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NARAC Dispersion Model Product Integration with RadResponder

National Atmospheric Release Advisory Center (NARAC)

Lawrence Livermore National Laboratory

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Disclaimer

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1. Synopsis

Work on enhanced cooperation and interoperability of Nuclear Incident Response Teams (NIRT) is a joint effort between DHS/FEMA, DOE/NNSA and EPA. One such effort was the integration between the RadResponder Network, a resource sponsored by FEMA for the management of radiological data during an emergency, and the National Atmospheric Advisory Center (NARAC), a DOE/NNSA modeling resource whose predictions are used to aid radiological emergency preparedness and response. Working together under a FEMA-sponsored project these two radiological response assets developed a capability to read and display plume model prediction results from the NARAC computer system in the RadResponder software tool.

As a result of this effort, RadResponder users have been provided with NARAC modeling predictions of contamination areas, radiological dose levels, and protective action areas (e.g., areas warranting worker protection or sheltering/evacuation) to help guide protective action decisions and field monitoring surveys, and gain key situation awareness following a radiological/nuclear accident or incident (e.g., nuclear power plant accident, radiological dispersal device incident, or improvised nuclear detonation incident).

This document describes the details of this integration effort.

2. Background

Both NARAC and RadResponder support different but yet complementary aspects of a response to a radiological event. Both organizations support the Interagency Modeling and Atmospheric Assessment Center (IMAAC), an effort under the National Response Framework to provide a coordinated set of modeling products and support in the event of a radiological emergency.

This section will provide background information on these two organizations.

2.1 NARAC

NARAC provides real-time computer predictions of the atmospheric transport of material from radioactive releases and of the downwind effects on health and safety. NARAC both develops and utilizes an advanced suite of modeling and analysis tools for this purpose. An important asset of the NARAC system is its staff of expert analysts who provide NARAC customers with quality-assured analysis and modeling results, training, and assistance in understanding modeling products.

NARAC hosts DOE/NNSA web-based software tools, CMweb (https://cmweb.llnl.gov) and NARAC Web (https://naracweb.llnl.gov), for authorized users. Since references to either application serve the same purpose in this report, only the term “CMWeb” will be used herein to describe the interface used by NARAC to deliver products to RadResponder.

2.2 RadResponder

RadResponder (https://www.radresponder.net), developed by Chainbridge Technologies, is a radiological incident management tool for responders at the federal, state, and local levels. The RadResponder Network enables organizations to rapidly record, share and aggregate radiological data, manage specialized personnel and equipment, and establish interagency partnerships.

3. Communication Policies

The RadResponder and CM Web development teams held a series of discussions to determine a common operational framework for inter-communications. Such a framework had to incorporate the needs and policies of the individual systems. This section will discuss the agreed upon policies for inter-communication.

3.1 Considerations

While both the RadResponder and CM Web systems support various aspects of a response to a radiological event, the user base of these two systems differ from each other. As a result, a user on one system may or may not have an account on the other system. A policy was therefore clearly needed as to which user base would be allowed to initiate a transfer of a NARAC product set.

Also, these systems are each restricted through their own authentication system. The user base initiating communication would therefore require access to the host system.

Another consideration was based on the NARAC operations staff, a team of highly trained assessment scientists that not only support the CM Web interface but also make up part of that system's user base. The NARAC operations team commonly uses the CM Web interface to run the NARAC models, and both communicate and provide products to their users. The NARAC to RadResponder interface would need to be consistent with this team's specialized use of the CM Web interface.

Consistency with current IMAAC policies for the dissemination of modeling products was also considered both necessary and important.

3.2 Uploading NARAC Products into RadResponder

It was determined that the ability to initiate a transfer of NARAC products into RadResponder would not be openly available to any user of either system. As a result, the following usage policies were established on the NARAC system:

- A NARAC operational scientist would be involved with any product to be sent to RadResponder. This would prevent the possibility of an inordinate and unauthorized number of NARAC products residing on RadResponder. It would also allow a NARAC scientist to quality assure and approve any NARAC product prior to being uploaded, a pre-existing and common NARAC operating procedure.

