Lessons Learned From a Regional Approach to Route Selection for Spent Nuclear Fuel Shipments to Yucca Mountain

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ABSTRACT

This paper describes the landmark route identification project of the Council of State Governments’ Midwestern Radioactive Materials Transportation Committee. The Department of Energy (DOE) asked four state regional groups to produce a regional suite of rail and highway routes to Yucca Mountain, Nevada. DOE will use the regional suites of routes as a primary input into the national route selection process. The Midwest’s project used federal guidelines and regional input to develop route comparison criteria for rail and highway routes from Midwestern reactors. With this project, the Midwest not only tested the viability of a regional approach to route selection, but also tested the practicality of the federal route selection guidelines. The results and lessons learned from this project will affect future spent fuel route selection processes at both a national and regional level.

INTRODUCTION

Last year the Council of State Governments’ Midwestern Radioactive Materials Transportation Committee completed a landmark project to identify rail and highway routes for shipping spent nuclear fuel from power plants in the Midwest to Yucca Mountain, Nevada. Yucca Mountain is the eventual site of a DOE geological repository for the long-term disposal of commercial spent nuclear fuel. Shipments to Yucca Mountain will not begin for at least another seven years, but the planning for such shipments, including route selection, has already begun. The committee’s route identification project is the first of its kind and will likely influence DOE in the selection of routes from plants across the country.

In the coming year, DOE will begin a national discussion on route selection from commercial nuclear power plants and DOE sites to Yucca Mountain. In advance of that discussion, DOE asked four State Regional Groups (SRGs), organized by the Council of State Governments – Midwest (CSG), the Council of State Governments – Northeast, the Southern States Energy Board, and the Western Interstate Energy Board to each propose a regional suite of rail and highway routes in advance of the national route selection process. Only the Midwest and the Northeast chose to accept this task; the other two groups instead will wait for DOE to propose routes and then will submit comments. The Midwest’s project tested the viability of a regional approach to route selection and the practicality of the federal route selection guidelines. The results of the project will be a primary input into the national route selection process, and the lessons learned will affect future national and regional route selection endeavors.

BACKGROUND

The Council of State Governments is a nonpartisan, nonprofit organization representing all three branches of state government and committed to working cooperatively on regional issues. The Midwest Radioactive Materials Transportation Project and the committee are the result of a cooperative agreement between DOE and CSG Midwest, which has been in place since 1989. The committee serves as the regional forum for discussion on radioactive materials transportation and allows the Midwestern states to form positions on important transportation issues. The twelve member states of the Midwestern Governors Association each appoint an executive agency representative to serve on the committee, and each of the twelve state legislatures can also appoint a member through the Midwestern Legislative Conference. The Midwest is the only SRG to have both executive and legislative members, which creates a unique dialogue and promotes inter-branch cooperation.

In December 2003, DOE unveiled a strategic plan for the Office of Civilian Radioactive Waste Management (OCRWM) [1]. In that strategic plan, DOE officials described the SRGs as the anchors for DOE’s interaction and coordination with the states as they prepare for spent fuel shipments to Yucca Mountain. It was at this meeting that the idea to conduct a regional route comparison project was first discussed. At its spring 2004 meeting in Topeka, KS, the Midwestern committee decided to pursue the project [2]. The goal was to develop a suite of highway and rail routes throughout the region that the Midwestern states would find acceptable as the starting point for the national route selection discussion. The committee gave itself a December 2005 completion deadline in order to present the results to DOE in advance of the national route selection process.

APPROACH

Committee members felt a regional approach to route comparison was the proper first step in the national route selection process for several reasons. First and foremost, the states need to know shipping routes well in advance of any campaign in order to prepare and train emergency responders. By conducting a regional analysis, the states believed they would have a better indication of which routes could be used during the actual campaign, and therefore could begin to prepare. Secondly, the committee felt that states have a better feel for the rail and highway routes that run through their jurisdictions. As part of the project, the committee consulted state Department of Transportation (DOT) personnel as well as other state experts, something that wouldn’t necessarily happen in a national process. Thirdly, the committee was concerned that the national route selection discussion would begin with the routes that appeared in DOE’s Environmental Impact Statement (EIS) [3]. The committee felt the routes in the EIS were a poor starting point for discussions.

