training records, etc.

Drill data importer

This is like the ARF importer and was funded as part of the original proposal (see item 2 in the proposal)

This is a data import format that will allow users to import samples, ARFs, associate ARFs with mixtures, associate samples with ARFs, and provide result data for them in a bulk fashion.

ICLN MDE format

Import/export format based on the ICLN Minimum Data Elements set. While the ICLN has since been mothballed, several governmental agencies in the CBRN world have already configured their systems for this format. Partners included the DOD, EPA, FDA, USDA, DOE, FBI, CDC for chem, bio, rad, and nuclear responses. We highly recommend this is programmed into Rad Responder and eventually CBRN responder since it is a light lift and could have a very high impact. Instead of a full importer, a repository for data sets to be posted as files would be useful to the responder. An export of this format would be useful but not necessarily required since exported data in the new full flat format can be manipulated by hand to match the ICLN MDE with only a little work.

Special Sample Types/Operations

Field Screening of samples

Some sample types, namely air samples and smears, will be counted in the field by collection teams to provide near real-time feedback on the radiological conditions encountered in the field. This data guides decisions on how the team will need to operate in the field including stay times and respirator use. These health and safety decisions are critical, and the data is very important in making them. This measurement data is typically recorded on paper and not tracked in our data systems but can have very

significant use outside of immediate health and safety decisions. For example, this data can be used to "triage" what samples have significant activity and should be prioritized for laboratory analysis. Also, assessment may use the field data to make quick, preliminary data products for stakeholders pending further lab analysis. Thus, storing this data in a retrievable way in RR is a very good idea. The challenge with storing this data is that it cannot simply be placed in the results table as the number of fields applicable to a field measurement are much fewer and the level of review required will be much less. Also, the analytes measured in the field, namely "gross alpha" and "gross beta" are very common analytes in laboratory analysis. We would not want field measurements of these analytes to clutter the table with the lab-grade measurements of these analytes. We propose a separate, optional child table be added to **all** sample types (to promote flexibility) that includes the following columns:

Table 3: Example "Field Count Data" child table underneath a sample

Analyte	Result	Unit	Instrument	Collector
Gross Alpha	256	dpm	Lud 2929 S/N#: 123455	Fournier, S.
Gross Alpha	256	dpm	Lud 2929 S/N#: 123455	Fournier, S.

The instrument would be a clickable link so the user could drill into it. The available analytes would be Gross Alpha, Gross Beta, Gross Beta/Gamma, Gross Gamma. Available units should just be the whole list of units available for results or field surveys in Rad Responder

Note: Consulting with a few field team experts would be good to make sure all possible analytes and units are available for entry.

Finally, once this is integrated, a rolled-up filterable, exportable view for all "field count data" should be constructed so users can pull this out *en-masse*. The same sample metadata that comes with the sample results export should come out with this data as well to enable flexibility with changing conops and uses of this data.

Cascade Impactor Air samples

A special type of air sampler attachment, called a cascade or annular kinetic impactor or simply an "impactor" may be used to take a specialized air sample that pre-filters the air particulate down to a binned particle size of interest. These devices can be stand alone or even run in a stacked configuration or "cascade" setup where several air samples representing different windows of particle sizes for the same air flow. Air particulates are either collected on filter paper or a type of glue covered disc that captures the particles. Currently neither RAMS nor Rad Responder can appropriately handle this type of specialized sample. However, with a few simple tweaks, the system would be able to reasonable. All the same air sample metadata used for paper and cartridge type samples applies to impactors so keeping impactors in this sample type makes sense. Simply adding an air filter type of "impactor" to the list that contains "paper" or "cartridge" would be an easy way to differentiate the air sample type. Another critical piece of information needed for these types of samples are the details of the impactor itself i.e. what particle size bin is represented by the sample. This can simply be an open text comment

field as these types of samples will be specialized and not very frequent. Example entry into this field would be something like “Impactor S/N: 12345, 1-5 um particle size” or “stage 3 of cascade impactor S/N: x3459834”. Using this information, combined with the sample metadata like volume, location and time, as well as the sample results would be all the analyst would need to use the data.

