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**Tools to Evaluate Transportation Infrastructure and Emergency  
Preparedness on Potential Radioactive Materials Shipment Routes**

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**ABSTRACT**

An important consideration for the U.S. Department of Energy (DOE) in planning for the future movement of spent nuclear fuel (SNF) from commercial reactor sites and other locations where radioactive waste is being stored is the identification and evaluation of feasible transportation modes and routes in proximity to a shipment origin. This can prove challenging as shipment origins are often located in areas where the transportation infrastructure may have size and weight limitations, may be in need of refurbishment, or may be subject to radioactive materials route restrictions. Additionally, although highly unlikely, in the event of an accident or incident during the transport of radioactive material, it is important that qualified emergency responders are able to arrive at the scene in a timely manner.

DOE has developed and is utilizing the Stakeholder Tool for Assessing Radioactive Transportation (START) to address these considerations. START is supporting DOE's efforts to collect and assess data about near-shipment-site transportation infrastructure, in anticipation that this information will be used in estimating infrastructure refurbishment needs and costs, recording known or potential route clearance challenges, and communicating about site-specific routing considerations. DOE is also using START to evaluate emergency response coverage on potential transport routes. This enables DOE to identify locations where radiological emergency response training may be needed in order to provide adequate coverage along the entire transport route of interest.

This paper describes the data, features and functionality within START to support the evaluation of transportation infrastructure and emergency preparedness on potential radioactive shipment routes, and illustrates its use in performing these assessments.

## INTRODUCTION

START is a web-based, geospatial information and decision-support tool developed by DOE's Office of Integrated Waste Management (IWM), for the purpose of evaluating transportation infrastructure, routing considerations, and performing analyses associated with the Department's transportation of radioactive materials.

START enables a user to represent a range of operating scenarios and performance objectives, with an emphasis on providing flexibility. The START platform uses geographic information system (GIS) data and spatial analysis capability, representing rail, truck, barge and intermodal infrastructure and operations in the continental U.S. The user can assess origin and destination facility locations, proximity to transportation networks, modal options, near-route emergency response assets, risk considerations, and view infrastructure conditions via satellite base maps and uploaded geo-tagged imagery. Outputs include performance measures and maps, which can be printed or exported to other software tools for further analysis.

GIS databases resident and accessible within the current version of START are shown in Figure 1. These databases are grouped by color code to represent spatial information of like kind. For example, the databases shaded in green represent mass gathering places, while those in pink are a collection of various political boundaries.

Shutdown Sites	Schools	Water Terminals
Potential Transload Sites	Colleges/Universities	Coast Guard Districts
Nuclear Reactors	Child Care Facilities	Captain of the Ports Zones
DOE and Other Facilities	Nursing Homes	Parks
Fire Departments	Airports	National Forests
TEPP Trained Personnel	Rail Network	Federal Lands
Police	Rail Freight Stations	Military Bases
Hospitals	Railroad Junctions	High Threat Urban Areas
State EOCs	Railroad Crossings	Tribal Lands
Theme Parks and Zoos	Rail Yards	Congressional Districts
Casinos	Railroad Bridges	States
Performing Arts Centers	Railroad Tunnels	State Legislative Districts
Stadiums and Arenas	Highway Network	Counties
Malls	Highway Bridges	City Limits
National Monuments/Icons	Navigable Waterway Network	Townships
Places of Worship	Locks/Dams	Municipalities

**Figure 1. START GIS data layers**

START is supporting DOE work in the following areas:

- Evaluating potential transport routes and estimated travel times based on selection criteria.
- Characterizing near-site mode and route infrastructure in proximity to shipment origins.
- Evaluating emergency preparedness and training needs along prospective transport routes.
- Informing transportation and throughput logistics considerations associated with integrated waste management system studies.
- Building stakeholder awareness of routing and decision-making considerations.