Finally, the regional framework has been incredibly successful on other projects, so the committee felt that route identification should initially follow the same path. When DOE labeled the regional groups the anchors of stakeholder interactions, they recognized the success the regions have had on forging opinions and recommendations on other aspects of the transportation program. The committee felt that if each region could successfully put together a suite of routes from which DOE would begin the national discussion it would increase the likelihood that the national suite of routes would be acceptable to all states.

In contrast to the EIS maps, the committee chose to produce of suite of highway and rail routes. A suite of routes, as opposed to one route from each reactor, provides variety, which in turn allows for greater security. In addition, multiple routes allow for flexibility in times of road construction or should an entire urban area need to be avoided due to weather or a special event. Also, since these routes represent the Midwest’s suggested starting point for the national route selection discussion, the committee felt it best to provide more than one option from as many reactors as possible, given the inevitability of further winnowing by DOE. In addition to a suite of routes from reactors in the Midwest, the committee initially planned to analyze routes from entry points on the region’s southern and eastern borders. After much discussion, however, it was decided that entry points may be hard to predict, especially since the Midwest plans to discourage shipments from the South going through the region.

To complete the task effectively and efficiently, the committee delegated the project to a smaller route identification work group comprised of committee members and state transportation and nuclear safety experts. The work group met through conference calls to discuss the project scope and to determine route comparison factors. Committee staff collected the appropriate data and did the calculations, and the work group came together to go over the initial results. The work group presented the initial results to the entire committee and subsequently received permission to interact with other stakeholders, including other regions and railroads. Using additional input from state agencies and other stakeholders, the work group was able to further refine the maps. Prior to presenting the final maps to DOE, committee members presented the findings to their governors and other interested state executives. Committee members did not seek official gubernatorial approval for the routes because the maps are not of ‘approved’ or ‘recommended’ routes. Rather, as previously mentioned, the maps are the committee’s suggested starting point for the national route selection process.

METHODOLOGY

The work group determined the best method of evaluation would be to compare all potential routes using a set of primary factors. The Federal Motor Carrier Safety Administration regulates the selection of highway routes for the transportation of radioactive materials (49 CFR 397.101, Subpart D) [4]. Shipments are required to use the shortest route along the interstate highway system, including city bypasses, unless an alternative route is designated by the state. The guidelines for designating an alternate route are laid out in the U.S. DOT’s *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Shipments of Radioactive Materials* [5]. The primary factors in these guidelines seek to limit the radiological risk of transporting radioactive materials. With slight modification, the work group chose to use the primary factors in these guidelines because they were a logical and scientifically defensible place to start.

The primary factors in the guidelines are divided into three areas: risk to the public during normal transport, risk to the public in the event of an accidental release, and the economic risk to the area in the event of an accidental release. As in the DOT guidelines, the work group chose to weight each of these factors equally in the analysis. Data required to perform the calculations for these factors include the length of the route, population along the route, accident rates, and traffic counts along the route. Data limitations required the work group to slightly modify the formulas for these factors. Table I outlines the original formulas, the work group’s modifications to those formulas due to data limitations or process decisions, and the data needed to execute the calculations.

Table I: Highway Primary Factors, Formulas, Data and Data Sources

<table>
<tr><th>Factor</th><th>Measurement</th><th>Original Formula</th><th>Modification</th></tr>
<tr><td>Factor 1: risk to the public during normal transport</td><td>dose to inhabitants
+ dose to other vehicles
+ dose to crew and people at truck stops</td><td>$((PL/v)*C_1)$
$+ ((LT/v^2)*C_2) + ((LT^2/v^3)*C_3)$
$+ (L/v)$

The original formula includes the dose to the truck crew.</td><td>$((PL/v)*C_1)$
$+ ((LT/v^2)*C_2) + ((LT^2/v^3)*C_3)$
$+ (.2L/v)$