Soil core samples

To study weathering and leeching of deposited activity into the soil it is necessary to collect a soil core sample. A soil core is a plug of earth in which layers are taken and analyzed separately so that analyte concentrations can be determined as a function of depth. To handle this in the current system would require a separate “soil” sample for each layer. The problem is the number of layers is not known until the laboratory performs the sample workup. A discussion needs to be had with RR stakeholders to evaluate the necessity of having a special exception or process to log soil core samples in RR. If the requirements already described in this document are implemented, a work around to handle this type of sample would be to at first, enter the soil core as a single soil sample. Then the lab would communicate how many layers will be analyzed and someone would essentially copy this sample tagging onto the existing sample ID field letters or numbers indicating the layer. Then, the lab would need a new ARF with all the layers defined so that when they report the data through the portal, the sample IDs would overlap. Then, it would be up to the management to make everyone aware of what soil cores look like in the system so they do not get mixed in with ground deposition or other bulk soil samples when analysts are looking at the data.

Appendix I – Equations

The uncertainty-weighted average of an analyte result (μ) is determined by:

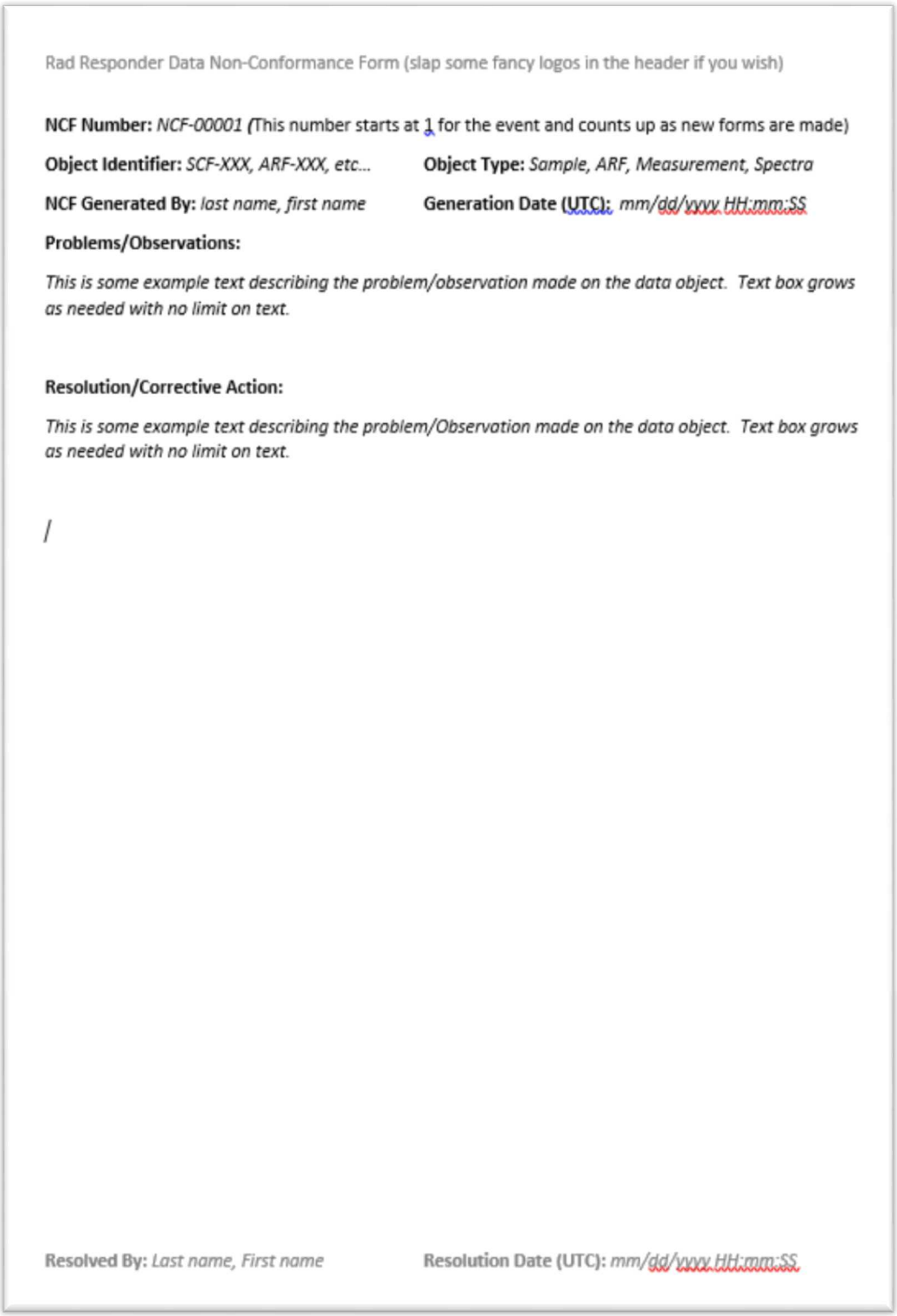
$$\mu = \frac{\sum_n \delta_n \cdot x_n}{\sum_n \delta_n} \quad (1)$$

