

**STATE OF NEVADA STUDIES OF POTENTIAL TERRORISM AND  
SABOTAGE AGAINST SPENT FUEL SHIPMENTS**

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**ABSTRACT**

The State of Nevada Agency for Nuclear Projects (NANP) began studying the potential impacts of terrorism and sabotage in the 1980s as part of a larger spent nuclear fuel transportation risk and impact assessment. Recently, NANP sponsored two contractor studies of potential terrorism and sabotage against spent nuclear fuel shipments. These studies documented significant changes in the nature of terrorism since the U.S. Nuclear Regulatory Commission (NRC) last publicly considered this issue in 1984. Based in part on these reports and supplemented by additional research, in June 1999 the State of Nevada petitioned the NRC to amend its transportation safeguards regulations (10CFR73) and to reexamine the consequences of attacks on spent fuel shipping casks utilizing a variety of weapons. NRC published the petition for rulemaking (Docket PRM-73-10) in September 1999, and accepted public comments through January 2000. The NRC has not published its response as of January 2001.

NANP contractors are conducting additional studies of the radiological and economic consequences of successful acts of sabotage, terrorism, and other human-initiated events. These studies are part of the State's review of the U.S. Department of Energy (DOE) Draft Environmental Impact Statement (DEIS) for the proposed Yucca Mountain repository. These studies will also support the impact report which the State is authorized to prepare in the event that the Secretary of Energy recommends the Yucca Mountain site for repository development. Nevada's initial review of the 1999 DEIS indicates that DOE underestimated by at least a factor of ten the impacts of a successful act of sabotage against a truck cask in an urban area. A successful attack utilizing a high-energy explosive device could result in more than 150 latent cancer fatalities and adverse economic impacts in excess of \$10 billion. NANP believes that other scenarios could result in even more severe impacts. Studies currently underway will identify alternative assumptions about weapons capabilities, spent fuel radiological characteristics,

meteorological conditions, and emergency response times and evacuation procedures. These alternative assumptions will be evaluated in conjunction with location-specific demographic and economic data to develop more refined consequence assessments. NANP expects to publish additional findings and recommendations by August 2001.

## INTRODUCTION

Nevada has been, and will likely continue to be, a corridor state for spent nuclear fuel (SNF) shipments. As the potential host state for a Federal geologic repository and/or interim storage facility, Nevada would be the ultimate destination for the entire nation's SNF and high-level radioactive waste (HLW). Nevada has an interest in protecting its citizens from risks associated with the transportation of SNF and HLW. Nevada also has an interest, as the entity responsible for immediate emergency response, in ensuring that transporters of these materials have adequately prepared for potential emergencies. Nevada is particularly concerned about the physical protection of shipments under the Nuclear Regulatory Commission (NRC) regulations at 10 C.F.R. Part 73.

Between 1964 and 1998, Nevada was traversed by approximately 321 truck shipments and 16 rail shipments of civilian SNF to and from nuclear reactor sites, research facilities, and interim storage facilities. (1,2) Nevada will likely continue to be a corridor state for SNF shipments to and from the Idaho National Engineering Laboratory. Nevada would also likely be traversed by SNF shipments to and from the Private Fuel Services storage facility proposed for the Skull Valley Goshute Reservation in Utah.

While these shipments are of concern, Nevada is primarily concerned about the potential for tens of thousands of shipments to the proposed geologic repository at Yucca Mountain and to a potential interim storage facility at the Nevada Test Site. The Nuclear Waste Policy Amendments Act (NWPAA) designated Yucca Mountain as the only site to be characterized for a national geologic repository for SNF and HLW. Legislation pending in Congress would designate the Nevada Test Site as sole location for a centralized interim storage facility.

According to the U.S. Department of Energy (DOE) Draft Environmental Impact Statement (DEIS), there could be as many as 96,000 truck and 300 rail shipments to Yucca Mountain over a period of 38 years. Under DOE's mostly rail scenario, there could be 19,800 rail and 3,700 truck shipments over the same period. (3) A recent NRC report estimated 50,000 to 75,000 shipments to Yucca Mountain if all civilian SNF were transported by truck. (4) A study prepared for Nevada by Planning Information Corporation projected 56,600 to 104,500 shipments over 40 years, for a repository combined with an interim storage facility. (5) Under all of these scenarios, Nevada would experience unprecedented risks associated with this massive transportation effort.