The only modification to the formula is to remove the dose to the truck crew. The work group felt that crew members should be considered radiation workers and their dose should not be included.</td></tr>
<tr><td colspan="4">Data and Sources for Factor 1:
P = people per square mile; population (POP) along the route is determined by TRAGIS. To get P, we divide the population by the square mileage, which is determined by multiplying the length (L) by the band width (2500m or 1.6 miles on either side). P = POP / (L x 3.2)
L = length in miles; determined by TRAGIS
T = average traffic count in vehicles per hour: Counts obtained from the Federal Highway Administration, Office of Highway Policy. Average count in vehicles per hour determined by averaging all daily counts along the segment from beginning to ending milepost and dividing by 24.
v = average speed in miles per hour; measured as the posted speed limit as reported by the Insurance Institute for Highway Safety.
$\mathbf{C_1} = 6.8 \times 10^{-5}$
$\mathbf{C_2}$ = conversion factor determined by distance between opposing lanes of traffic; distance between lanes measured as distance between centers of opposing lanes of traffic. This distance is the median width plus width of one lane of traffic. Average median width along the segment obtained from the Federal Highway Administration, Office of Highway Policy. It is determined by averaging all widths from beginning milepost to ending milepost. Lane width along the interstate highway system is a standard 12 feet.
$\mathbf{C_3}$ = conversion factor determined by average vehicle separation (v/T) in feet; determined by multiplying the average speed (v) by 5280 to get feet per hour, and then dividing by average hourly traffic (T).</td></tr>
<tr><td>Factor 2: risk to the public in the event of an accident</td><td>Population x multiplier / length x accident rate</td><td>$(((P_1 \times .75) + (P_2 \times .25))$
$/L)*AR$
The original formula called for population counts in a 0-5 mile (P_1) and 5-10 mile (P_2) bands.</td><td>(POP/L)*AR

Data limitations only allowed measurements of population in a 0-2500m band. The work group determined all population within this band is under the same risk, so no multiplier is necessary.</td></tr>
</table>

Table I: Highway Primary Factors, Formulas, Data and Data Sources (Cont’d)

<table>
<tr><td colspan="4">Data and Sources for Factor 2:
POP = population along the route in 0-2500 meter band: determined by TRAGIS
L = length in miles
AR = accident rate in accidents per mile per day; accident counts for each county along each segment were obtained from state DOTs. Since it is difficult to determine at which milepost each accident occurred, and for consistency and conservancy, the work group decided to use all accidents on the specific roadway from each county the segment passes through. The accident counts for these counties were summed, divided by 365 to get accidents per day, and divided by length (**L**) to get accidents per mile per day.</td></tr>
<tr><td>Factor 3: economic risk to the area in the event of an accident</td><td>Square mileage for each category in 0-5 band x multiplier + square mileage for each category in 5-10 band x multiplier / length x accident rate</td><td>$(((SM^{0-5} \times M_1) + (SM^{5-10} \times M_2)) / L) * AR$

The original formula called for land use square mileage in 0-5 mile (SM^{0-5}) and 5-10 mile (SM^{5-10}) bands.</td><td>$((SM \times M_1)/L) * AR$

Since population was only available up to 2500m, the work group decided to reduce the land use band to 0-2500m. In doing this, the 5-10 mile part of the equation is removed.</td></tr>
<tr><td colspan="4">Data and Sources for Factor 3:
SM = square mileage by land use; land use data obtained from the U.S. Geological Survey and analyzed using ArcView GIS software.

Land Usage Type (SM) — Multiplier (M_1)
Rural/vacant sq mileage — .002
Single family sq mileage — .1
Multiple family sq mileage — 2
Commercial sq mileage — .2
Parks/public land sq mileage — .265

L = length in miles
AR = accident rate in accidents per mile per day</td></tr>
</table>

With slight modification, the work group elected to use these factors for both potential highway and rail routes. The decision was significant because it assumes that measures of risk for highway transport are also appropriate for rail. The work group made this difficult decision for two reasons. First, the Midwestern states have always reasoned that shipments of similar material should be treated in similar fashion. Second, since a project of this sort had never been undertaken before, the work group was interested in testing whether the DOT guidelines would work for rail as they work for highway. The work group felt the decision was defensible because the DOT guidelines try to reduce the risk of transportation to the public and environment, which should be a goal regardless of mode. Similarly, whether shipping by highway or rail, the work group felt routes should minimize travel through densely populated or high-accident areas, which is reflected in the DOT guidelines. Table II outlines the data and formula changes necessary to modify the guidelines for rail route comparison.

