

STAKEHOLDER TOOL FOR ASSESSING RADIOACTIVE TRANSPORTATION (START)

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The U.S. Department of Energy, Office of Nuclear Energy is laying the groundwork for implementation of the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste. This includes a planning project to address technical and logistical aspects of transporting SNF. A key project component is the development and utilization of a decision-support tool to evaluate transportation routing options and emergency preparedness. START (Stakeholder Tool for Assessing Radioactive Transportation) is a web-based application that utilizes geographic information systems (GIS) technology to represent transportation network operations as well as proximate features, such as tribal lands, emergency response capability, schools and environmentally-sensitive areas. Modes and routes between designated shipment origins and destinations can be evaluated according to multiple routing criteria, and constraints can be imposed that require the route to pass through or avoid specified locations. Considerable information is produced describing route efficiency, safety, security and environmental exposure that enable stakeholders to understand the implications of alternative route options. This paper describes START's capabilities.

I. INTRODUCTION

Stakeholder Tool for Assessing Radioactive Transportation (START) is a web-based, decision-support tool developed by the U.S. Department of Energy (DOE) as part of its Nuclear Fuels Storage and Transportation (NFST) Planning Project, for the purpose of evaluating routing options associated with the surface transportation of radioactive shipments (rail, truck, barge or combinations thereof).

The initial release of START, Version 1.1, is designed to focus on moving commercial SNF and GTCC waste from shutdown nuclear power plants, to be relocated to an interim storage facility. At present, the preferred method for these shipments is to use dedicated trains operating predominantly on mainline track. For

most shutdown sites, access to this network will typically require initial use of a local/regional (short line) railroad, or involve intermodal shipments where the access leg is a movement performed by heavy-haul truck and/or by barge.

DOE anticipates that START users will be comprised of federal, state, tribal and local government officials; utility companies; transportation carriers; support contractors; and other relevant stakeholders. For this reason, START has been designed to enable the user to represent a wide range of operating scenarios and performance objectives, with an emphasis on providing flexibility. Additionally, the tool makes extensive use of geographic information systems (GIS) technology for performing spatial analysis and map creation.

START is designed to run on any personal computer equipped with web access. It is strongly recommended that the user run START using the Google Chrome browser, as this is the browser for which the application has been quality-controlled. Also, certain functions within START can only be utilized if the user has access to a spreadsheet program (e.g., Microsoft Excel, Apple Numbers, Google Spreadsheet) and Google Earth. If those START functions are considered necessary to support the user's application needs, the user should obtain these respective software programs.

START is being served by Idaho National Laboratory. The program can be accessed by qualified users from the following url: <https://gis.inl.gov/start>.

II. START FEATURES AND FUNCTIONS

Embedded within START are a variety of features and functions that enable the user to explore a wide range of operating scenarios and performance objectives. In doing so, the user has the flexibility to explore various transportation options from multiple perspectives and at varying levels of detail.