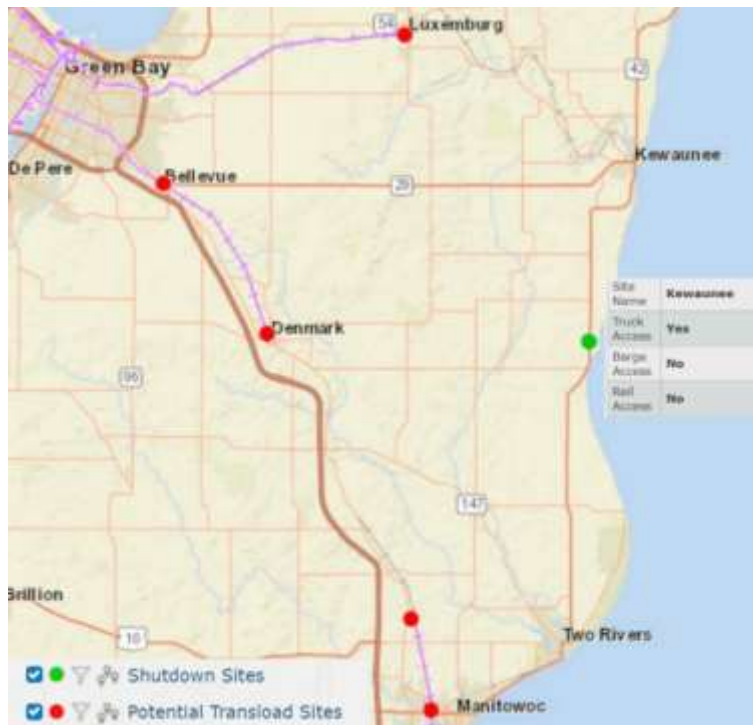
The focus of this paper is on two of these areas, namely: 1) characterization of near-site mode and route infrastructure in proximity to shipment origins, and 2) evaluation of emergency preparedness and training needs along prospective routes. These are discussed, in turn, below.

### **CHARACTERIZING NEAR SITE TRANSPORTATION INFRASTRUCTURE**

An important consideration in planning for the movement of SNF from where it currently resides is the identification and evaluation of feasible transportation modes and routes in proximity to the shipment origin. This can prove challenging as shipment origins can often have limited modal options, are located in areas where the transportation infrastructure may have size/weight limitations or traffic conflicts, be in need of refurbishment, or subject to regulatory route restrictions. Some examples of how START is being utilized for this purpose are provided below.

#### **Access to Rail From Shipment Origin**

As it is anticipated that rail will be a primary mode for commercial SNF transport from nuclear power reactors, being able to access the railroad network from the shipment origin becomes an important consideration. In cases where shipment origins do not have direct access to rail on the premises, it becomes necessary to identify feasible locations where a rail connection can be established. Such is the case for the Kewaunee reactor site, where SNF would have to be heavy hauled by truck to a proximate railhead and transloaded on to a rail car. As shown in Figure 2, multiple locations have been identified within START as candidate options.



**Figure 2. Location of rail access proximate to Kewaunee commercial reactor**

#### **Potential Modal Conflicts**

When SNF is being transported by either truck or rail, there are typically multiple locations where the road and rail networks intersect. When these intersections are physically divided, via tunnels or bridges, traffic can pass without conflict. However, in many instances these

intersections are physically located at-grade, creating a potential safety hazard. Awareness of these locations and their associated rail crossing characteristics (e.g., sign only, flashing lights, flashing lights with gates) can be an important consideration. Figure 3 displays the locations of at-grade rail crossings in close proximity to the Ft. Calhoun reactor site.