Repository shipments are scheduled to begin in 2010. Under the NWPAA, DOE is responsible for the transportation of SNF and HLW from 77 generator and storage sites to the repository. Once repository and/or storage facility operations have begun, DOE shipments of SNF and HLW will impact up to 45 states. More than 138 million people

live in the 734 counties along potential highway routes. (6) Shipments will traverse up to 58 Indian Reservations, including 14 Indian Reservations in Nevada. (7)

Cross-country SNF shipments to Nevada could begin as early as 2004 if Congress enacts interim storage facility legislation.

## **STATE OF NEVADA CONTRACTOR STUDIES, 1988-1995**

The Nevada Agency for Nuclear Projects (NANP) began studying the potential impacts of terrorism and sabotage in the late 1980s as part of a larger SNF transportation risk and impact assessment. In 1988, NANP hired Mountain West Research (MWR) of Phoenix, Arizona, to assemble an expert study team and prepare a comprehensive report on high-level nuclear waste transportation. MWR described and evaluated DOE's planned transportation system, developed a set of preferred management options which would maximize safety and minimize adverse impacts to Nevada, and recommended an interdisciplinary study plan for transportation impact assessment, risk communication, and risk management. The MWR report, referred to as the Transportation Needs Assessment (TNA), (8) became the basis for virtually all NANP transportation activities during the decade of the 1990s.

### **Transportation Needs Assessment**

MWR developed a set of preferred management options for the physical protection of SNF and HLW shipments. From the beginning, the MWR study team emphasized the difficulty of applying the probabilistic risk analysis techniques used in DOE and NRC impact reports. The MWR researchers concluded: "Social risks, such as sabotage and terrorism, are difficult to quantify. Since these actions are directed towards deliberate destruction of containers or vehicles, however, a few attempts may be sufficient to release a large amount of radioactivity or, in the case of manipulation, to cause an accident. Hence, the small probability of occurrence is superceded by the near-certainty of the effect. That is why risk management has to deal with these risks in great detail; for just one incident may well cause tremendous damage. But even incidents causing only minor damage are likely to yield a long-lasting impact on social and political perceptions. This could not only weaken public confidence and trust in official decision-makers and decision-making institutions, but also hurt economies in the host state and corridor states." (8)

The TNA recommended that Nevada study five options for terrorism and sabotage against SNF shipments: use of explosives (including airblasts, contact or breaching charges, shaped charges, and platter charges); hijacking of transportation vehicles; manipulating the vehicle; manipulating the vehicle's operator; and theft (for purpose of obtaining materials). The TNA recommended a six-step risk assessment/risk management process: scenario assessment, vulnerability analysis, screening of management options, resilience analysis, decision analysis, and sensitivity analysis. The TNA again emphasized the limited usefulness of probabilistic analysis for these purposes.

“Traditional risk assessment methods rely on a sufficient data base to derive meaningful probabilities for each investigated incident. Furthermore, the occurrences of failures must follow a specific pattern including random variation. But sabotage and terrorist attacks meet neither of these criteria. Past data on human intrusion does not allow any numerical extrapolation to determine relative frequencies nor do we have a good model on the underlying distribution function of such incidents. Apparently, terrorist attacks are not randomly distributed, but depend on political or psychological circumstances. Unless we find an adequate model to explain and predict such circumstances, we are unable to determine probabilities for different types of incidents. Using expert judgement to elicit probabilities does not overcome this conceptual problem, because experts themselves lack the necessary knowledge to make such judgements.” (8)

The alternative approach embodied in the TNA recommended an interpretive methodology, specifically role-playing by researchers or groups of experts, based on the assumption that terrorists will design attacks on traditional concepts of cost-effectiveness. Second, the TNA recommended consideration of a range of attack objectives and methods, including disruption of shipments, accident without release, and accident or attack with explosives intended to cause release. Third, the TNA recommended consideration of a range of perpetrators, including political terrorists, antinuclear radicals, right-wing extremists, and disgruntled employees.

