

METHODOLOGICAL CONSENSUS IN COMPARING ROUTES FOR TRANSPORTING SPENT NUCLEAR FUEL

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ABSTRACT: METHODOLOGICAL CONSENSUS IN COMPARING ROUTES FOR HIGH LEVEL WASTE TRANSPORTATION

Choosing routes on which to ship high level nuclear waste to a disposal site poses unique challenges. To successfully designate routes for shipping high level waste as part of a complex and lengthy shipping campaign, it will be necessary to successfully integrate public policy and technical analysis. Two recent route comparison studies suggest that the ability to integrate them is possible. Methods of doing so are evolving. These studies will be described and their promise for the future described. Route selection is key transportation issue but technical analysts must ensure their work can contribute to the policy discussion.

INTRODUCTION

The purpose of this paper is to suggest that a “metanoia”- a shift of mind¹ is taking place in the process used to select the routes for transporting radioactive waste. This change is taking place at the staff level and mirrors national trends in environmental decision-making.² By advocating integration of public policy and technical information, this paper hopes to describe a doctrine for route selection that will move discussion about route selection away from a sterile past, toward a realistic future.

This paper begins by defining current perspectives on about route selection, then describes a route selection report and a case study that possess suitable characteristics. The paper identifies the similarities of these studies and suggests how transportation professionals involved in radioactive waste transportation route selection can use these similarities to make their technical work heard by policy makers. The paper concludes by defining these characteristics and making recommendations about future work on route selection. One assumption made in this paper is that lessons for high level waste transportation can be learned from the low level waste transportation program. By moving low level waste properly, the DOE will know what steps are necessary to move the high level waste just as well.

Route Selection

The dimensions of many other issues (notably emergency management) can only be estimated until routes are selected. Agencies that once disdained transportation issues are beginning to recognize that it is central to the success or failure of any disposal program.³ Transportation is intruding into the radioactive waste community as never before for three reasons: 1) Interim storage raises the likelihood of a high level radioactive waste disposal program that is no longer dependent on geological investigation 2) DOE's accelerated cleanup program has increased the volume of low-level and mixed waste being transported and 3) Route selection that effectively integrates public policy and technical information is actually working.

The primary challenge for professionals involved in route selection is to ensure that technical analysis plays a part in the decision making process. Technical policy analysis is often never used by decision-makers.⁴ To make technical analysis an effective part of route selection, transportation officials must do technical work that decision-makers can and will use. A route selection must be also seen by the affected parties to be the result of a legitimate process. Integrating technical and public policy relies on commonly accepted democratic processes and makes it possible to make tough policy decisions despite organized opposition.

It is important to carefully define two components. The "technical" component of route selection refers to route comparisons that measure risk through quantitative means. This absolute definition of risk relies on fault trees, statistics and probability to compare the routes being considered for transporting waste.⁵ This is the traditional process of risk assessment. The public policy component of route selection refers to the political context in which route selection is made. It is somewhat qualitative in nature and relies heavily on the political requirement of local, state, and national politics. Another crucial part of a route selection is the need for a legitimate process. In this case, legitimacy refers to a process conducted in accordance with some set of rules or with established legal forms or requirements. Route comparisons may take place in a policy environment where ground rules for the comparison are established and adherence to the comparison process is what ultimately lends legitimacy to the analysis.

The challenge for the technical community is how to ensure that technical analysis can influence public policy. A negotiated route selection process that is comprehensible to decision makers will be accepted as legitimate and ultimately more acceptable to the public. A technically valid analysis that does not accept political realities may be discarded or ignored. Collaborative efforts between DOE, states, local governments and carriers provides an essential characteristic of legitimacy that point the way to solving the route selection problem. This kind of integration requires that cooperating agencies share power. This is an approach to regulatory problems the DOE has effectively adopted in other areas and has termed "collaborative decision-making."⁶ A DOE study done to examine the transportation of low level waste to the Nevada Test Site demonstrates that routes can be selected through a cooperative process whose limits are established by technical criteria.

Why is this important?