Table II: Rail Primary Factors, Formulas, Data and Data Sources

<table>
<tr><th>Factor</th><th>Measurement</th><th>Original Formula</th><th>Modification</th></tr>
<tr><td>Factor 1: risk to the public during normal transport</td><td>dose to inhabitants
+ dose to other vehicles
+ dose to crew and people at rail yards</td><td>$((PL/v)*C_1)$
$+ ((LT/v^2)*C_2) + ((LT^2/v^3)*C_3)$
$+ (L/v)$

The original formula includes the dose to the rail crew.</td><td>$((PL/v)*C_1)$
$+ (.2L/v)$

As with highway, the work group chose to remove the dose to the rail crew. In addition, there are no other vehicles traveling next to trains, so the dose to other vehicles was removed.</td></tr>
<tr><td colspan="4"><u>Data and Sources for Factor 1</u>:
P = people per square mile; population (POP) along the route is determined by TRAGIS. To get P, we divide the population by the square mileage, which is determined by multiplying the length (L) by the band width (2500m or 1.6 miles on either side). P = POP / (L x 3.2)
L = length in miles; determined by TRAGIS
v = average speed in miles per hour; measured as the fastest speed the train could travel, which is determined by track class. Oak Ridge National Laboratories provided a list of track classes for the major track subdivisions. Whichever subdivision the majority of the segment was part of was the assigned track class and corresponding track speed.
$\mathbf{C_1} = 6.8 \times 10^{-5}$</td></tr>
<tr><td>Factor 2: risk to the public in the event of an accident</td><td>Population x multiplier / length x accident rate</td><td>$(((P_1 \times .75) + (P_2 \times .25))$
$/L)*AR$

The original formula called for population counts in a 0-5 mile (P_1) and 5-10 mile (P_2) bands.</td><td>(POP/L)*AR

Data limitations only allowed measurements of population in a 0-2500m band. The work group determined all population within this band is under the same risk, so no multiplier is necessary.</td></tr>
<tr><td colspan="4"><u>Data and Sources for Factor 2</u>:
POP = population along the route in 0-2500 meter band; determined by TRAGIS
L = length; determined by TRAGIS
AR = accident rate in accidents per mile per day; accident counts for each rail line in each county along each segment were obtained from the Federal Railroad Administration. Similar to highway, the work group decided to use all accidents from each rail line in each county the segment passes through. The accident counts for these counties were summed, divided by 365 to get accidents per day, and divided by length (L) to get accidents per mile per day.</td></tr>
</table>

Table II: Rail Primary Factors, Formulas, Data and Data Sources (Cont’d)

Factor 3: economic risk to the area in the event of an accident	Square mileage for each category in 0-5 band x multiplier + square mileage for each category in 5-10 band x multiplier / length x accident rate	$(((SM^{0-5} \text{ x } M_1) + (SM^{5-10} \text{ x } M_2))/L)*AR$ The original formula called for land use square mileage in 0-5 mile (SM^{0-5}) and 5-10 mile (SM^{5-10}) bands.	$((SM \text{ x } M_1)/L)*AR$ Since population was only available up to 2500m, the work group decided to reduce our land use band to 0-2500m. In doing this, the 5-10 mile part of the equation is removed.

Data and Sources for Factor 2:
SM = square mileage divided by land use; land use data obtained from the U.S. Geological Survey and analyzed using ArcView GIS software.

Land Usage Type (SM)	Multiplier (M_1)
Rural/vacant sq mileage	.002
Single family sq mileage	.1
Multiple family sq mileage	2
Commercial sq mileage	.2
Parks/public land sq mileage	.265

L = length in miles
AR = accident rate in accidents per mile

The DOT guidelines also include a set of secondary factors to evaluate routes if comparison using the primary factors doesn’t distinguish a clear preference. The secondary factors in the guidelines are emergency response capabilities, evacuation capabilities, special facilities in the area, and accident fatalities/injuries along the route. The work group felt that these factors did not accurately represent what the Midwest states felt was most important when considering potential routes, and therefore chose to develop a separate set of secondary factors and weight them accordingly. The four secondary factors evaluate urban areas traversed, accident rates along the route, road or track quality, and traffic density along the route. These factors more accurately reflect the Midwest’s desire to keep shipments away, to the extent possible, from highly populated, high density, accident-prone areas, and keep shipments on the best roads and track. Table III shows the formulas, data, and data sources for the secondary factors. Significantly absent from these factors is time in transit. Although intrinsically involved in each of the primary factors with the use of length and speed variables, time in transit was not considered on its own as a priority factor.