#### **Implementation of TNA Recommendations .**

In December 1988, NANP staff and contractors began developing plans for an independent assessment of sabotage and terrorism risks following the recommendations of the TNA. Assembly Concurrent Resolution No. 8 of the 1987 Nevada Legislature directed NANP to prepare a comprehensive plan addressing nuclear waste transportation issues. The resulting ACR8 Report included plans for sabotage and terrorism studies by the University of Nevada Las Vegas (UNLV) Transportation Research Center. (9) NANP also considered testimony regarding terrorism risks, particularly regarding the vulnerability of shipping casks to shoulder-fired anti-tank missiles, presented at DOE public hearings in Nevada during 1989. (10)

NANP contractors prioritized three types of attacks for study: capture of shipment with intent to ransom cask (threat to blow up cask); capture of shipment with intent to cause radiological contamination; and attack on shipment with intent to cause radiological contamination. Four types of weapons were identified for study: man-portable explosives, remote-controlled mines, massive truck bombs, and armor-piercing guided missiles. Contractors also identified future social and political conditions which might increase the probability of attacks with high-energy explosives. (11) The proposed terrorism study project was deferred due to budget cuts and DOE program delays in early 1990.

NANP resumed assessment of terrorism risks in 1995 in response to DOE's publication of a Notice of Intent to prepare an EIS for the Yucca Mountain repository. NANP advised DOE that the EIS "must examine the full range of credible transportation risks and impacts, especially low probability/high consequence events such as very severe

accidents and successful terrorist attacks which might result in loss of radiation shielding and/or release of radioactive materials to the environment. " NANP also stated its intention to independently assess the consequences of terrorist attacks on shipping casks in preparation for review of DOE's Draft EIS. (12)

### **STATE OF NEVADA CONTRACTOR STUDIES, 1996-1997**

In preparation for review of DOE's Yucca Mountain DEIS, NANP sponsored two contractor studies. Published in 1997, these reports (13,14) critically evaluated previous NRC and DOE terrorism consequence assessments; identified expected repository shipment characteristics relevant to terrorism risk assessment; summarized lessons learned from previous attacks on transportation infrastructure; and recommended a preferred approach to terrorism consequence assessment, given the structural and analytical deficiencies in previous NRC and DOE approaches. <sup>a</sup>

#### **Evaluation of Previous Consequence Assessments.**

The NANP studies critically evaluated previous consequence assessments. NRC contractor reports prepared in the late 1970s estimated that sabotage of a spent fuel shipment in an urban area could result in hundreds of early fatalities and thousands of latent cancer fatalities, and economic losses in the billions of dollars. NRC responded to these risk assessments by issuing interim physical protection requirements for spent fuel shipments in July, 1979, followed by amended rules, 10 CFR 73.37(a) through (e), effective July 3, 1980. The rules required armed guards in urban areas, advance NRC approval of shipping routes, and other precautions.

In the early 1980s, NRC and DOE sponsored further research on the consequences of terrorist attacks, including scale-model and full-scale tests at Sandia National Laboratories and Battelle Memorial Institute, to determine the effects on shipping casks of attacks involving certain high-energy explosive devices. These studies demonstrated that terrorists using shaped charges could blow a 6-inch hole in the cask wall, penetrate the cask deeply, and disperse one percent of the fuel mass to the environment. Since only a tiny fraction of the fuel was released in respirable form, however, NRC concluded that the health effects of a successful attack would be far less than previously estimated (no early fatalities and less than 7 latent cancer fatalities even if the attack took place in New York City under worst case conditions). The NRC further concluded that the transportation safeguards regulations could be reduced, and in 1984 NRC issued a proposed rule eliminating requirements for armed guards, advance route approvals, communications centers, and advance coordination with local law enforcement agencies. (15)

Nuclear industry reviewers generally agreed with the NRC's technical findings and supported the proposed rule. State governments and environmental groups were generally opposed, and some reviewers were highly critical. A number of the opposition comments included detailed criticisms of the Sandia and Battelle research programs, and questioned the NRC's technical analyses and conclusions. (16) The NRC never responded publicly

to these criticisms. With no public explanation, the NRC terminated activity on the proposed rule in January 1987. The NRC later refused to provide related documents requested under the Freedom of Information Act. (17) As a result, major controversies in three important aspects of sabotage consequence assessment remain unresolved.