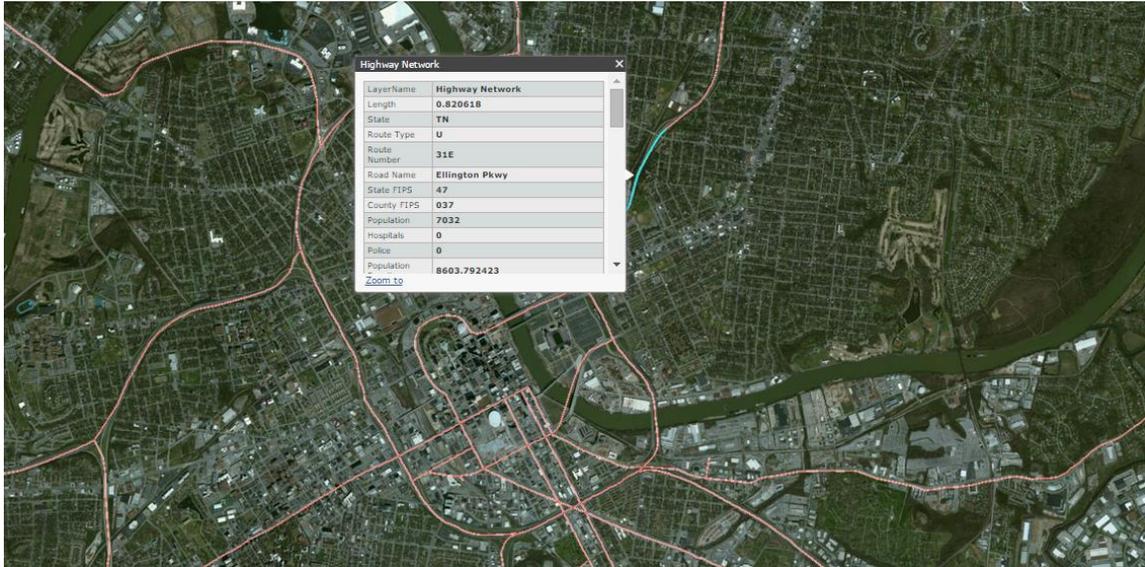


Figure 1. Highway segment with attribute table

II.A. Map Controls

One of the important START features is the ease with which the user can manipulate the maps to display the location and geographic scale of interest. This is accomplished using three capabilities: 1) zoom in/out, 2) pan, and 3) point-and-click.

II.B. Basemap Selection

START provides a basemap at all times that serves as background geography to provide the user with a spatial reference as well as a visual aid. Several basemap options are available for the user to consider in selecting the desired background. These include topographic, street, terrain, satellite imagery, and canvas options.

II.C. Feature Layers

START provides a considerable amount of spatial information that is available to support transportation planning. These feature layers define both the transportation network itself as well as characteristics of the surrounding area. The user is provided with an extensive list of layer options from which to choose (see Appendix A). These layers represent locations and characteristics of potential shipping origins and destinations, major surface freight transportation networks, political boundaries, and populations, facilities and land uses in proximity to possible shipping routes.

When a selection is made, START automatically populates the map with icons (points, polygons or lines) demarcating where the selected features are located. Points are used when the feature is a specific facility, such as a school or fire department. Polygons are used to

represent an area expanse, such as a tribal land or state boundary. Lines are reserved for representing the surface freight transportation modes (rail, truck, barge), where each line in the network corresponds to a segment of the transportation system.

The attribute table within a feature layer contains associated information that is unique to each feature (e.g., road or rail segment, police station, county). This information enables the user to understand the descriptive characteristics of the specific feature, helping to ascertain the extent to which the location is important in the transportation planning process. Once a feature layer is selected to be displayed on the map, the user can click on a feature icon, segment or polygon to display the attributes of that feature in a pop-up window. Figure 1 shows this result for a segment in the highway network line layer. The segment attributes describe several physical and operational characteristics of the transportation system as well as what is located in proximity to each segment, but the pop-up window only shows a portion of the available data. In such cases, note that a scroll bar is provided for the user to view the remainder of the information not immediately shown.

II.D. Performing a Routing Analysis

A routing analysis is initiated by prompting the user to select a shipment origin, destination and mode(s). Several options exist for the user to specify a shipment origin or destination:

- Shutdown (nuclear power plant) site
- Railhead
- DOE or other shipping facility

- Nuclear facility
- Draw origin

With the exception of the draw origin option, when any of the other selections are prompted, icons will appear on the map showing eligible locations. Hovering over the symbol and clicking the mouse permits the user to specify the location as either a shipment origin or destination. By contrast, the “draw origin” option allows the user to place the cursor over any location in the continental U.S. and designate it as the shipment origin/destination.

The user may elect to require the route to pass through one or more specified locations. A menu button is provided to initiate the process, following which the user positions the mouse at the point on the transportation network to designate the point where the shipment must pass through. Multiple pass-through points can be specified by continuing to move the mouse to each desired location and then clicking to record that site. Similarly, the user can impose barriers (either points or areas) requiring the route to avoid one or more specified locations.

Next, the user is presented with several options from which to select the method by which START searches for a preferred route. In Version 1.1, the user can opt to minimize one of the following:

- Travel time
- Trip distance
- Population exposure
- Proximity to environmentally sensitive areas
- Proximity to large gathering areas

After the route preference selection has been made, a list of route performance measures appears, prompting the user to designate which one(s) should be included in the analysis output. Figure 2 shows an example of the user choosing to find the route that minimizes travel time and opting to display all available performance measures (scroll bar used to see remainder of options).

START then begins executing the routing analysis based on the user’s selections. If a feasible route cannot be found, for example rail access is not available at the designated origin or destination when a user opts to route exclusively by rail, START will return an error message indicating a route could not be found. Otherwise, the analysis is completed, with the route results available in both map and tabular form.

II.E. Route Analysis Results

One of the outputs that START provides is a summary report, comprised of two sections: 1) a review of the user-defined routing inputs (i.e., shipment origin, destination, mode, criteria, performance measures), and 2) the overall route performance metrics for the identified route.