Where δ is the 1-sigma measured uncertainty of the analyte result (x) for the n^{th} sample. Equation (1) is summed over all of the samples in the drawing. The Standard deviation can be determined over the same data set by the inverse of the root of the sum of the 1-sigma uncertainty as shown in Equation (2).

$$\sigma = \left(\sqrt{\sum_n \delta_n} \right)^{-1} \quad (2)$$

Appendix II – Mockups

Rad Responder Non-Conformance form report



Rad Responder Data Non-Conformance Form (slap some fancy logos in the header if you wish)

NCF Number: *NCF-00001 (*This number starts at 1 for the event and counts up as new forms are made)

Object Identifier: *SCF-XXX, ARF-XXX, etc...* **Object Type:** *Sample, ARF, Measurement, Spectra*

NCF Generated By: *last name, first name* **Generation Date (UTC):** *mm/dd/yyyy HH:mm:SS*

Problems/Observations:

This is some example text describing the problem/observation made on the data object. Text box grows as needed with no limit on text.

Resolution/Corrective Action:

This is some example text describing the problem/Observation made on the data object. Text box grows as needed with no limit on text.

/

Resolved By: *Last name, First name* **Resolution Date (UTC):** *mm/dd/yyyy HH:mm:SS*

Data Verification Form

The data verification form is used to communicate the result of the in-depth QA review the QA specialist performs. This form is broken out into a few sections and allows the user to enter text in each. A PDF ort of this form should be able to be printed from the new ARF data review section. The user control to fill this out should look very similar to the form itself.

Rad Responder Sample Analysis Data Verification Form

Analysis Request ID: *ARF-001*

QA Review Checklist:

- ☐ Custody records continuous and complete
- ☐ All requested analytes reported for all samples on ARF
- ☐ Results reported in correct units
- ☐ Uncertainty and detection limits reported
- ☐ Measurement sensitivity requirements met
- ☐ Electronic data compare correctly against reports
- ☐ All necessary reports included in data package (requested data package level requirements met)
- ☐ Lab-reported QC data meets requirements

QA Reviewer Comments:

This box will contain an unlimited amount of text that the QA reviewer will type in to communicate any issues found with the data package. Any unchecked item above will need to be explained in detail here. The box will expand as needed.

QA Reviewer: *Last name, First name* QA Review Date/Time: *mm/dd/yyyy hh:mm:ss*

Lab Portal Screens

The following are some suggestions for the UI implementation of the Lab Portal requirements. Of course, UI expert and developer discretion/guidance is anticipated and appreciated.

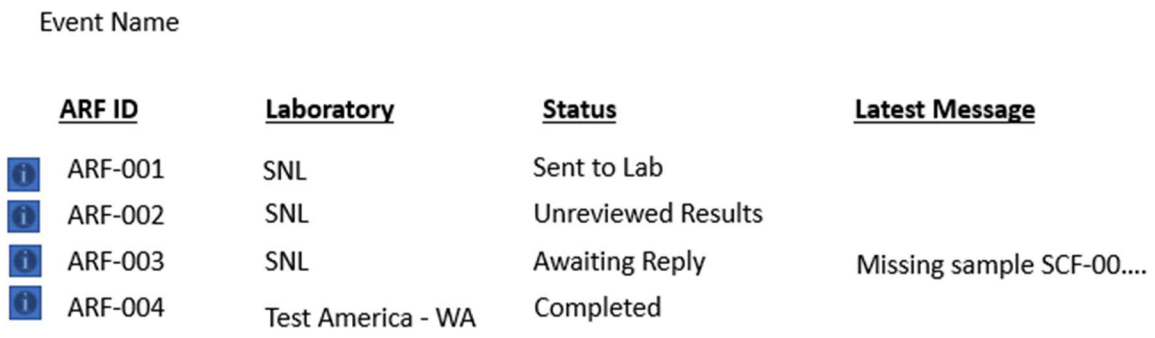


Figure 13: Main Portal Dashboard

This is the main portal dashboard. If a FRMAC user (or full user rather) is logged in, all the events ARFs will show up here. Users will drill into each ARF to obtain the files or enter/resolve messages.