First, critics believe that the NRC significantly underestimated the potential for damage to the cask and spent fuel, and thus significantly underestimated the amount of SNF which might be released to the environment by a successful attack using high-energy explosive devices. Based on the Sandia tests, the NRC assumed the reference weapon would not completely perforate the cask. The NRC rejected the conclusion by the U. S. Army Ballistic Research Laboratory peer reviewers that the reference weapon used in the full scale test would likely cause complete perforation of current-generation truck casks with thinner walls. The NRC also rejected the U.S. Army peer reviewers' concern that after the cask was breached, a second explosive device could be used to further damage the fuel rods and disperse radioactive materials to the surrounding area. (18) Other reviewers noted that NRC failed to consider other military weapons, commercial shaped charges, and combinations of breaching and incendiary weapons which could cause greater damage and dispersal. (16)

Second, critics rejected the NRC's focus on the respirable release as the primary measure of consequence. The NRC argued that the "consequences of an act of sabotage would be a direct function of the quantity of spent fuel that would be released in respirable form [particles having a diameter of less than four microns]." (15) States and interest groups strongly criticized the NRC for ignoring the health effects and other environmental impacts of larger SNF fragments dispersed to the environment. (16) The U.S. Army peer reviewers noted that the reference weapon would likely disperse fragments over a 100-meter blast zone. (18) Several comments also noted that the NRC ignored the impacts of on bystanders and emergency responders of direct gamma and neutron radiation from the damaged cask. (16)

Third, critics noted that the NRC completely overlooked other significant impacts. The State of Michigan commented: "The cleanup after even a partially successful sabotage attempt could entail soil removal, equipment disposal, water resource cleanup, and potentially the purchase of private residences in a sabotage area and would therefore be very costly." (16) Other reviewers stressed NRC's failure to consider the social and psychological impacts of a successful terrorist attack; the standard economic impacts on businesses, including cleanup and disposal costs; and the potentially enormous economic losses resulting from social stigma effects and perceived risks. (16)

### **Identification of Shipment Characteristics Relevant to Risk Assessment.**

The NANP studies identified likely characteristics of repository shipments that are particularly relevant for terrorism risk assessment. These characteristics include multiple modes and routes; long distance shipments (average greater than 2,000 miles); daily shipments (3 - 9 per day); routes through highly populated areas; routes which place shipments in tactically disadvantageous positions; routes with marginal safety design

features; routes with limited rest and refueling locations; and routes with low likelihood of swift local law enforcement agency response.

To illustrate these characteristics, NANP staff and contractors identified highly vulnerable route segments in Nevada including: I-15 and US 95 through downtown Las Vegas, especially the intersection known locally as the "Spaghetti Bowl;" the Union Pacific (UP) mainline through downtown Las Vegas, and tunnels along the UP between Uvada and Elgin; and steep grades to and from mountain passes along US 93, State Route 375, and US 6, the proposed heavy haul truck route between Caliente and Tonopah.

### **Lessons Learned from Previous Attacks on Transportation Infrastructure.**

The NANP studies reviewed previous incidents of attempted sabotage and sabotage prevention, including: the 1986 attempt to derail a train transporting spent fuel in Minnesota; the 1939 derailment of a Southern Pacific passenger train near Harney, Nevada; the 1995 derailment of an Amtrak passenger train near Hyder, Arizona; and the 1995 New York City conspiracy to bomb the George Washington Bridge and the Lincoln and Holland Tunnels. The NANP studies concluded that a comprehensive terrorism/sabotage risk assessment must consider that: transportation infrastructure used by spent nuclear fuel shipments could be attacked by a range of adversaries including antinuclear activists, political terrorists, and transportation industry personnel; that rail and/or highway infrastructure could be targeted; and that attacks could occur at urban and/or rural locations.