Table III: Secondary Factors, Formulas, Data and Data Sources

Factor (weight)	Measurement	Formula	Data and Source
Factor 1: avoid urban areas (50%)	Square mileage of ‘urban’ land along the route	(L*3.2)*Urban SqM Percentage	TRAGIS provides both the length (**L**) and the percentage of land within the 2500 meter band that is considered urban. TRAGIS measures urban land is that which has more than 3326 people per square mile.
Factor 2: avoid high accident rate areas (20%)	Accidents per mile per day	Accident count/365/L	See Tables 1 and 2 for accident rate (**AR**) calculations and data sources.
Factor 3: keep shipments on the best road/track (15%)	Highway: (lane width factor) + (median width factor) + (pavement condition rating factor)	<u>lane width</u> 12ft =1 <u>median width</u> 0-25ft = 3 26-50ft = 2 51+ft = 1 <u>pavement condition</u> 0-75 = 3 76-99 = 2 100+ = 1	The Federal Highway Administration, Office of Highway Policy provided median width and pavement condition data. Average median width and pavement condition was determined by averaging all counts along the segment from beginning to ending milepost. All lanes on the interstate system have a lane width of 12. Based on averages, each segment was awarded a point value for each measure. These point values were added together to determine the segments overall point value.
	Rail: (track class factor)+(dual track percentage factor)	<u>track class</u> 1-3 = 3 4 = 2 5+ = 1 <u>dual track %</u> 0-50 = 3 51-75 = 2 76-100 = 1	Oak Ridge National Laboratories provided a list of track classes and the percentage of each subdivision that had dual tracks. Whichever subdivision the majority of the segment was part of was the assigned track class and dual track percentage. Point values were then assigned to each segment and the point values were added together to determine the segments overall point value.

Factor 4: avoid high traffic areas (15%)	Traffic density	Highway: average daily traffic Rail: average daily tonnage	Highway: Counts obtained from the Federal Highway Administration, Office of Highway Policy. Average count in vehicles per day determined by averaging all daily counts along the segment from beginning to ending milepost. Rail: TRAGIS provides tonnage density rating counts of 1-7 along each segment. We averaged the tonnage density count along the segment and applied the average to a chart based on an average of 1 having 0 tons per year and an average of 7 having 40 million tons per year.

Once the comparison factors were finalized, the work group generated potential routes using DOE’s Transportation Routing Analysis Geographic Information System, or TRAGIS [6]. DOE has been using TRAGIS in one form or another to evaluate shipping routes since 1979. The work group decided to include all reasonable routes in the analysis. In other words, routes that directed shipments eastward, to the far north or far south were not included. In addition, in the rail analysis, the work group used individual judgment to exclude routes that had excessive carrier changes and therefore seemed operationally undesirable. Fig. 1 provides an example of analyzed highway and rail routes from the Dresden nuclear power plant near Morris, IL. Figs. 2 and 3 show all analyzed highway and rail routes from all Midwestern reactors.