The lab user will only see the ARFs sent to their lab.

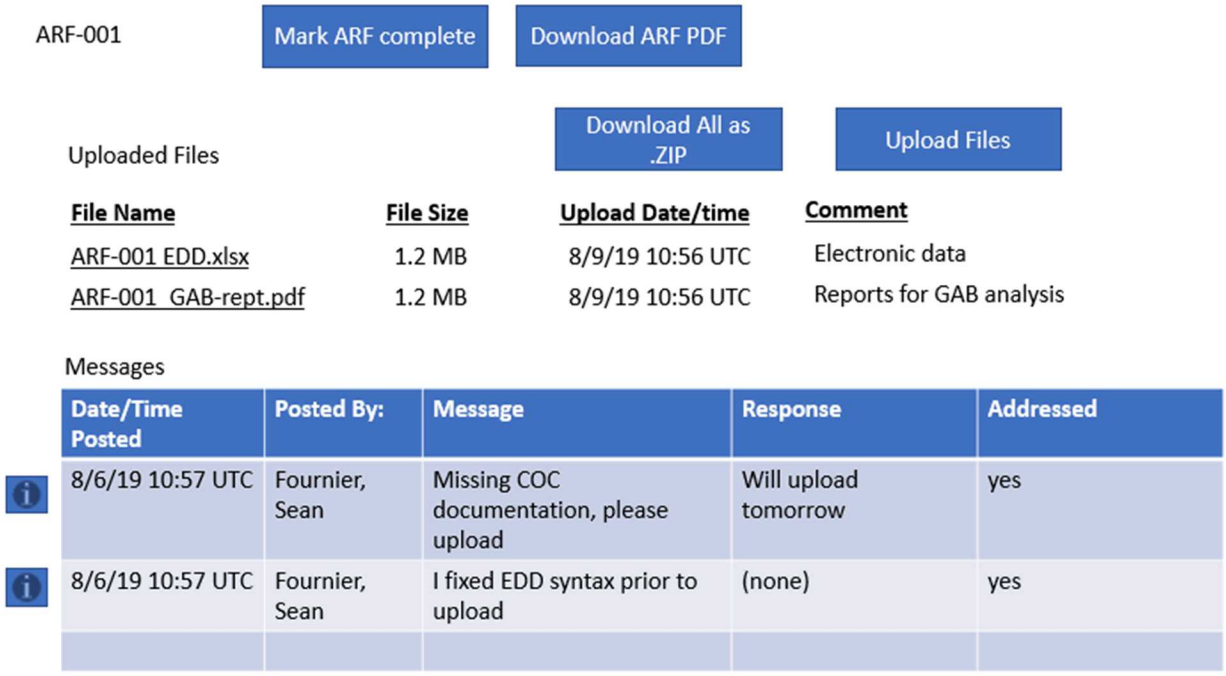


Figure 14: Lab Portal - ARF Detail Page Example

Lab Portal – ARF detail page:

- Each file downloadable by clicking file name
- All files downloaded to .ZIP by clicking button
- Message board has edit control buttons to the left of each message to edit the text or add a response
- Clicking Upload files should open a dialog to allow user to upload individual files, add a comment OR upload multiple files and then put in optional comments on each.
- Files should have edit buttons that allow users to remove files in case files are mistakenly uploaded.
- Uploaded files should be viewable when drilled into the ARF in the other RR views under the results section for completed ARFs
- Mark ARF complete button should only show up for non-lab users, this toggles an auto message to the lab stating that the ARF has been completed and no action is needed.