Lessons learned from previous incidents of infrastructure sabotage, particularly insights into the intentions and capabilities of the attackers must be applied to the assessment of potential attacks on infrastructure used by nuclear waste shipments. Attacks on trains, bridges, and tunnels without warning show a willingness if not an intention to kill, maim, and terrify tens, hundreds, or thousands of people at a time. The attackers' technical expertise, at least in the case of the rail sabotage events, has been sufficient to defeat existing technical countermeasures, such as electronic warning systems. The attackers' success in causing accident conditions such as derailments at speeds of 50-60 miles per hour, followed by 30 foot drops, demonstrates their ability to at least challenge the containment performance standards of NRC-certified shipping containers. Finally, the incidents studied demonstrate that attacks on infrastructure do not require the procurement of exotic weapons to be successful.

### **Preferred Approach to Terrorism Consequence Assessment.**

The NANP studies recommended a preferred approach to terrorism consequence assessment that would be consistent with certain key assumptions about the expected repository transportation system based on information available in 1997. The reference weapons were chosen to represent current capabilities, consistent with the current NRC design basis threat for radiological sabotage. The reference shipping casks were selected to be consistent with current DOE SNF transportation plans. The reference SNF and HLW radiological characteristics were selected to be consistent with existing and

projected inventories, expected repository waste acceptance criteria, and current NRC regulations. Credible worst-case assumptions about the timing and location of a potential attack were developed based on literature reviews, interviews with State and local officials, windshield surveys of the Nevada routes most likely to be used for shipments to a repository, and site visits to selected locations.

Large, portable antitank missiles, such as the TOW or Milan missiles, or their equivalent, were selected as the reference weapon. For purposes of scenario development, the reference weapons were assumed to be man-portable, operated by one to three persons, and capable of firing up to three missiles. The GA 4 cask was selected as the reference truck shipment target. The NAC-STC was selected as the reference rail shipment target. The reference spent fuel selected for terrorism consequence assessment was 10-year-cooled, medium-high burnup, Westinghouse PWR assemblies. A GA 4 truck cask loaded with 4 assemblies of the reference fuel would represent a total source term of about 850,000 curies. A NAC-STC rail cask loaded with 26 assemblies of the reference fuel would represent a total source term of about 5.5 million curies.

The NANP studies identified combinations of location, timing, and weather conditions as important determinants of impacts on public health and safety, environmental quality, and business activities and property values. These factors determine the number of people initially exposed to incident consequences, the nature and duration of exposure to incident consequences (especially exposure to released radionuclides), and the timing and effectiveness of emergency response activities.

Given current routing assumptions, the NANP studies determined that the worst-case urban location for an attack would be in Las Vegas, along the Union Pacific mainline, or along I-15, between Blue Diamond Road (State Route 160) and Craig Road. The worst-case time for large-scale population exposure would generally be between 3:00 PM and 6:00 PM on a Friday afternoon. Worst-case weather conditions would be high winds with no precipitation. A credible weather scenario would be a 12-hour period of sustained winds in excess of 30 miles per hour, with frequent gusts of 50-60 miles per hour. Immediate special concerns would be evacuation of as many as several hundred thousand visitors and residents and potential contamination of hotel, resort, and casino properties worth billions of dollars.

Given current routing assumptions, the NANP studies determined that the worst-case rural location for an attack would be on the Union Pacific mainline in Meadow Valley Wash between Moapa and Elgin. The worst time for widespread environmental damage, would generally be a time when emergency response was slow or delayed by other events or limited personnel, for example on a Saturday night between 9:00 PM and midnight, or Sunday morning between 8:00 AM and 11:00 AM. Worst-case weather conditions would be heavy rains resulting in flash flooding. A credible weather scenario would be 6 or more inches of rain in a 24-hour period. Immediate special concerns, depending on the exact location of the attack, would be contamination of the Moapa Indian Reservation, agriculture lands and residences, and water resources including Lake Meade.