- The NARAC scientist would not be burdened with authentication details as required by a separate username and password. Authorization would be handled in an automated fashion between the two systems.

On the RadResponder system, any incoming NARAC product would need to be associated with an "Event" and its corresponding "Sponsor". An event is the pre-existing structure on RadResponder in which users were accustomed to working. Sets of events fall under a specific Sponsor. The NARAC scientist would therefore require pre-hand knowledge as to the RadResponder Event designated for hosting the uploaded product set. NARAC products would then be automatically available to any RadResponder user having access to that event.

Another advantage of having a NARAC scientist manage an upload is worth mentioning. NARAC personnel can customize NARAC model output to reflect particular needs of an event or exercise. Such customization was involved in the demonstrated uses of this capability discussed in section 5.

3.3 NARAC Product management within RadResponder

Even with the restriction of only allowing NARAC scientists to upload product sets into RadResponder, the need for management and archiving older products was recognized. A common example of this requirement, taken from typical NARAC support of Radiological Response Exercises, is the fact that NARAC will re-run their models whenever quality field data is received hence creating and possibly uploading multiple product sets. Communication becomes essential in these situations to make end users aware of which product sets reflect the most current field information.

The RadResponder team was therefore tasked with providing the NARAC system with a procedure for archiving previously uploaded product sets. It was appropriate to have the ability to decide which products should be archived be on the NARAC side as they were generating the model output.

4. KML Data Format

A data format common to both RadResponder and NARAC would be required. The fact that both systems already used the Google based Keyhole Markup Language (KML) format as an option for data products made this an advantageous selection. KML therefore became the data format of choice.

A technical note is appropriate here. The actual file format used for a transfer is the compressed data format known as KMZ, which serves as a container of a KML file and other supplementary information. For all practical purposes, the terms KML and KMZ are interchangeable in this report.

4.1 Advantages

There were several advantages to the selection of KML as the data format to be used between the two systems.

- On the NARAC side, any future updates made by NARAC to its KML products would automatically be displayed in RadResponder.
- Both systems would not be burdened with maintaining a new and output format.
- Reproducibility and consistency – Each uploaded version could always be reproduced and viewed in Google Earth.

4.2 Disadvantages

One disadvantage of the KML structure is that it restricts the type of information that can be included in a product transfer. To get around this, files and other data can be included into the final KMZ package. There is no standard guidance though for processing data on the receiving end in when using the compressed and unstructured KMZ container as opposed to the structured KML format.

4.3 KML Standardization

Standardization within a KML file is defined by an Extensible Markup Language (XML) schema, an official definition of the structure and content of both KML and XML files. When two communicating parties adhere to the same schema, inter-communications is easier to implement.

Despite the pre-existing use of KML by both RadResponder and NARAC, some KML standardization issues were encountered due to the use of slightly different schemas on the two systems. The NARAC development team updated the format it used to better follow the standard schema used by the RadResponder team.

5. Intercommunications – Web Services

It was clear to both development teams that an automated form of communication between the two systems would be appropriate as opposed to the simpler idea of letting a user transfer a NARAC product and providing interfaces to upload that product into RadResponder. This form of communication would need to be comprised of a set of functions or calls that would process the needed requests and passing of data. For all practical purposes, each of these individual calls is handled by a Web Service. A Web service can be initiated indirectly by a user, but the user may or may not be aware of all the information being passed between the two systems.

Based on the agreed upon policy of NARAC initiating communication to push a data product, the RadResponder team developed a special Application Programming Interface (API) for their NARAC counterparts. The NARAC team had the responsibility of modifying their system to make calls as needed to RadResponder using the provided API. The calls each took the form of a request from NARAC and a return of data or information from RadResponder. The NARAC calls would also include data or information as part of their requests. The resulting web services are summarized as follows:

- Request from CM Web asking for a listing of all the existing events on RadResponder. The sponsor associated with each event is also provided.

- Request from CM Web to RadResponder to upload the KMZ product into a specific event. NARAC provides the name of the event as well as the KMZ based product.

- Request from CM Web to RadResponder for a listing of all the previously uploaded KML products. RadResponder returns the list with each list item containing the relevant information such as the name of the KMZ file, the event to which it was uploaded, and more.