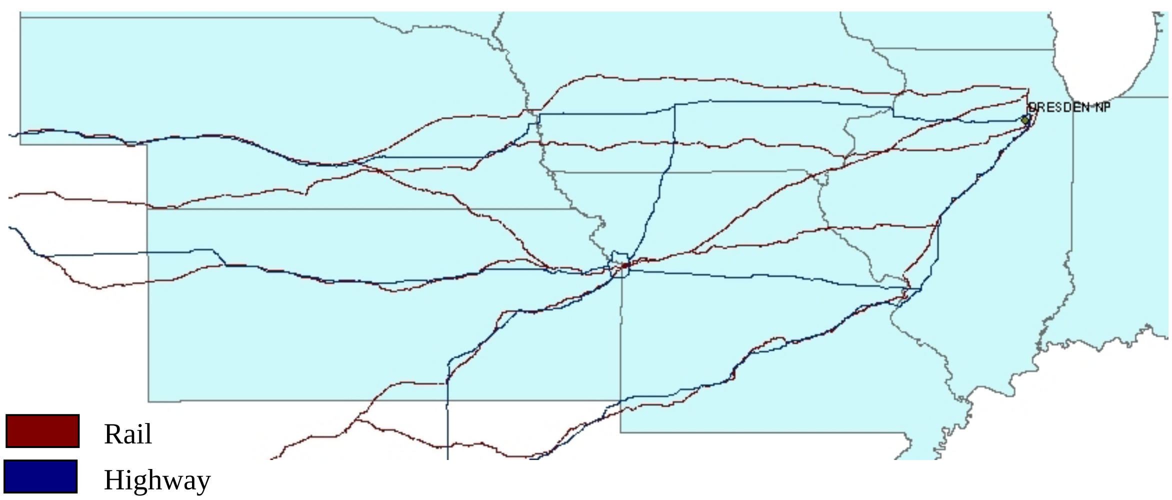

Fig. 1 : Analyzed rail and highway routes from Dresden nuclear power plant to Yucca Mountain, NV

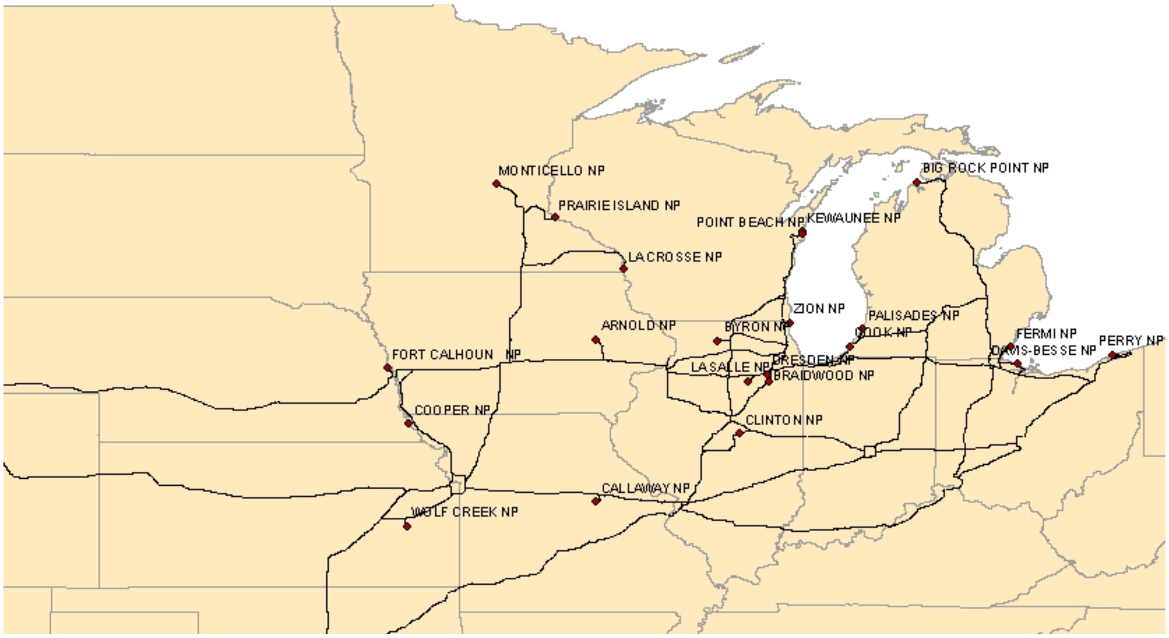

Fig. 2: All highway routes analyzed in the Midwestern route identification project

Fig. 3: All rail routes analyzed in the Midwestern route identification project

TRAGIS provided a substantial amount of the required data; however, it did not provide even enough data to satisfy the DOT guidelines in their original form. Data collection took several months and required contacting numerous federal and state agencies. Each set of routes from each reactor was analyzed separately. Each route was segmented prior to comparison in order to facilitate calculations; a new segment began either when the route changed highways or rail carriers, or when the route crossed state lines. Calculations were performed for each segment and then segment results summed to get the route total. Once all routes from the reactor were analyzed in this manner, the route totals were normalized. Any routes that were within 20% of the lowest normalized score were then run through the calculations for the secondary factors.