With the exception of the average accident frequency, trip distance, travel time and average population density, the remaining evaluation measures are an aggregation of the amount or number of features located within a one-half mile buffer (one-half mile on each side of network segment) of the entire route.

Also available as an output option is a route details table. This table presents, in sequence from route origin to route destination, every transport segment associated with the highlighted route. The user may scroll down the table to continue viewing each segment that comprises the route, or across to see the attributes associated with each route segment. When the cursor hovers over a specific route segment in the table, the data in the table and map segment are highlighted. By clicking on the magnifying glass icon associated with each route segment, the map zooms to the segment in question.

When a routing analysis is completed, the route map and corresponding performance metrics are automatically saved within START and labeled with the date and time the route was generated. Users have the option to edit saved route names according to their preference. START



Figure 2. Routing criteria and output selection

also provides the user with the ability to recall and overlay one or more saved routes, so that prior analyses can be reviewed and route comparisons can be made within the START application.

START also provides the capability for the user to export route results to a spreadsheet program using comma separate value (CSV) text file format, and to Google Earth using keyhole markup language (KML). This enables the user to perform manipulations that can take advantage of the functionality that such tools offer. Tabular data in CSV format can also be read into a GIS desktop software application, such as ArcGIS Desktop or ArcGIS Explorer, and joined with transportation feature layers using unique link IDs. Newer versions of ArcGIS or other GIS applications supporting KML files may allow import of KML route shapefiles, which can then be joined with the attributes in the CSV table, enabling users to conduct more detailed geospatial analysis or generate sophisticated map products, as desired.

Besides options to export START routing analysis results to outside spreadsheet and mapping software, the user has the ability to produce maps at any time within START by manipulating the basemap, feature layers, routing analysis results and zoom feature to create the desired product. These capabilities aid the user in understanding what is occurring on each route segment and may enhance communication with various stakeholders.

II.F. User Feedback

Throughout a START session, the user has an opportunity to provide feedback to the development team through a selection option. Space is provided for the user to submit comments pertaining to what the user likes about START, suggestions for further START enhancements, or bugs that have been encountered while using the program. This information is automatically sent via email to the START development team for consideration.

III. FURTHER DISCUSSION

START has been designated for official use only, meaning that prospective users must register for an account when accessing the web site, and must meet certain eligibility criteria. A Version 1.1 user manual has been prepared to guide registered users through the tool's features and functions.

START, Version 1.1 training sessions have been held to familiarize DOE staff and contractors, as well as state and tribal stakeholders with the tool's capabilities. Users have been impressed with START's ease of use,

comprehensive level of information to support transportation planning, and visual appeal provided by the mapping capabilities.

As NFST project activities evolve, START will be utilized in support of development of the National Transportation Plan, route selection process design and preliminary routing analysis, policy development, data collection activities at shutdown power plant sites, and coordination with overall waste management system integration.

IV. CONCLUDING REMARKS

The decision to develop START was based on a vision that stakeholders involved in the transportation of SNF, HLW and other radioactive materials would benefit immensely from being able to leverage state-of-the-art GIS platforms and databases in evaluating transportation strategies. START represents a departure from prior DOE transportation planning tools in achieving this objective. Beyond its role in supporting NFST project activities, START can serve as a valuable resource for other DOE programs as well as other government agencies involved in the transportation of radioactive and other hazardous materials.

REFERENCES

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opinions of authors expressed herein do not necessarily state or reflect those of the DOE.

APPENDIX A – START FEATURE LAYERS

Point Layers

- Shutdown sites
- Shutdown site railheads
- Nuclear reactors (commercial and research)
- DOE and other shipping facilities
- Dams
- Fire departments
- Locations of DOE Transportation Emergency Preparedness Program (TEPP) trained personnel
- Hospitals
- Malls
- Highway bridges
- Railroad bridges
- Police departments
- Marine (water) terminals
- Rail freight stations
- Schools
- Child care facilities
- Nursing homes
- Places of worship
- Government offices
- Intermodal terminals

Polygon Layers

- Sensitive environmental areas
- Stadiums and arenas
- Railroad terminal areas
- Universities
- Tribal lands
- Counties
- Congressional districts
- Coast Guard districts
- Census block population
- States
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Line Layers

- Highways
- Railroads

- Waterways
- Designated highway hazardous materials routes
- Hurricane evacuation routes