**Figure 3. Rail at-grade crossings near Ft. Calhoun reactor site**

### **Highway Route Restrictions**

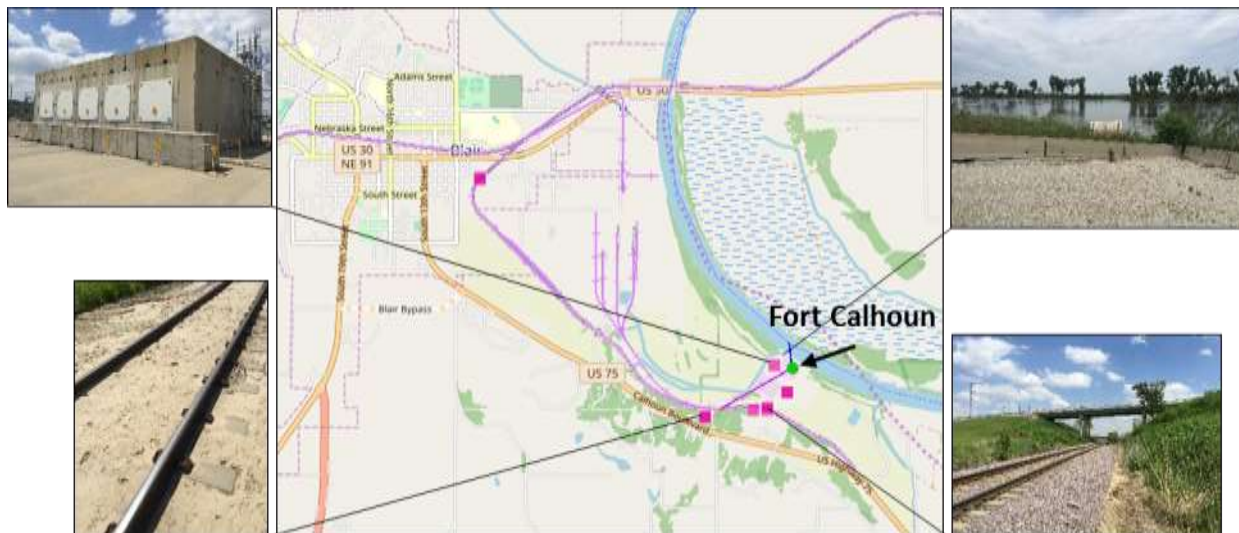
Certain segments of the highway network may be designated for use by different types of hazardous materials shipments, whereas other segments may be restricted. Knowing where these conditions apply can impact the feasibility of using certain routes for SNF truck transport. As California is one of the states that have been active in establishing such designations, the Humboldt Bay reactor site, which does not have direct rail access, must contend with these considerations (see Figure 4).



**Figure 4. Hazmat highway route restrictions near Humboldt Bay reactor site**

**Geocoded Photos**

Where in-person evaluations of shipment origin sites have been conducted, and geocoded photos taken of transportation infrastructure (see Figure 5), that imagery is being imported to START and catalogued at precise map locations. The imagery can subsequently be used as a resource for estimating infrastructure refurbishment needs and costs, recording known or potential route clearance challenges, and communicating about site-specific routing considerations.



**Figure 5. Location and Characteristics of Rail and Barge Access in Proximity to Fort Calhoun Power Plant Site and SNF Storage**



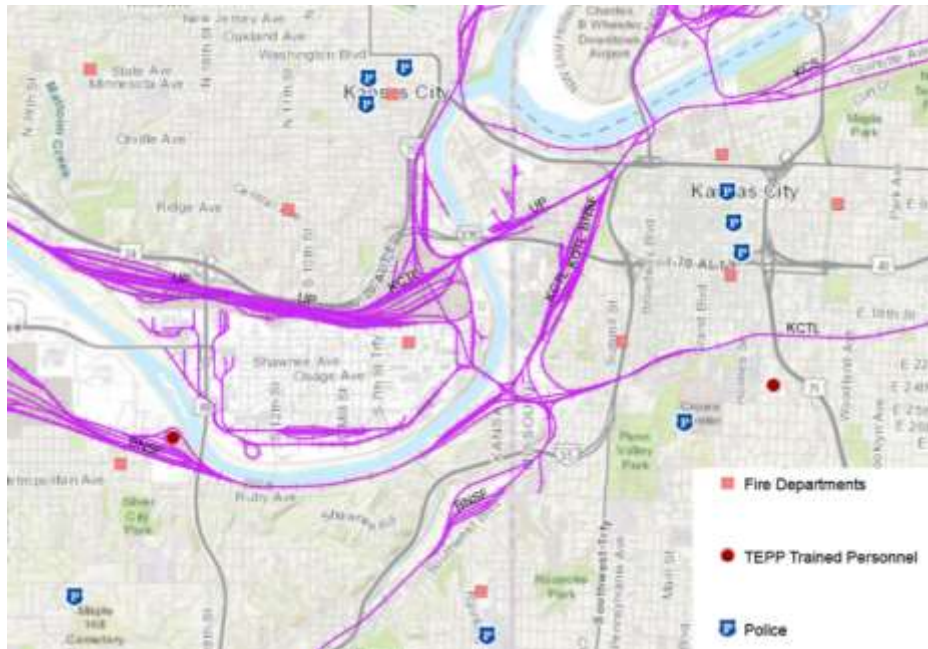
## **EVALUATING RADIOACTIVE RESPONSE CAPABILITIES & TRAINING NEEDS**

Safety and security are priorities of any DOE radioactive material shipping campaign. In the more than 70-year history of domestic transport of SNF, there has never been a radiological injury. However, as part of the Department's commitment to public safety, DOE provides federally-funded radiological response training to emergency responders along radioactive materials transportation corridors through its Transportation Emergency Preparedness Program (TEPP). This program is designed to ensure that federal, State, Tribal and local responders have access to the plans, training and technical assistance necessary to effectively respond to transportation incidents involving DOE-owned radioactive materials. The availability of TEPP-trained responders complements other safety and law enforcement resources, such as fire departments, police, and medical services.