Route selection for high level waste transportation will be the most publicly contentious part of the waste disposal process. Route selections made for purely technical reasons can have undesirable consequences. Before the recent elections in Germany, nuclear power was a part of their energy "mix." Due to the riots and scandals associated with shipping spent fuel, the new German government has decided to abandon nuclear power altogether.⁷ If the waste disposal program is not to become a divisive national issue, as it became in Germany, a route selection process must work within the constraints of public policy. However, a route selection made for political reasons undisciplined by technical understanding is also undesirable. Without technical input, the most trivial hazard will allow powerful majorities will impose their will on less influential minorities. This arbitrary action may increase disposal costs, increase risk, and alienate portions of the public.⁸

ALTERNATIVE VIEWS ON THE TRANSPORTATION ISSUE

Past discussion about the transportation of spent fuel has generally focused on either absolute the risks of transporting the fuel⁹ or on the challenges of communicating the risk to the

public.¹⁰ The first perspective asserts that there is little risk caused by the transportation of high level nuclear waste and that the public is irrational for believing that radioactive waste transportation is dangerous. This perspective eagerly refutes the “Mobile Chernobyl” assertions of nuclear opponents. The problem with this approach is that public concern is more complex. Route selection is as much about trust, democracy, and our form of government as it is about the probability or consequences of a release.¹¹ Often, assessments of the risks of transporting radioactive waste do not address these other constraints. While the risks of transporting spent fuel may, indeed, be small, the process by which the risk was imposed is highly important. This could lead to a situation in which a valid technical analysis is ignored and route selections will be entirely the realm of political power.

The second perspective argues that risk communication can make a difference in allaying public concerns along transportation corridors. This is certainly true, but it does not go far enough. The same problems that have beset risk-based perspectives also limit the usefulness of risk communication. The depth and complexity of public concern about issues like radioactive materials is often not touched even by effective risk communication. Past risk communication failures serve to highlight the importance of the process used to make decisions.¹² If the public believes a route selection process is insufficient, then talking about it will only make matters worse.¹³ A collaborative decision model, in which DOE shares power with stakeholders, may accomplish more than the best risk communication program. Public policy can be successfully integrated with technical analysis. Technical analysis must tread a very fine line to avoid being discarded altogether.

TEC ROUTING WHITE PAPER

DOE established the TEC in 1992 to bring together organizations that are concerned about radioactive materials transportation. In March 1998, the TEC routing subcommittee issued a white paper entitled “Routing Issues Related to US Dept of Energy Radioactive Materials Transportation: Discussion and Recommendations.” Lists of issues important to states, tribes, and local governments comprise the heart of the paper. The paper argues that because states and local governments have a constitutional role in protecting their citizens, they necessarily also have a role to play in route selection. It is impossible for states and localities to ignore a lengthy radioactive material shipping campaign. The paper makes three recommendations related to radioactive waste transportation that are summarized here:

1. DOE should develop a standardized cooperative approach to route selection for all unclassified shipping campaigns involving radioactive materials. As its model, DOE should use the route selection process established for the WIPP program.
2. DOE’s route selection program should attempt to promote safety and public acceptance of the routes, reduce the number of routes to permit focusing limited emergency management resources and provide time for affected parties to prepare their emergency management personnel
3. The Secretary of Energy should widely disseminate the white paper to engender discussion throughout the federal government.

The white paper recommendations highlight the importance of the process of route selection. Rather than involve only the affected parties near the origin of the shipments, the paper recommends collaborating between affected parties within the transportation corridor through which the waste will pass. This collaboration will ultimately legitimize the route selections, and equip policy makers with technical information they need to respond to public concerns.

Collaboration of this sort was clearly envisioned by the US Department of Transportation: "As DOT acknowledged. The state governments are in a better position than either the federal or the local governments to consider the overall safety impacts of routing decisions. For this reason, DOT invested states with the authority to designate alternate highway routes."¹⁴ The DOT accepted the need for something like a collaborative process of route selection.

The other dimension of the white paper is that the route selection must strive to integrate their public policy concerns in to the technical analysis. The paper suggested that localities have meaningful input into route selection by 1) "identifying criteria and recommending priorities for such criteria," 2) know how the data will be used, and 3) "have input on how the results may be presented in a meaningful and understandable manner to decision makers and the public."¹⁵ These three comments characterize the conditions necessary for a successful collaborative route comparison. By allowing outside parties to assist DOE in establishing the rules of engagement in a route comparison study, the outside parties become invested in the process and the study itself. This interaction vests the study results with a power and legitimacy they would not otherwise possess. It brings the technical and the political together. The process advocated by the TEC white paper has been successful in an area already imbued with anti-waste disposal sentiments.