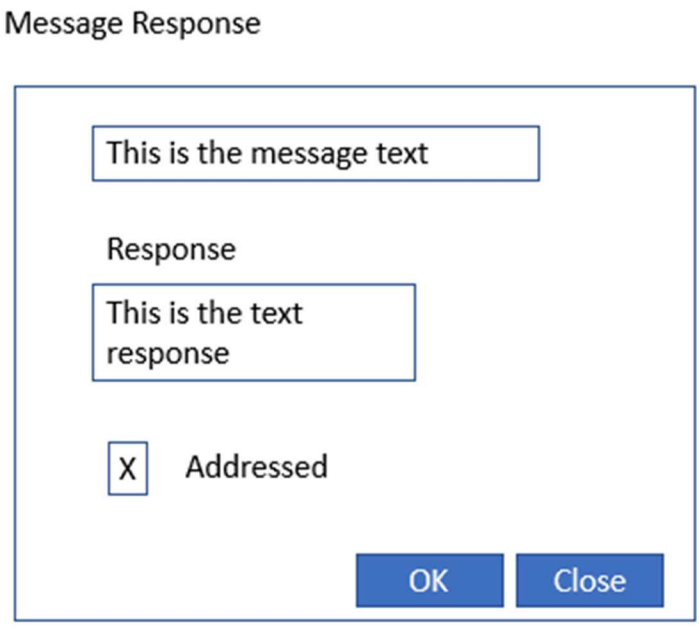


Figure 15: Lab Portal Message Dialog example

This is the message edit dialog. It allows the user to edit the text of the message or the response and mark the comment addressed. Response is not required to manually check addressed but putting text in will automatically check the box.

Appendix III – Items to duplicate from RAMS

ARF-Based Data Review Utility

The result review utility that exists currently in RAMS under the ARF is well liked by the community so far. It should be replicated in RR and extend to quantitative spectra as well.

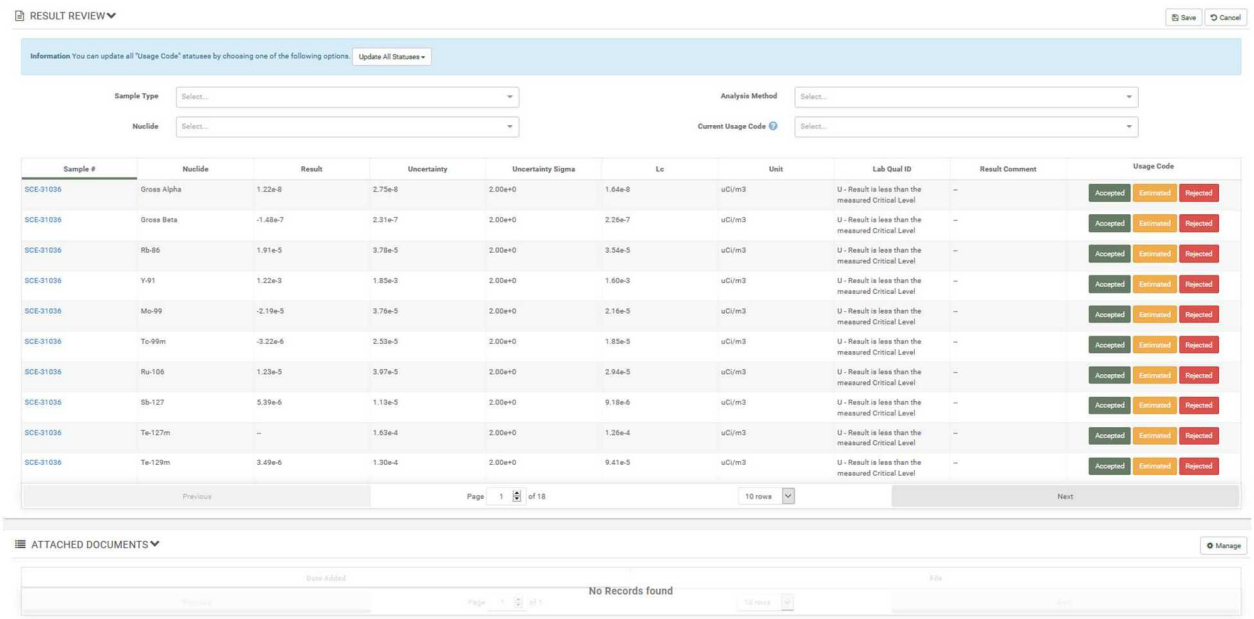


Figure 16: Screenshot of existing RAMS data review utility to be duplicated in RR under the ARF view

RAMS Advanced Data Export Format

The format below was recently deployed in RAMS and has proven to be exceptionally useful for the data scientist. It includes all relevant fields for a sample analytical result. While RR may not have all of these exact fields, the table below demonstrates the essence of what is needed. A flattened data format that can easily be used and manipulated in excel that includes all the relevant fields for all sample types and result types is what the data scientist needs.