START is being used to identify where TEPP-trained personnel are located along shipping corridors, identify spatial gaps between trained personnel, and support efficient deployment of DOE training resources. START also contains spatial data representing the location and capabilities of fire departments, police, hospitals, and state emergency response centers. This information can be displayed in map form and can be filtered to identify a subset of locations that meet user-defined capability requirements. DOE is also using START to evaluate the quality of emergency response coverage on potential transport routes by assessing the timeliness with which responders can reach the scene of an incident, and the corresponding personnel and equipment available.

### **Proximate Response Assets**

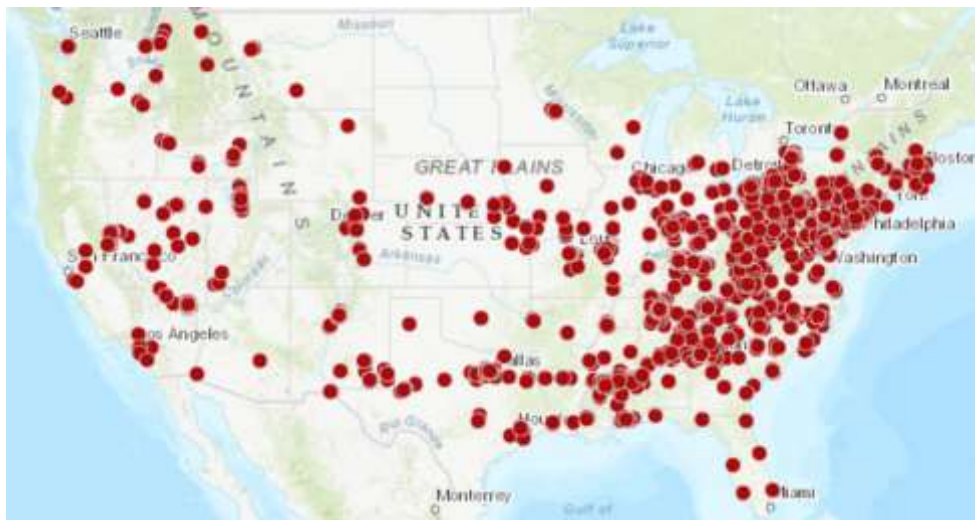
Local fire departments are typically the first responders to an incident scene, and make early decisions on how to manage the situation (e.g., cordon off the area, call for additional support, etc.). Law enforcement tends to arrive in short order as well, restricting access to the site and managing public safety. When the incident involves a shipment of SNF, radiological specialists are summoned to determine whether a release has occurred or remains a potential threat, as well as further risk mitigation actions to take. It is therefore important to have knowledge of the proximity of these response resources relative to potential SNF shipment routes. Figure 6 displays these response assets in proximity to the freight rail network in the Kansas City area. In addition to the location of each resource, START data includes information on the respective attributes of each entity (e.g., contact information, number of employees, available equipment, etc.).