CASE STUDY: LOW LEVEL RADIOACTIVE WASTE SHIPMENTS TO THE NEVADA TEST SITE (NTS)

In the fall of 1996, the Nevada Risk Assessment Project (NRAMP) concluded that DOE could save a considerable amount of money by employing intermodal transportation.¹⁶ In this shipment technique, waste leaves the generator site by truck and travels to a rail yard where it is loaded onto rail cars and is shipped via rail to a site near the final destination. At this site, waste is off-loaded from the train and placed onto trucks for the final stage of the trip to the disposal site. Intermodal shipping is common practice for other commodities and applying it to transporting LLW is certainly cost-effective.

The problem for the DOE Nevada Operations Office (DOE/NVOO) was to select an intermodal site for the destination end of the journey - that is, the rail site nearest to the final disposal site at the Nevada Test Site (NTS). This group cooperated with DOE to compare the five sites and routes from the five sites to the NTS.

The DOE/NVOO ultimately formed a group to study the problem from among its stakeholders. The final study, entitled "Nevada Test Site Intermodal Transportation Facility Site and Routing Evaluation Study," was published in January of 1998. The DOE broke new ground by entering into a cooperative study of this type.

Evaluating an intermodal site is unusual because both the site characteristics and the routes used to travel to and from the site are important - in this case the routes were of primary importance. An intermodal site can be established with very little preparation. It was likely that any potential site could support intermodal shipments. However, route comparison loomed as the challenge for the study. Five potential sites were considered. These sites are depicted in Figure 1. At the first meeting, the study group chose the criteria used to evaluate the alternate sites.