The route totals for the secondary factors were normalized and the top 2-3 routes from each plant, depending on scores, were accepted into the suite of routes. Table IV shows the results of the primary factor analysis of and Table V the results of the secondary factor analysis of highway routes from the Dresden plant. As demonstrated by these tables, the first Dresden route had the best primary and then secondary score.

Table IV: Primary factor analysis results of highway routes from Dresden nuclear power plant.

Route (description)	Factor 1 Results (Normalized Score)	Factor 2 Results (Normalized Score)	Factor 3 Results (Normalized Score)	Final Normalized Score
Dresden 01 (I80)	4.351 (.167)	454.646 (.010)	.130 (.013)	.19
Dresden 02 (I80, I35, I70)	4.614 (.177)	461.119 (.010)	.270 (.027)	.21
Dresden 03 (I80, I35, I40)	4.119 (.158)	3852.260 (.083)	.760 (.076)	.32
Dresden 04 (I55, I70)	4.989 (.191)	11186.297 (.241)	2.776 (.279)	.71
Dresden 05 (I55, I70, I35, I40)	4.389 (.168)	13014.789 (.281)	3.090 (.311)	.76
Dresden 06 (I55, I44, I40)	3.604 (.138)	17377.470 (.375)	2.920 (.294)	.81

Table V: Secondary factor analysis results of highway routes from Dresden nuclear power plant.

Route (description)	Factor 1 Results (Normalized Score)	Factor 2 Results (Normalized Score)	Factor 3 Results (Normalized Score)	Factor 4 Results (Normalized Score)	Final Normalized Score
Dresden 01 (I80)	.013 (.501)	.019 (.443)	3.714 (.493)	30313.857 (.541)	.49
Dresden 02 (I80, I35, I70)	.013 (.499)	.024 (.557)	3.618 (.507)	25727.091 (.459)	.51

RESULTS AND CONSULTATIONS

The work group found that the primary and secondary factors did produce a suite of routes that had lower affected populations, lower accident rates, and better road and track conditions. The process did a good job of narrowing down the list of potential routes, and as would be expected, many of the lowest risk routes converged as they moved westward towards Yucca Mountain.

The work group felt, though, that quantitative analysis alone could not determine the final results. As mentioned earlier, one reason behind the Midwest’s pursuit of the regional approach to route identification was the belief that state transportation officials and other state experts have a better feel for the routes that pass through their jurisdictions. With that in mind, the work group shared the initial results with the full committee and asked committee members to solicit the opinions of their state DOT personnel or other interested state agencies. The work group also solicited comments from other affected SRGs.

In addition to SRG and state agency opinion, the work group also felt that for rail, operational constraints were not considered in the quantitative analysis. Some common sense based on transport carriers' expertise had to be considered. With that in mind, the committee gave the work group permission to consult affected railroad companies. Work group members met with six Class I railroads (Union Pacific, BNSF, Canadian National, Canadian Pacific, Norfolk Southern and CSX Transportation) to go over the operational viability of the rail routes. Railroad representatives provided specific comments on interchange points and rail line usage.

These consultations provided the work group with additional information to further reduce the number of routes in the suite. Any routes or segments that state agencies identified as problem areas were reevaluated and altered if necessary. The suite was also altered to correct any operational roadblocks the railroad representatives identified.

After several months of consultations and reevaluation of the maps, the final suite of routes was presented to the full committee. Fig. 4 shows a map of the final results. Committee members were not asked to approve the suite of routes, nor were they asked to seek official approval from their governors. Rather, since the suite of routes represents the Midwestern states' preferred starting point for the national route selection discussion, the work group asked that committee members simply inform their governors' of the process and results of the project.

Fig. 4: Final rail and highway route results of the Midwestern route identification project

The work group presented the suite of routes to DOE a year and a half after beginning the route identification process. The routes were presented as those that meet the regional criteria for ensuring the selection of safe routes and the region's suggested starting point for national route selection discussions. The Midwestern states realize that the suite does not necessarily reflect the routes that DOE will ultimately use to ship spent fuel and high-level waste to Yucca Mountain. However, they do hope that the suite will be a primary input into the development of the national suite of routes, along with other regional input and operational considerations. The states believe that the work group spent considerable time developing criteria, producing and analyzing potential routes, and consulting with other stakeholders, and therefore DOE should give the results the utmost consideration.