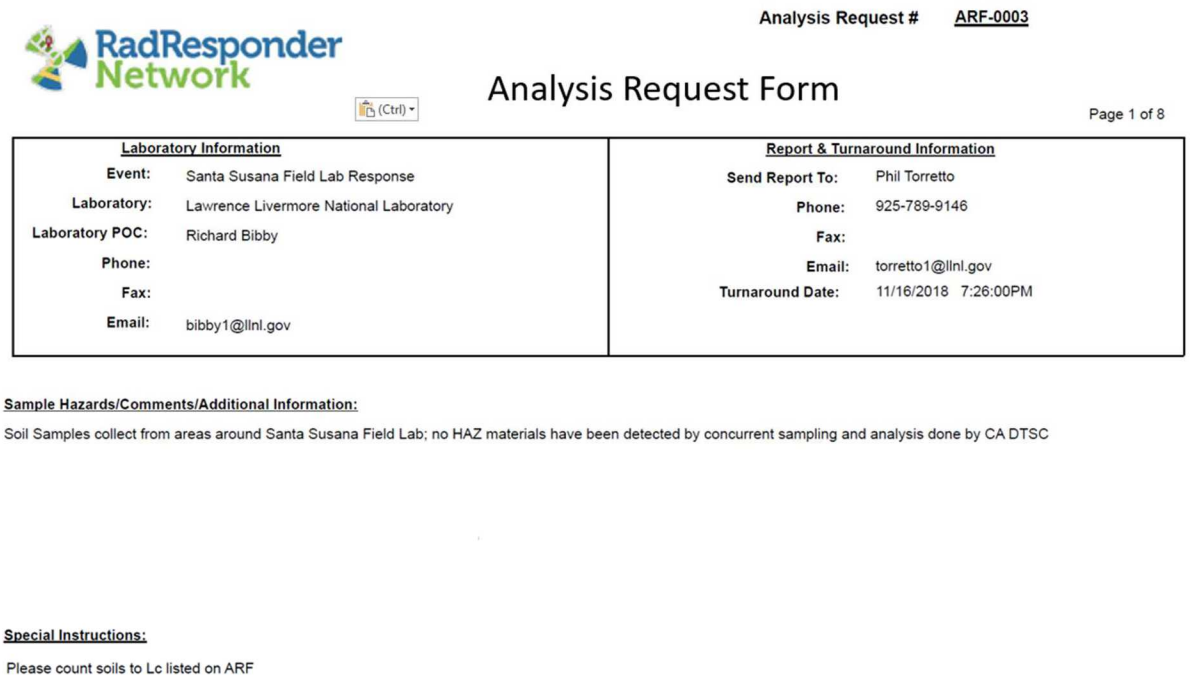
Table 4: Example "advanced data export" format for sample results

RAMS Field Name	Example	Example
Sample Barcode	SCF-3-351	SCF-8119
Sample Status	Result Received	Sent To Laboratory
Sample Type	Air Filter	Soil
Sample Collection Date	10/10/2016 4:00:00 PM	9/28/2016 4:00:00 AM
Sample Size	23.8790448	100
Sample Size Unit	cubic meters	grams
Sample Contact Dose Rate	5	1
Sample Contact Dose Rate Unit	uRem/hr	mR/hr
Sample Latitude	45.386745	45.923963
Sample Longitude	-93.863426	-94.635846
Sample Description	filter	
Sample Field Team		Lima
Sample Source	Simulated Data	*Manual Data Entry
Sample ARF Attached	ARF-036	ARF-017
Sample Repackaged	False	False
Sample Receipt Date		
Sample Has Non-Conformance?	False	False
Sample Info For Lab		
Sample Date Time On (Air)	10/10/2016 8:00:00 AM	
Sample Date Time Off (Air)	10/10/2016 4:00:00 PM	
Sample Start Flow (Air)	2.95	
Sample Stop Flow (Air)	3.02	