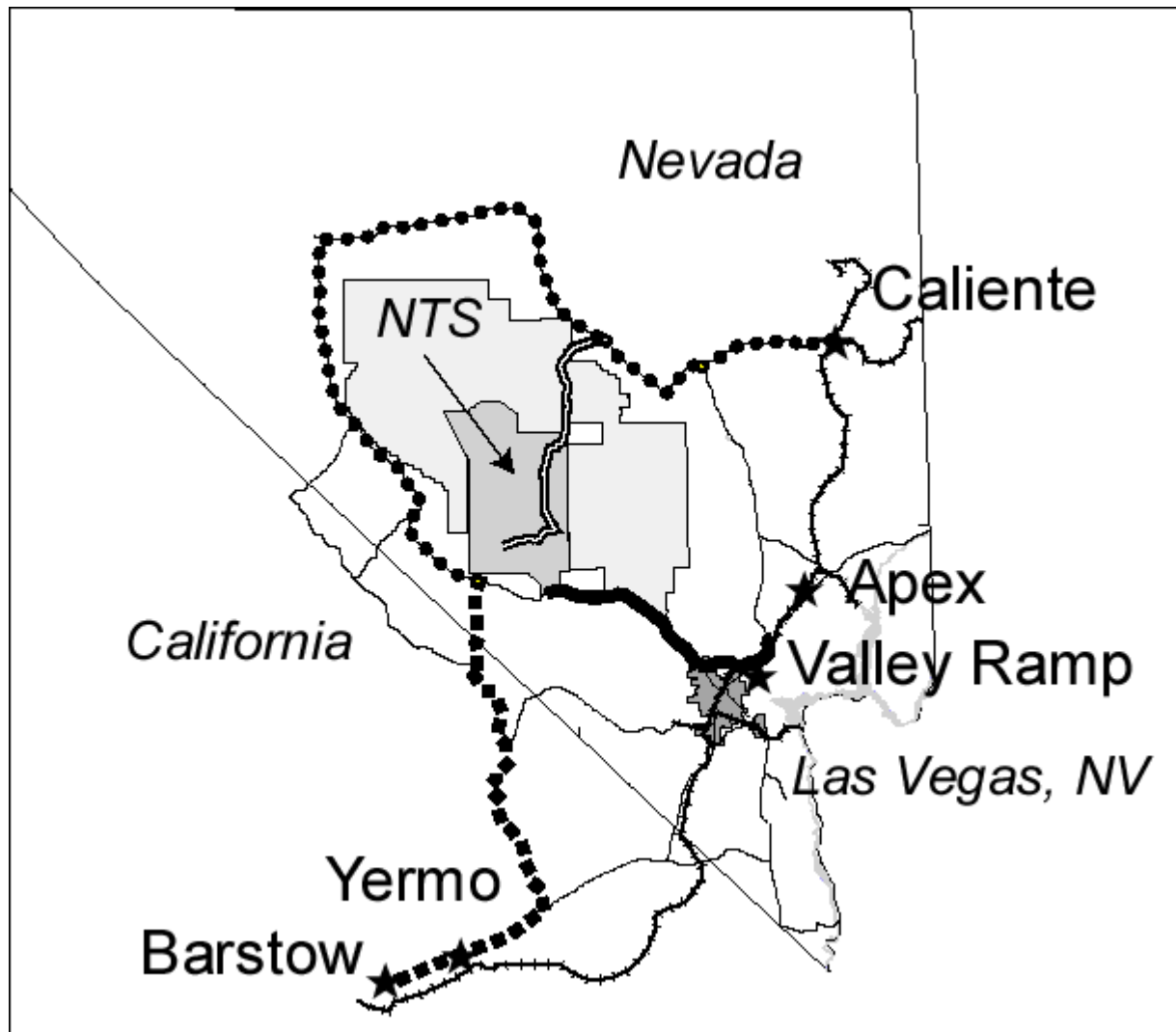


Figure 1 Potential Intermodal Sites

Study Criteria and Process

The study is unusual because it sought to *limit* rather than increase the number of variables measured. This was deliberately done to make the study fast and efficient. Previous experience suggested that a successful study would avoid collecting a surfeit of unmanageable or meaningless information. The study group also established three characteristics for the intermodal site evaluation criteria:

1. Data about the evaluation criteria must be readily available. The limited budget and data forced the study team to make a virtue of necessity by limiting rather than expanding the amount of data used. The study team assumed that the policy makers who used the study would only need a few criteria to make a decision. Presenting less data would not interfere with their decision-making.
2. The criteria must be immediately meaningful to the intended audience. The intended audience of the study consisted of the local elected officials and the populace living adjacent to the affected routes. The study team decided that it was important to avoid the need for

interpretation of the study's results. The facts of the route comparison should be immediately apparent to the audience without intervening interpretation. In other publications, this has been characterized as "transparent."¹⁷

3. The study criteria must be acceptable to the affected parties. Not surprisingly, Nevada stakeholders have a sophisticated and highly developed policy infrastructure working on the issue of radioactive waste. The competing interests and strengths of the Nevada stakeholders meant that agreeing to the criteria also meant investing in the outcome of the study. The staff who agreed to the study were also agreeing that the study results would be regarded as legitimate. Their participation in defining the study variables made the study "fair." This is a critical point. The DOE/NVOO knew that they would be able to ship the waste from any of the intermodal sites. They wanted to find a site that would be acceptable to affected stakeholders. The willingness of DOE to enter into the process made DOE staff more credible and engendered trust from among stakeholders.

The evaluation criteria used to compare intermodal sites were: 1) site capabilities 2) cost 3) public safety and 4) community acceptance. The site capability criterion was fundamental in that it established whether or not an intermodal facility could operate at the site. The evaluation of site capability entailed an on-site inspection of the proposed locale in order to determine whether or not that site was physically suitable as potential intermodal facility. The physical requirements for an intermodal site are very small and nearly any level piece of ground adjacent to a rail line can be readily used for intermodal operations. The issue of site capability arose in connection with the study only with regard to the quality of the track leading to a potential site. The conclusion reached by the comparison of the sites was that there were existing intermodal capabilities that could handle the proposed traffic at both Yermo and Valley Ramp. The other sites were all feasible, but some preparation was necessary at the other sites.

The second criterion was cost. The uncertainties associated with the DOE's own disposal plan made it difficult to provide potential shippers with a total number of containers required by the shipping program. As a result, the cost estimates were high estimates likely to rapidly shrink, as the economies of scale associated with large shipping campaigns became known. The table in Figure 2 depicts the price to ship one 20-foot container of low level waste from Fernald, Ohio to each of the sites. Each of the intermodal sites was less expensive than continuing the current shipping campaign, which cost approximately \$3,600 per 20-foot container.

Site	Union Pacific RR via Utah	Union Pacific RR via Arizona
Caliente	\$2,850	--
Apex	\$2,950	--
Valley	\$3,100	--
Dunn	--	\$3,500
Yermo	--	\$3,500

Figure 2 Cost comparison between intermodal sites

As indicated by the table above, the DOE will realize important cost savings over the life of the shipping campaign by utilizing intermodal transportation instead of all-truck. In this case, the Caliente site was the optimal site.