- Request from NARAC for RadResponder to remove or archive a previously uploaded from its containing event. NARAC provides the name of the product.

The first two services listed above handle the main goal of delivering a NARAC product. The last two services provide a manner to archive and manage the uploaded products; a capability deemed important to manage both the number and relevance of NARAC products on RadResponder.

Once these calls were established, both development teams still needed to provide the appropriate user interfaces for their respective users. Implementation details are not shared at that point between the two systems and such a policy is considered good practice. To illustrate that point, if the NARAC system uses the web service call to archive an uploaded product, the RadResponder team is free to determine how to best do that on their system.

5.1 Authentication

The communication between the two systems is authenticated with a generic username and password. This allows the IMAAC system to upload a product set to any pre-existing event on RadResponder. The IMAAC system does not concern itself with whether or not the stuff happens.

6. User Interfaces

This section will discuss the user interfaces in both CM Web and RadResponder resulting from the common operating framework. It should be remembered that the term “end user” has a different meaning in the two applications. On the CM Web system, the end user is a member of the NARAC/IMAAC assessment team as other CM Web users have not been given access to this capability. It should be noted that NARAC scientists have the ability to upload any run on the CM Web system, not just runs they create.

On the RadResponder side, the end user represents a RadResponder account holder having access to the event in which the NARAC/IMAAC product set has been uploaded. A side by side comparison of an NARAC/IMAAC product set as it appears in CM Web with the corresponding version in RadResponder will also be presented. This section could also serve as a basis for a user’s guide but it has not been written with that purpose in mind.

6.1. CM Web

The interface available to the NARAC scientist for the purpose of uploading a NARAC run to RadResponder is shown below in Figure 1.

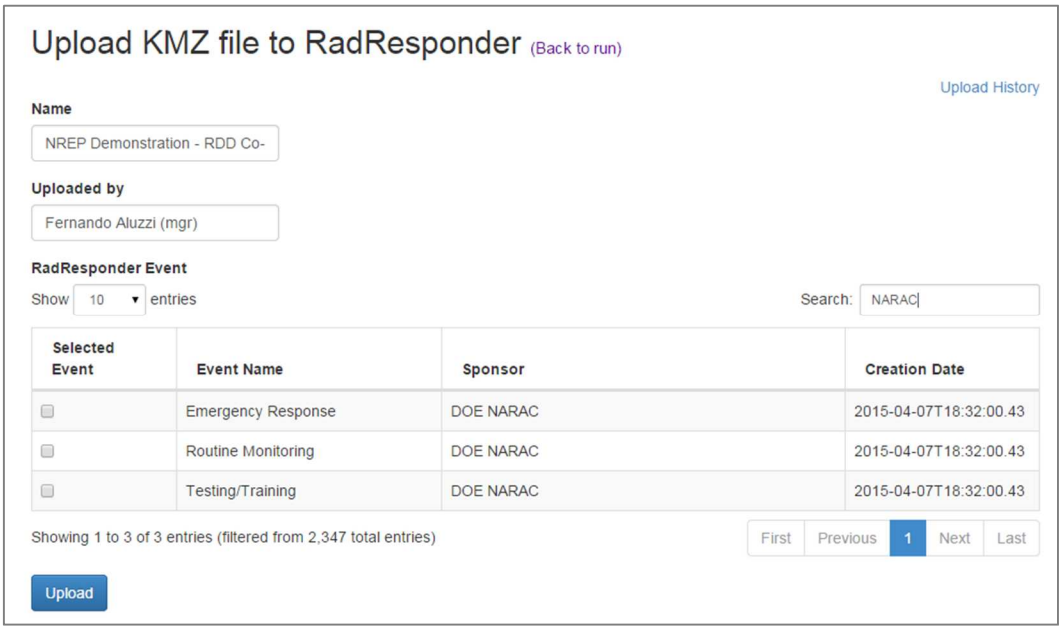

Figure 1 – CM Web interface for uploading products onto RadResponder

This interface is made accessible only within the context of a NARAC run or calculation each of which automatically provide a single KML product. This interface takes advantage of that by correlating each interface session with the KML from the current NARAC run. That allows for a simpler interface by not requiring the user to select the NARAC KML.