## **STATE OF NEVADA PETITION FOR NRC RULEMAKING, 1999-2000**

Nevada's Attorney General filed a petition for rulemaking with the NRC in June 1999. The petition requested a general strengthening of the current transportation safeguards regulations and a comprehensive reexamination of the consequences of radiological sabotage against SNF shipments. Nevada's request was based on the following developments: changes in the nature of the terrorist threat, increased vulnerability of shipping casks to terrorist attacks involving high-energy explosive devices, increased opportunities for attacks against repository shipments, and increased symbolic value of repository shipments as terrorist targets.

The NRC docketed the petition (Docket PRM-73-10) and published it in the Federal Register on September 15, 1999. NRC extended the public comment period through January 28, 2000, in response to a request from the National Research Council Transportation Research Board Committee on Hazardous Materials. More than 20 parties, including 11 States, filed comments on the petition. The NRC has not published its response as of January 2001.<sup>b</sup>

### **Request for Amendments to Current Regulations .**

Nevada requested that the NRC amend the current safeguards regulations in order to better deter, prevent, and mitigate the consequences of any attempted radiological sabotage against shipments of SNF. Specifically, Nevada requested amendments and clarifications to:

- Reexamine the Design Basis Threat for Radiological Sabotage - 10 C.F.R. 73.1(a)(1);
- Expand the Definition of "Radiological Sabotage" - 10 C.F.R. 73.2;
- Strengthen Requirements for Advance Approval of Routes - 10 C.F.R. 73.37(b)(7);
- Adopt New Requirements for Planning and Scheduling - 10 C.F.R. 73.37(b)(8);
- Strengthen Escort Requirements for Shipments by Road - 10 C.F.R. 73.37(c);
- Strengthen Escort Requirements for Shipments by Rail - 10 C.F.R. 73.37(d); and
- Adopt new regulations to require that all rail shipments be made in dedicated trains - 10 C.F.R. 73.37(d).

### **Request for Consequence Assessment.**

Nevada requested that the NRC completely reexamine the issue of terrorism and sabotage in order to determine the adequacy of the current physical protection regulations, and in order to assist DOE and the affected stakeholders in the preparation of a legally sufficient environmental impact statement as part of the NRC licensing process. Specifically, Nevada requested the NRC evaluate attacks against transportation infrastructure used by nuclear waste shipments, attacks involving capture of a nuclear waste shipment and use of high energy explosives against the cask, and direct attacks upon a nuclear waste shipping cask using antitank missiles.

Nevada requested a consequence assessment based on assumptions specific to DOE's repository proposal, and addressing the full range of impacts of a terrorism/sabotage event resulting in a release of radioactive materials, including immediate and long-term implications for public health; environmental impacts, broadly defined; standard socioeconomic impacts, including cleanup and disposal costs and opportunity costs to affected individuals and business; and so-called special socioeconomic impacts, including individual and collective psychological trauma, and economic losses resulting from public perceptions of risk and stigma effects.

Additionally, Nevada requested that the NRC engage an independent technical organization with appropriate expertise to advise the Commission on two critical issues: the need for full-scale and/or scale model physical testing to determine cask vulnerability to attack with high-energy explosive devices, and the appropriateness of existing computer models for evaluating environmental dispersion of released radionuclides, resulting health effects, cleanup and disposal requirements, and economic costs.

### **Basis for the Nevada Requests.**

Nevada's request for a general strengthening of the safeguards regulations and for a comprehensive reexamination of radiological sabotage consequences was based on the following developments:

Changes in the nature of the terrorist threat, increased vulnerability of shipping casks to terrorist attacks involving high-energy explosive devices, increased opportunities for attacks against repository shipments, and increased symbolic value of repository shipments as terrorist targets. Nevada submitted extensive documentation in support of these claims.

The petition documented significant changes in the nature of the terrorist threat since the NRC last evaluated the adequacy of its SNF transportation safeguards regulations. Since 1984, three major changes have occurred in the nature of the terrorist threat that argue for a strengthening of the safeguards regulations: the increasing lethality of terrorist attacks in the United States; an increase in serious terrorist attacks and threats against transportation systems; and renewed concerns about nuclear terrorism generally, and specifically, terrorist actions involving potential radioactive contamination.