The third criteria relate to public safety and environmental protection. The intention for public safety was to create the simplest measure of potential consequences of a waste spill. The study did not seek to solve problematic issues of the health effects of exposure, nor did it seek to find some optimal method of measuring the consequences of a spill. Both the DOE staff and stakeholders realized that the most sophisticated risk analysis would not change the attitudes of the elected officials along the route. The importance of maintaining consensus among the affected parties was more important than creating a more technically elegant analysis. For this reason, the study team used population data from the census, average annual daily traffic counts (the number of vehicles using a road during a 24 hour period), and maps of environmentally sensitive areas for public safety.

This points out another item where consensus was important. Available population data was aggregated at the census tract level. These larger areas provide a less accurate picture of the population in the region than the data aggregated at the smaller, but immediately unavailable census block level of detail. The study group participants were aware of this feature of the census data and vigorous, informed discussion took place. The final resolution of the difficulty was that the affected parties accepted that the population number would not be as accurate as it might have been. They agreed to this concession only because the analysis of each route had the same problem. Cooperation was more important than accuracy. The data were acceptable, as long as the data were accurate to the same degree for every entity along the route.

Figure 3 contains the results of the Public Safety analysis. It is clear that the route being used by the DOE could be improved by adopting the Caliente intermodal site. Once more, the Caliente intermodal site and the route from it to the NTS were optimal for shipping the low-level waste.

Site	Population within 2.5 Miles	Highest AADT road segment	Environmentally sensitive areas
Caliente	1,431	2,100	Kershaw Ryan State Park Toiyabe National Forest Humboldt National Forest
Apex	294,129	102,000	Floyd Lamb State Park Las Vegas Dunes Rec. Area Four municipal parks
Valley	293,903	102,000	Floyd Lamb State Park Four municipal parks
Dunn	1,030	24,000	Mojave River Afton Canyon

			Natural Area Death Valley National Park
Yermo	7,645	24,000	Mojave River Death Valley National Park
Current shipping route	461,358	102,000	Hoover Dam Lake Mead Rec. Area 20 municipal parks in Clark County

Figure 3 Summary comparison table

The last criterion used to compare the intermodal sites was community acceptance. This measurement used a “key informant” survey to gauge the sentiment of the populations near the intermodal sites by questioning their representatives. In past discussions, attempts to use “perceived risk” as the basis for route selection have failed. Proponents of perceived risk theories argue that the fear of a controversial program can be more severe than the potential for physical harm. This is certainly a plausible argument; however, the argument has not been developed in a way that makes it applicable to the problem of route selection and comparison. Rather than lead the study team into debilitating arguments about the validity and relevance of perceived risk, the key informant survey was used instead. The people chosen to answer the survey (usually elected officials) have a stake in a safe transportation program. Their positions make them extremely conservative on behalf of their constituents. At the same time, their position as policy makers ensures that they cannot be unreasonably cautious or irrationally overprotective. The elected officials in Caliente actively supported the idea of an intermodal sight and were the only parties who willingly accepted the notion of a site in their vicinity.¹⁸

The Decision Rules

How would the study results be used? This depended on the decision rule adopted by the DOE. Shrader-Frechette characterizes two types of decision-making rules as Bayesian and MAXMIN.¹⁹ In Bayesian utility, decisions are based on the sum of calculated utilities. This process is familiar to most risk assessment professionals and conforms to the standards of many engineering safety studies.²⁰ In the case of risk assessment, failure probabilities are substituted for the sum of utilities. A typical risk assessment calculates risk by summing the probabilities of all of the potential risks caused by a particular activity. This enables the risk assessor to compare risks and then chose between them. This approach to deciding was not used.

An alternative to Bayesian is MAXMIN. Using this decision rule, the decision-maker minimizes the worst possible outcome.²¹ This is the decision rule used by Nevada and California policy makers as well as the DOE/NVOO officials (albeit tacitly). The cause of the potential harm, whether “perceived,” “real,” “quantitative,” or “qualitative” was not important. The issue of overriding significance was that the worst possible outcome must be avoided. Despite the harmlessness of low level radioactive waste, policy-makers defined the worst possible outcome as harm to the Las Vegas economy or tourist population. Understanding this decision rule provides a clearer perspective on the approach adopted by Nevada stakeholders.

The results of the study were immediately useful to policy-makers. The significance of the study findings and their applicability needed no explanation or interpretation. The compelling logic of the Caliente intermodal location was plainly apparent and was reinforced by each variable. Technical information was presented to decision-makers in a useful form. The process used to evaluate routes was open to the staff of the agencies affected by the transportation program. Staff “bought off” on the criteria and agreed to be bound by the self-imposed rules of study. This gave the study legitimacy and made elected officials more comfortable with the study results. Non-participants who complained about the study results were dismissed out of hand because they had been offered the opportunity to participate, but had failed to do so.