The interface is initially populated with a listing of all the events on RadResponder as opposed to a smaller predefined set. This large listing is the result of using a generic account for NARAC during web service communications. As a result, the NARAC scientist must have prior knowledge as to the RadResponder event to select. To assist in finding a specific event and also manage the large event listing, a filtering capability (Search field in Figure 1) is available. Filtering is applied to all the interface fields: Event Name, Sponsor, and Creation Date.

Once an event has been selected, the NARAC scientist simply clicks the “Upload” button. The interface will then give way to a message indicating whether the transfer was (or was not) successful. The NARAC results will automatically be placed within the corresponding event on the RadResponder system.

The NARAC scientist has the option of changing the name of the KML product. By default, this product is given the same name as the NARAC run.

As discussed earlier, the ability to archive and manage the uploaded NARAC products on RadResponder was also developed. A link on the upload interface, *Upload History*, will lead the NARAC scientist to a second interface providing such a capability. An example listing is shown in Figure 6-2. This listing will display all previously uploaded products including those that have

been archived. The history of uploaded NARAC products is displayed in terms of the RadResponder event, the uploaded KML file name, user performing the upload, and the upload date. Information on all prior archiving is provided in the final two fields: *Archived By* and *Archived Date*. The two archive fields will be blank whenever the corresponding product has yet to be archived.

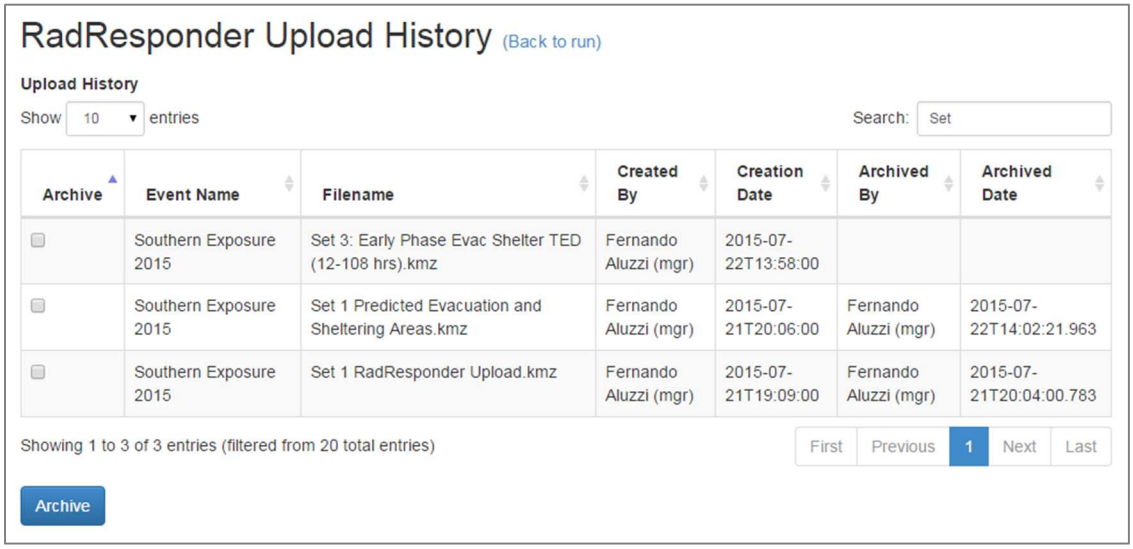

Figure 2 – CM Web interface for archiving products on RadResponder

6.2. RadResponder

In order to view a NARAC product set within RadResponder, a user must select the event to which the NARAC product set has been sent. No notices are currently provided to users as to which RadResponder events contain NARAC/IMAAC products. Therefore the availability of NARAC products must be coordinated beforehand. A given RadResponder event can contain multiple NARAC products.

When a RadResponder does enter an event contain one or more NARAC products, access to these products is available through an IMAAC menu. An example IMAAC menu and its product listing are shown in Figure 3.