LESSONS LEARNED AND CONCLUSIONS

As previously stated, the committee chose to undertake the project not only to produce a suite of routes, but also to test the viability of a regional approach to route comparison and the practicality of the federal route selection guidelines. A primary lesson learned from the process was that the regional route identification process does in fact work. When asked their thoughts about the process, work group members agreed that the regional project was the logical first step in the national route selection process. The Midwestern states felt strongly that they were in a better position to judge the quality of the rails and roads running through their jurisdictions. While the national route selection process will most likely take into consideration the quality of the route infrastructure, the Midwestern states felt that their individual DOTs and other state experts had intimate knowledge about the traffic, safety, and viability of potential routes.

More importantly, the Midwestern states felt that by conducting a regional review of potential routes, the factors and conditions most significant to the Midwest would receive primary consideration. While every region undoubtedly wants to keep shipments on the best road and track, specific factors that are necessarily important to the highly populated, though small Northeastern states are likely different from those factors significant to the large, sparsely populated Western states. A regional analysis allowed the Midwestern states to identify urban areas, high accident areas, high traffic areas, and areas of poor road or track as places to avoid. Again, though these factors may indeed be singled out in the national route selection discussion, the Midwestern states felt there was no guarantee, and therefore chose to pursue the regional analysis first. While certainly every route in the suite has its pluses and minuses, the suite as a whole is acceptable to all the Midwestern states as the preferred starting point for national discussions. At minimum, the least acceptable routes through each state were eliminated, and those that remain meet the Midwest’s regional criteria for ensuring the selection of safe routes.

Another lesson learned is that the DOT guidelines can be adapted to analyze both potential highway and rail routes. There are no federal guidelines for selecting rail routes for hazardous material shipments. This posed a problem to the Midwest’s methodology, and the work group made the significant decision to use the highway guidelines for rail route analysis. The results proved that this was an appropriate decision. Both the highway and rail routes identified by the process avoid, to the extent possible, high population and accident-prone areas, and stay on the best road and track. The Midwestern states realize that it is impossible to entirely avoid urbanized areas or high traffic areas. The interstate system in its design runs from one population center to the next, and rail lines often do the same, however the process did identify the lowest risk routes out of those available.

A third lesson learned is that applying the DOT guidelines is difficult but is a good first step in route analysis. The work group found that while the data to satisfy the formulas for the DOT guidelines was not impossible to find, it was not readily available. Data was collected from a variety of sources including state DOTs, the U.S. Geological Survey, the Federal Highway Administration, and the Federal Railroad Administration, among others. Because some of the data was collected from individual state agencies, the data was not necessarily uniform across states. However any differences in data from state sources were overcome by adapting it to meet standard measures. The committee concluded that a central source for route selection data would be ideal; however data collection and adaptation were not so prohibitive as to make the application of the guidelines impossible. The committee concluded that the DOT guidelines are a practical and defensible place to start route comparison analyses.

A final lesson learned is that while the DOT guidelines are a good place to start, quantitative analysis alone cannot determine the final suite of routes. The quantitative analysis did a good job of narrowing down a seemingly exhaustive list of potential routes, but that analysis alone cannot narrow the list far enough. Some common sense, based on transport carriers' experience and state officials' expertise, must also be considered. In addition, TRAGIS can generate a comprehensive list of potential routes, but data alone cannot determine whether the routes and rail routes in particular, are operationally viable. Therefore some qualitative consultation is a necessary step in the process.

In the coming year, DOE will embark on a national route selection process. The Midwestern states hope that the results of this route identification project will be a primary input into that discussion. In addition, the Midwestern states hope that the experience and lessons learned from this project will influence the process for that national discussion. Committee members and work group participants found the project to be a worthwhile endeavor. Though daunting, the regional approach was successful, as was the adaptation and use of the DOT guidelines. While ultimately the national route map may not exactly reflect the results of this project, the Midwest's groundbreaking effort will undoubtedly influence DOE and any others who initiate a route comparison project.

REFERENCES

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