Sample Flow Rate (Air)	cubic meters/hr	
Sample Depth (Soil)		2
Sample Depth Unit (Soil)		centimeter
Sample Surface Area (Soil/Swipe)		100
Sample Surface Area Unit (Soil/Swipe)		Square Centimeters
Sample Veg. Collected (Soil)		True
Sample Surface Type (Swipe)		
Sample Milking Date (Milk)		
Sample Feed (Milk)		
Sample Milk Type (Milk)		
Sample Population (Milk)		
Result Analysis Request #	ARF-036	ARF-017
Result Analysis Method	Gas Proportional Counting	Gamma Spectroscopy
Result Type	Sample	Sample
Result Nuclide	Gross Alpha	Ba-140
Result Value	0	0.18752
Result Uncertainty	2.5E-05	0.004198
Result Unc Sigma	2	2
Result Critical Level	5E-05	0.00267
Result MDA	0.0001	
Result Unit	uCi/m3	uCi/kg
Result % Recovery	1	
Result Laboratory	RPSD Laboratory	Minnesota Department of Public Health Laboratory
Result Comment		
Result Wet Mass(kg)		1
Result Dry Mass(kg)	0.028	
Result Reported Wet Dry Mass	Dry	Dry
Result Upload Date	10/16/2016 4:15:10 AM	10/17/2016 9:04:12 PM
Result Status		

Result Val Qual		
Result Lab Qual	U - Result is less than the measured Critical Level	A - Result is approved and is above the required Critical Level
Result Usage Code	Not Reviewed	Not Reviewed
Result Detection Level Provided	Yes	
Result Assessment Review Status	Not Reviewed	Not Reviewed
Result Replaced Result	False	False
Result Used by Assessment	False	False
Result QC Batch Id	1	B6J0123
Result Reviewer Comment		

Analysis Request Form mockup



RadResponder Network

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Analysis Request # **ARF-0003**

Analysis Request Form

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Laboratory Information		Report & Turnaround Information	
Event:	Santa Susana Field Lab Response	**Send Report To:**	Phil Torretto
Laboratory:	Lawrence Livermore National Laboratory	**Phone:**	925-789-9146
Laboratory POC:	Richard Bibby	**Fax:**	
Phone:		**Email:**	torretto1@llnl.gov
Fax:		**Turnaround Date:**	11/16/2018 7:26:00PM
Email:	bibby1@llnl.gov		

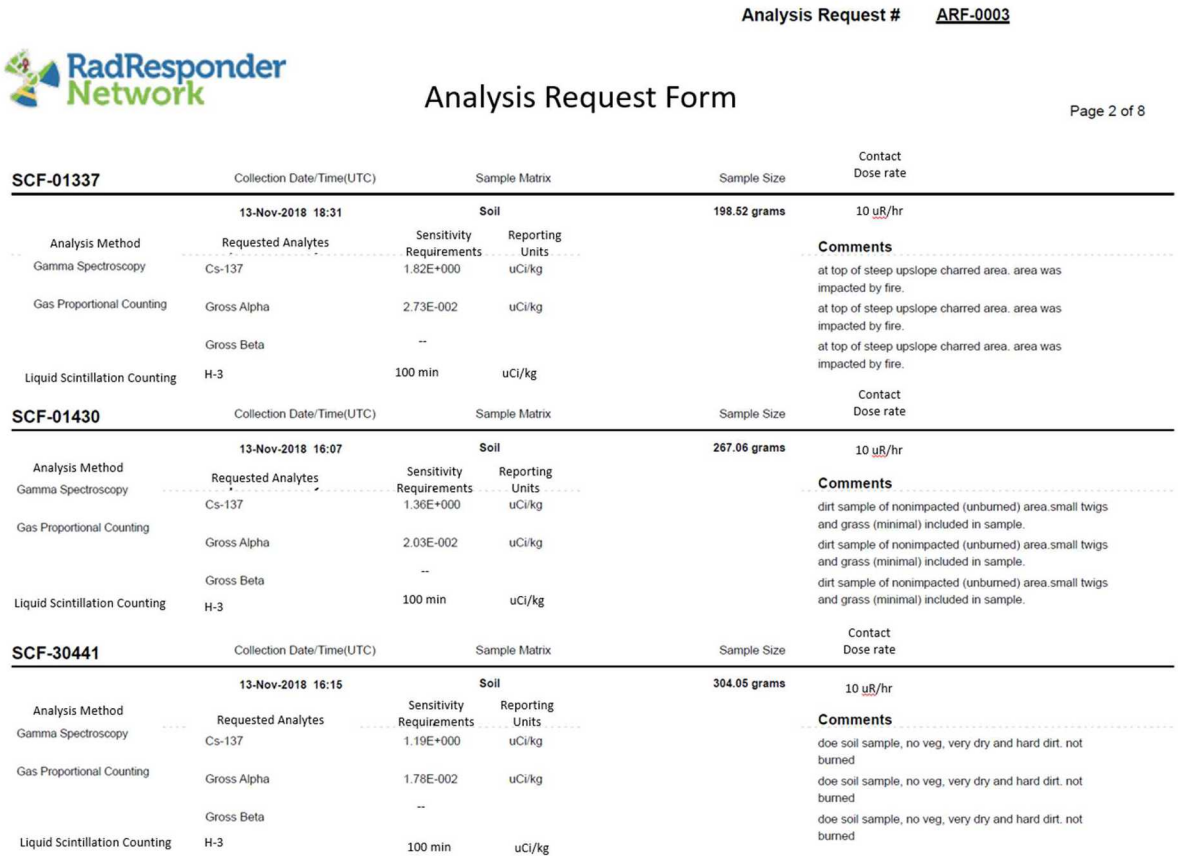
Sample Hazards/Comments/Additional Information:

Soil Samples collect from areas around Santa Susana Field Lab; no HAZ materials have been detected by concurrent sampling and analysis done by CA DTSC

Special Instructions:

Please count soils to Lc listed on ARF

Figure 17: ARF cover page mock-up



Analysis Request # ARF-0003

RadResponder Network

Analysis Request Form

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SCF-01337	Collection Date/Time(UTC)	Sample Matrix	Sample Size	Contact Dose rate
	13-Nov-2018 18:31	Soil	198.52 grams	10 uR/hr

Analysis Method	Requested Analytes	Sensitivity Requirements	Reporting Units	Comments
Gamma Spectroscopy	Cs-137	1.82E+000	uCi/kg	at top of steep upslope charred area. area was impacted by fire.
Gas Proportional Counting	Gross Alpha	2.73E-002	uCi/kg	at top of steep upslope charred area. area was impacted by fire.
	Gross Beta	--		at top of steep upslope charred area. area was impacted by fire.
Liquid Scintillation Counting	H-3	100 min	uCi/kg	

SCF-01430	Collection Date/Time(UTC)	Sample Matrix	Sample Size	Contact Dose rate
	13-Nov-2018 16:07	Soil	267.06 grams	10 uR/hr

Analysis Method	Requested Analytes	Sensitivity Requirements	Reporting Units	Comments
Gamma Spectroscopy	Cs-137	1.36E+000	uCi/kg	dirt sample of nonimpacted (unburned) area.small twigs and grass (minimal) included in sample.
Gas Proportional Counting	Gross Alpha	2.03E-002	uCi/kg	dirt sample of nonimpacted (unburned) area.small twigs and grass (minimal) included in sample.
	Gross Beta	--		dirt sample of nonimpacted (unburned) area.small twigs and grass (minimal) included in sample.
Liquid Scintillation Counting	H-3	100 min	uCi/kg	

SCF-30441	Collection Date/Time(UTC)	Sample Matrix	Sample Size	Contact Dose rate
	13-Nov-2018 16:15	Soil	304.05 grams	10 uR/hr

Analysis Method	Requested Analytes	Sensitivity Requirements	Reporting Units	Comments
Gamma Spectroscopy	Cs-137	1.19E+000	uCi/kg	doe soil sample, no veg, very dry and hard dirt. not burned
Gas Proportional Counting	Gross Alpha	1.78E-002	uCi/kg	doe soil sample, no veg, very dry and hard dirt. not burned
	Gross Beta	--		doe soil sample, no veg, very dry and hard dirt. not burned
Liquid Scintillation Counting	H-3	100 min	uCi/kg	

Figure 18: ARF body mockup

Analysis request form body:

- Group records by sample ID, then by analysis method

Requested analytes and analysis methods pull in from the mixture. Table is sorted by analysis method then by requested analytes. Anchor analytes are placed at the top and then the rest are sorted alphabetically. Analysis methods with a count time specified has the count time printed at the top and any subsequent analytes have blank sensitivity requirements and units.

Reporting units are a property of the mixture and are specified for each sample type.

Appendix IV: Composite Lab Analysis Workflow Diagram