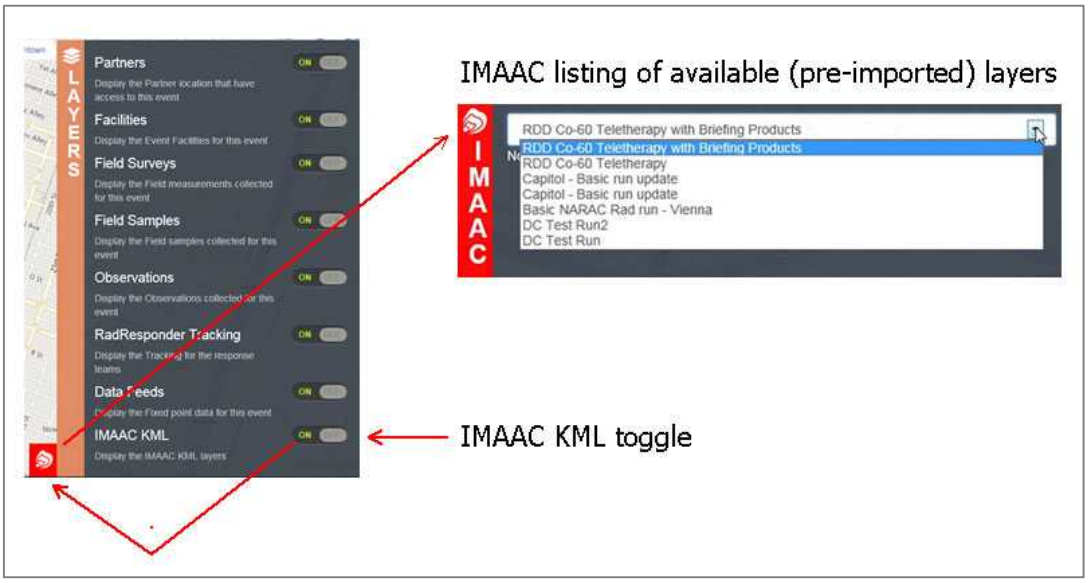

Figure 3 – IMAAC Menu on RadResponder

The “IMAAC KML” option, available within the Layers menu and on by default whenever NARAC/IMAAC products are available, will toggle on the “IMAAC” Layers menu (upper right section of Figure 3). The IMAAC Layers menu will automatically list any available NARAC generated KML products that match the current event time span.

A typical radiological product set will contain multiple contoured products each providing a different type of model prediction such as a specific dose type. Once a specific data product is selected from the IMAAC menu, these contoured model predictions will be listed. An example listing of available contoured products within a KML file is displayed in Figure 4.