**Figure 6. Response assets in proximity to freight rail network**

**Radiological Training Coverage**

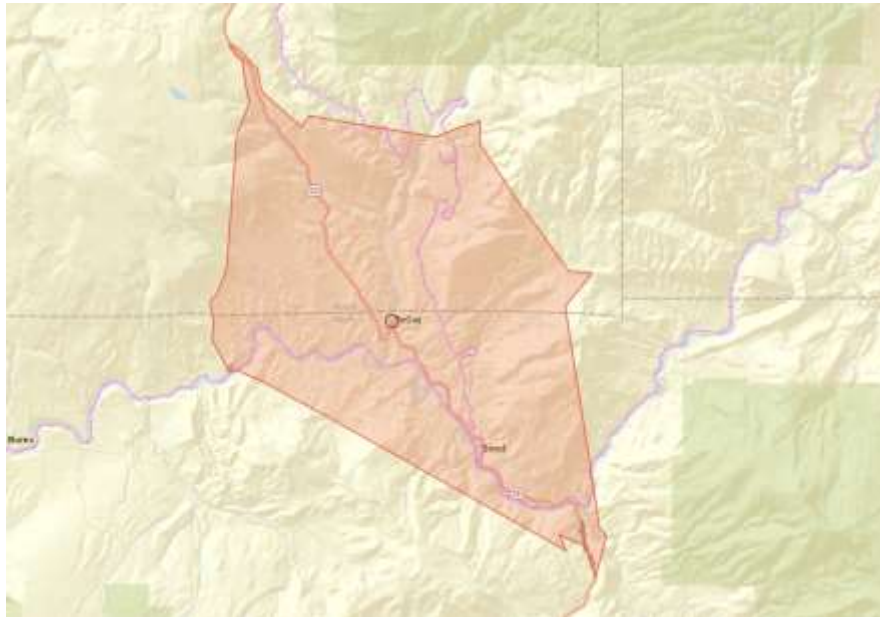
As future shipments of SNF are expected to originate throughout the country, the extent of system-wide coverage of TEPP-trained personnel is of interest. Figure 7 displays a density map of where active TEPP-trained personnel are located within the continental U.S. Note the relatively dense coverage in the eastern part of the country compared to other regions. Having this information available in START can help DOE identify where to concentrate future TEPP-training efforts.



**Figure 7. Nationwide Coverage of TEPP Trained Responders**

### **First Responder Service Area Coverage**

The ability of fire departments, as first responders, to reach the scene of an incident depends on the distance from the station to the incident site as well as the availability and quality of the road network. Included within START is a capability that allows the user to determine the service area coverage from a specified location based on a user-defined maximum response time. In Figure 8, a hypothetical maximum response time of 15 minutes is used to estimate the response coverage of the McCoy, Colorado fire department. Also included in the figure is an overlay of the freight rail network passing through the McCoy vicinity, as a reference of where the fire department can respond within 15 minutes in the event of an incident occurrence while an SNF shipment is passing through.

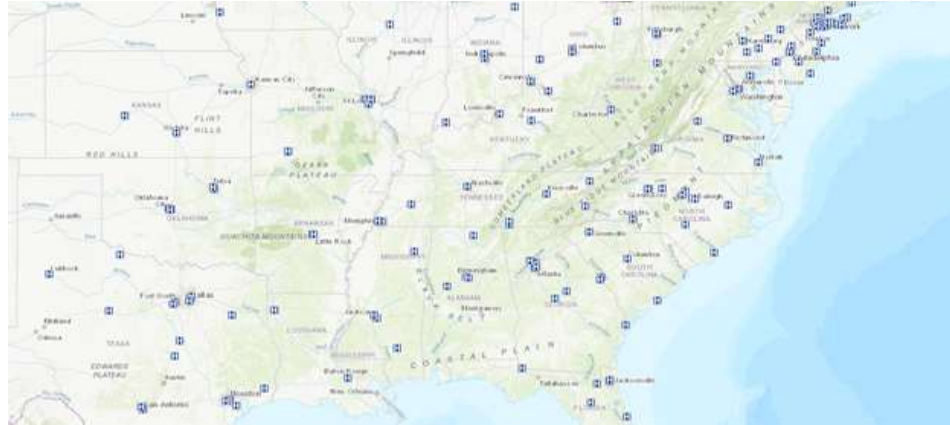


**Figure 8. 15-minute response coverage for McCoy, CO fire department**

### **Medical Assistance**

In the event of a transportation incident that involves serious or life-threatening injuries, access to medical assistance is critical. However, not every medical facility is equipped to handle such conditions. As START provides a GIS database of the location of hospitals in the continental U.S. and their corresponding attributes, these hospitals can be filtered to identify those that meet specified criteria. Figure 9 provides an example of START's filtering capability, showing only the location of those hospitals with more than 500 beds.





**Figure 9. Hospitals with 500 or more beds**

## **CONCLUSION**

Advances in information technology have provided tremendous opportunities to collect and utilize geo-spatial data in support of more informed decision-making. DOE has leveraged the availability of GIS information and spatial analysis capability to develop, in START, a platform with the capability to support planning for the movement of SNF across a wide range of transportation operating scenarios and performance objectives. This has enabled DOE to utilize START as part of several ongoing initiatives, including characterizing near-site mode and route infrastructure in proximity to shipment origins, and evaluating emergency preparedness and training needs along prospective transport routes. Looking into the future, we expect START will continue to provide important insights in those areas where the tool is supporting ongoing DOE initiatives, and perhaps into new programmatic areas as well.