RECOMMENDATIONS

Since there appears to be a growing consensus about how routes should be compared and that there is a need to integrate public policy and technical considerations, what are the next steps? The following list of recommendations may help ease the inclusion of technical considerations in route selection.

First, there is a need to establish a process for national route selection. This process must begin to examine routes from each known origin to the proposed, but known destination. There are already numerous organizations familiar with the issue that can begin serious work on route selection. Among these groups are the Transportation External Working Group (TEC), the Western Interstate Energy Board, and the Southern States Energy Board. Although the DOE is working on improving its own national transportation program, a critical part of that program must be collaboration between affected parties at a national scale. Anything less will create a contentious policy environment in which technical analysis will not play its necessary role.

Next, information requirements and problems associated with route comparison should be settled in national forums and changes immediately implemented. The technical analysis performed for the NTS Intermodal study was severely constrained by the lack of data. The quality of relevant data varies widely at the state level. If technical analysis is to be brought into route selection, the necessary data should be collected in the appropriate form prior to the commencement of route selection negotiations.

Lastly, the procedures for states to select routes other than the default highway route are contained in the Guidelines for Selecting routes for Highway Route controlled Quantity Shipments of Radioactive Materials (US DOT May 1992) (Guidelines).²² States must embark on an “equivalent” process of analysis to use other routes. The Guidelines do not indicate that modern risk assessment tools should be integrated into the analysis. The Guidelines should be updated to allow the integration of modern risk assessment tools (e.g. RADTRAN, RISKIND) into the process of selecting alternate routes.

CONCLUSION

The case study cited above demonstrates that effective route selections can be made in a cooperative manner. In order for route selection to be effective, it must follow a process that is seen to be legitimate, it must also seek to be transparent to the end user (the policy maker). Technicians and policy analysts must learn to integrate their work in a way that will be meaningful for the elected officials who will ultimately negotiate routes. Marrying the technical rigor of a traditional risk assessment with sensitivity to public policy is a necessary condition for an optimal route selection. Technical analysts must rise to the challenge if route selection is to

be anything other than a purely political exercise. This viewpoint does not denigrate traditional risk analysis. Rather, it acknowledges how policy is really made and urges technical analysts to do their part in making policy. The procedure needed to resolve the national problem of route selection is in sight. Future discussion about route selection should start by building on past success.

FOOTNOTES

¹ Senge, Peter. *The Fifth Discipline*

² Brooks, David, Cell-Phone Naturalists. *The Weekly Standard* October 26, 1998 24-25.

³ Nye County resolution

⁴ See Hank Jenkins-Smith *Democratic Politics and Policy Analysis* Wadsworth Inc Belmont CA 1990, and Michael S. Goldstein, Alfred C Marcus and Nancy Perkins Rausch "The Nonutilization of Evaluation Research," *Pacific Sociological Review* Vol. 21 No 1 Jan 1978.

⁵ Rhyne, William.

⁶ Boucher, Laurie and Ingrid Rosencrantz, Pete Karcz, Nancy Werdel, and James Poppeti. "Collaborative Decision-Making Between Federal and State Agencies Yields Cost Savings of Approximately \$275 Billion" pp. 1-9.

⁷ Fleck, Fiona "Shroeder Team resolved to scrap nuclear plants,"

⁸ The most egregious recent example of this kind of behavior can be found in Associated Press "Plutonium Shipments will bypass Michigan," *Windsor Star* Oct 2, 1998.

⁹ An emblematic paper of this type is Richardson, John "any Truth in the 'Mobile Chernobyl' Characterization for SNF Transportation?"

¹⁰ One example of this position can be found in Wagschall JoAnna J "Communicating Risk When Dealing with High-Level Radioactive Waste"

¹¹ See Slovic, Jenkins-Smith

¹² Risk Communication failures from Paul Stern's book.

¹³ For a brief smattering of a large and ever growing literature see Waste Management Presentations

¹⁴ TEC paper page 9

¹⁵ Ibid., p 13.

¹⁶ NRAMP, DOE can save a lot of money by going intermodal

¹⁷ "Transparent" risk analysis

¹⁸ A result confirmed by a ballot question in November 1998

¹⁹ Shrader-Frechette Kristin *Risk and Rationality* University of California 1991 p 101-102

²⁰ Ibid. pp. 104-108

²¹ Ibid. pp. 116-123

²² Guidelines