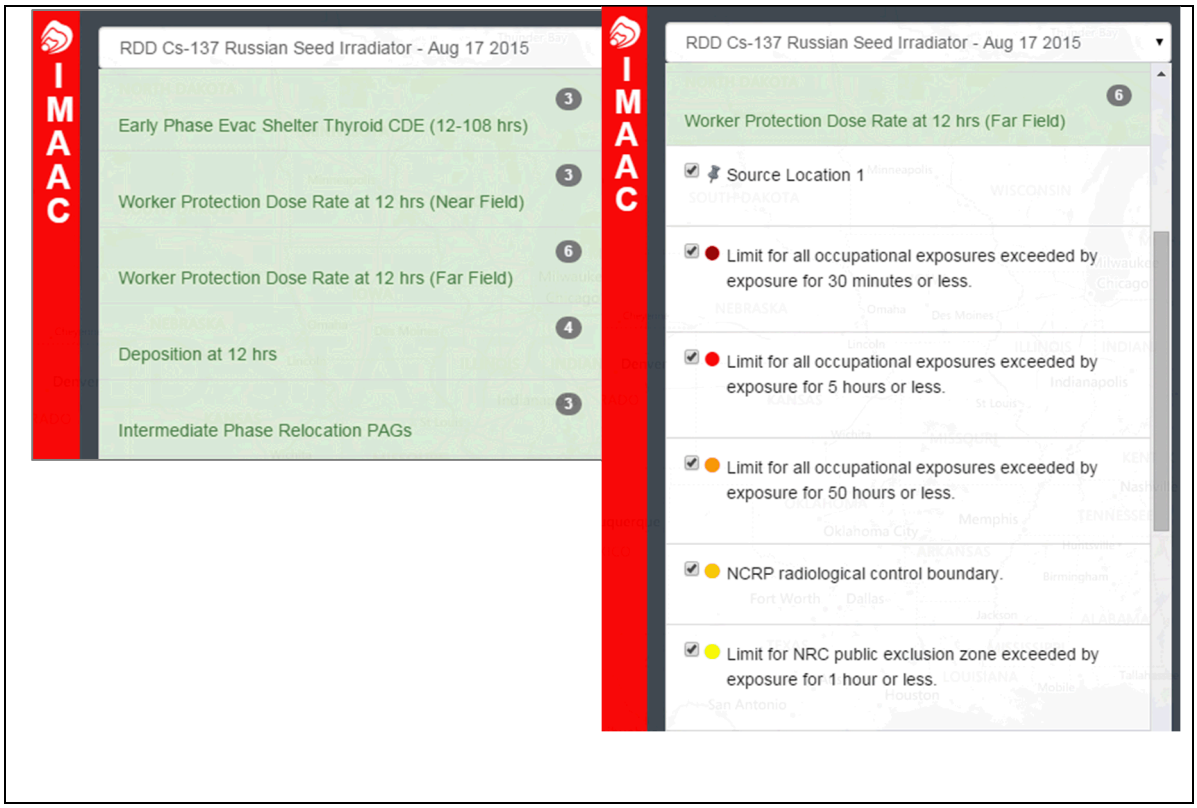

Figure 4 – An example listing of the available contoured areas for a NARAC predicted dose effect.

6.3. Example Side-By-Side Comparison

Figure 5 below shows a side-by-side comparison of an example NARAC model prediction in the two systems.

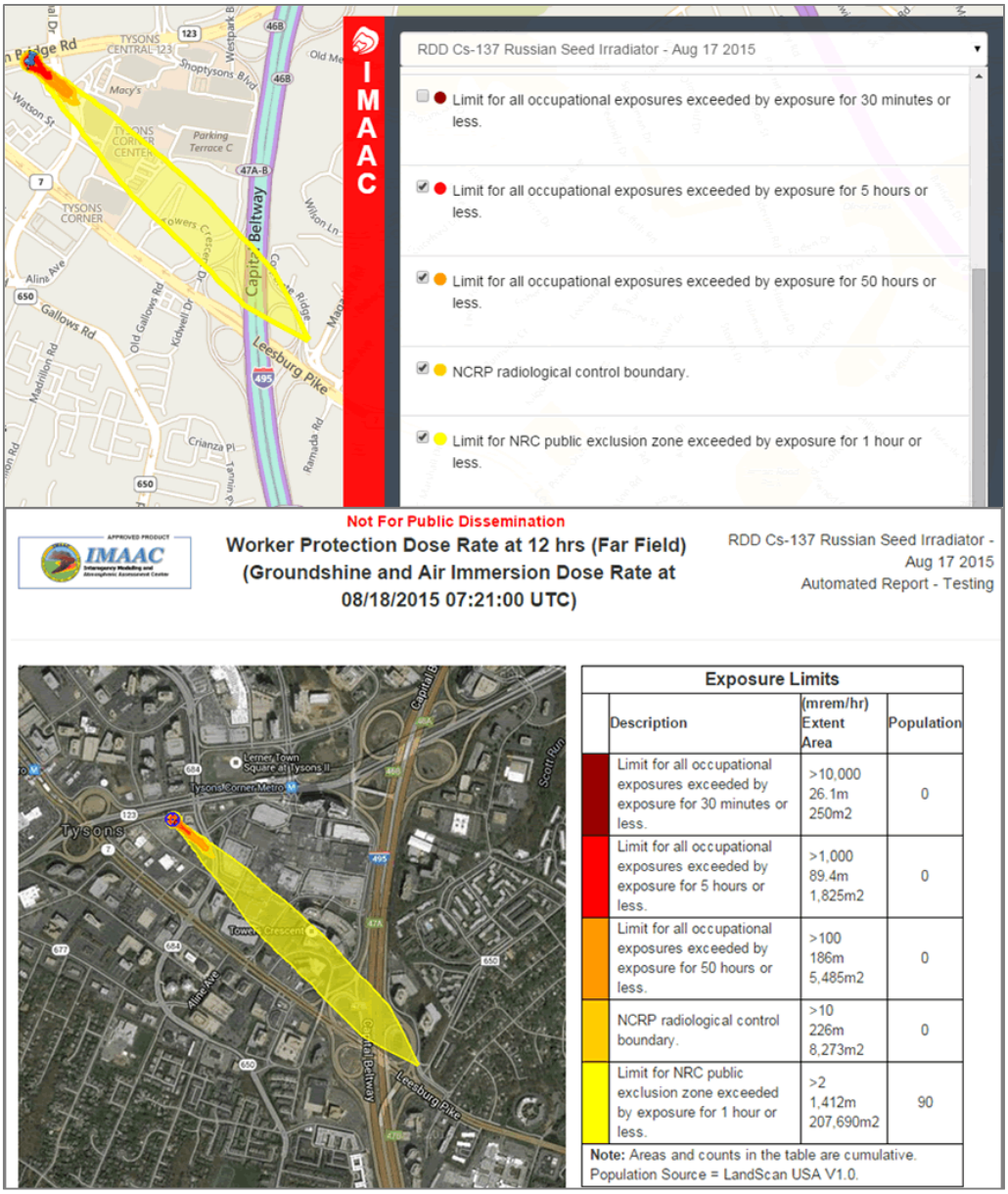

Figure 5 – An example NARAC/IMAAC product in RadResponder (top) and CM Web (bottom)

To accommodate all the legend information from the original IMAAC product (specifically dose level, downwind extent, area, and population) a RadResponder user must click within the contour of interest, bringing up the summary shown in Figure 6 below:

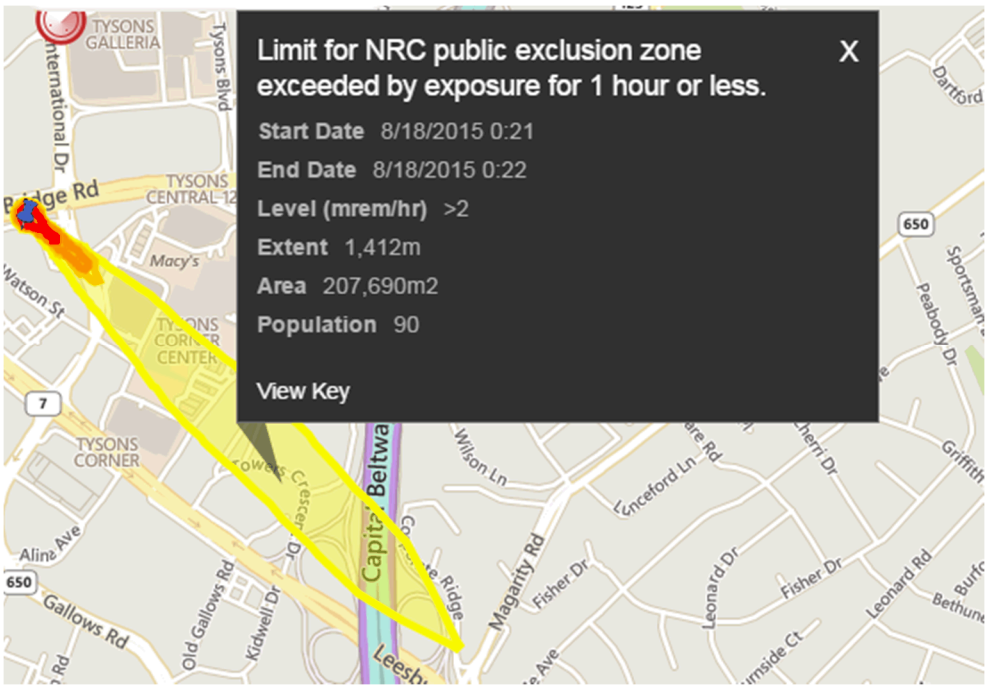

Figure 6 – Detailed legend information for one specific contour level.

All of the corresponding legend information can be brought up as a single entity, shown below in Figure 7, by clicking the *View Key* option.

IMAAC Key

Exposure Limits

Description	Level (mrem/hr)	Extent	Area	Population
Limit for all occupational exposures exceeded by exposure for 30 minutes or less.	>10,000	26.1m	250m2	0
Limit for all occupational exposures exceeded by exposure for 5 hours or less.	>1,000	89.4m	1,825m2	0
Limit for all occupational exposures exceeded by exposure for 50 hours or less.	>100	186m	5,485m2	0
NCRP radiological control boundary.	>10	226m	8,273m2	0
Limit for NRC public exclusion zone exceeded by exposure for 1 hour or less.	>2	1,412m	207,690m2	90

Note: Areas and counts in the table are cumulative. Population Source = LandScan USA V1.0.

Figure 7 – Detailed contour legend information from a NARAC product as seen in RadResponder.

7. Demonstrated use of capability

The opportunity to use this new capability arose several times during the following 2015 events:

- National Radiological Emergency Preparedness Conference, April 27-30
- Virtual Table Top Exercise, May 15 supporting the Southern Mutual Radiation Assistance Plan.
- National Drill Day Webinar, May 19, 2015.
- Southern Exposure Exercise (DOE), July 2015:
- Health Physics Society Annual Meeting, July 12-16, 2015, (Professional Enrichment Program)
- Training Events by Chainbridge/RadResponder:

Each of these events involved specific modeling needs of the NARAC system as coordinated by the RadResponder team. The final NARAC products in RadResponder were used either for demonstration purposes or in support of an exercise scenario.

8. Future Work

While it is possible to suggest several collaboration efforts between RadResponder and NARAC, this section will only focus on future work serving to extend this current integration effort.

As shown earlier, the graphical display of NARAC products in RadResponder is accompanied by information specific to the contoured areas providing dose estimates. A NARAC product set can provide other information such as the assumptions or inputs used in the calculation, details on the type of dose that is being projected and more. The use of the KML format as well as interface considerations on the RadResponder side imposed limitations as to the extent of information that could be respectively transferred and displayed. Future efforts should address these limitations and provide the aforementioned background information for any NARAC products.

One method for addressing the KML restrictions would be to incorporate new geographical information system (GIS) formats. One example would be the commonly used Shapefile format. All formats though would provide their own format specific limitations. GIS development of existing formats as well as the creation of new formats will increase the need to address this aspect of the integration between the two systems.

9. Summary

The efforts of this project have resulted in a new connection between the CM Web and RadResponder systems allowing the products from any standard CM Web calculation to be automatically sent to RadResponder. The automated design of the capability, relying on non-browser based (Web Services) http communication, minimizes user interaction therefore providing a faster transfer that is less prone to errors.

After a development and testing period, this capability became operational in April of 2015. Since that time, this capability has been well received after being utilized in several exercises, training sessions, and other RadResponder events held in support of its users. Suggested improvements from the RadResponder community are expected during the next year or two, after they have been able to use and better understand the modeling product(s) provided by this integration effort.

The underlying technical framework for this integration was completed early enough to allow for an extensive testing and implementation period during the latter half of the work effort.

10. References

NARAC Public Web Pages: https://narac.llnl.gov

RadResponder WWW Home Page: https://www.radresponder.net

Chainbridge Technologies, WWW Home Page: http://www.chainbridgetech.com, 8229 Boone Blvd, Suite 600, Vienna, VA 22182

11. Abbreviations

CM – Consequence Management

DHS – Department of Homeland Security

DOE – Department of Energy

EPA – Environmental Protection Agency

FEMA – Federal Emergency Management Agency

IMAAC – Interagency Modeling and Atmospheric Assessment Center

KML – Keyhole Markup Language

KMZ – Zipped (compressed) versions of KML files

NARAC – National Atmospheric Releaase Advisory Center

NIRT – Nuclear Incident Response Team

NNSA – National Nuclear Security Administration