The petition also documented developments that have increased the vulnerability of spent fuel shipping casks to terrorist attacks involving high-energy explosive devices over the past decade and a half. First, the capabilities and availability of explosive devices, especially antitank weapons and commercial shaped charges, have increased significantly. Second, new spent fuel shipping cask designs, developed to increase payloads without exceeding specified weight limits, appear to be more vulnerable to attacks involving past, current, and future military weapons systems and civilian explosives.

The petition submitted evidence that spent nuclear fuel shipments to a geologic repository and/or centralized interim storage facility will be dramatically different from past shipments in the United States. Nevada argued that the following differences will create greater opportunities for terrorist attacks and/or sabotage against SNF shipments, and may also increase the consequences of any incidents which occur:

- long-duration, highly visible, nationwide shipping campaign;
- regular and predictable shipments, to a single destination;
- large increase in amount of spent fuel shipped, and increased numbers of truck and rail shipments annually, averaging several cask shipments per day, every day, for 30 years;
- substantial increase in number of active routes and average shipment distances, with potential implications for selection of targets and attack locations;
- significant concentration of shipments along certain highway and rail routes west of the Mississippi River, with implications for shipments through heavily populated areas and through locations which place shipments in significantly disadvantageous tactical positions; and
- potential use of routes within Nevada with marginal safety design features, limited rest and refueling locations, and low likelihood of swift local law enforcement agency response.

The petition also maintained that a national repository or storage facility may have a greater symbolic value to terrorists than current at-reactor storage facilities, and that the enhanced symbolic value of the facility as a target may extend to SNF shipments to such a facility. Facilities operated by DOE, the U.S. government agency responsible for producing nuclear weapons, may have greater symbolic value as terrorist targets than commercial nuclear facilities. Two Rand Corporation studies found that DOE nuclear programs may be especially attractive targets for state-sponsored terrorists and domestic right-wing radicals. (19,20)

### **Definition of the Design Basis Threat for Radiological Sabotage.**

The petition requested that the NRC clarify the definition of the design basis threat for radiological sabotage. Current regulations require licensees to design safeguards systems which can protect shipments against attacks involving several well-trained and dedicated individuals, hand-held automatic weapons, a four-wheel drive land vehicle, and hand-carried equipment, including incapacitating agents and explosives. (10 C.F.R. 73.1(a)(1)(i)) The regulations also specify that the attackers may receive insider (employee) assistance (10 C.F.R. 73.1(a)(1)(ii)) and utilize a four-wheel drive land vehicle bomb (10 C.F.R. 73.1(a)(1)(iii)). Nevada maintains that the definition of hand-carried equipment, in the hands of several well-trained attackers, using a four-wheel drive vehicle to carry their equipment, includes (but is not limited to) the following explosive devices: one or more large military demolition devices, such as the U.S. Army M3A1 shaped charge weighing 40 pounds; a significant quantity (limited only by the carrying capacity of the vehicle) of commercial explosives packaged in crates, boxes, suitcases, or other hand-carried containers; and numerous man-portable antitank weapon systems

such as the Carl Gustav M2 recoilless gun (weight 15 kg), the Milan antitank missile (weight 32 kg), and the infantry version of the TOW 2 antitank missile (weight 116 kg with tripod launcher). Nevada also requested that NRC consider amending the design basis threat to include use of explosive devices and other weapons larger than those commonly considered to be hand-carried or hand-held, and the use of vehicles other than four-wheel drive civilian land vehicles.

### **Definition of Radiological Sabotage.**

The petition requested that the NRC amend the definition of "radiological sabotage" (10 C.F.R. 73.2) to explicitly include deliberate actions which cause, or are intended to cause economic damage or social disruption, regardless of the extent to which public health and safety are actually endangered by exposure to radiation. An incident involving an intentional release of radioactive materials, especially in a heavily populated area, could cause widespread social disruption and substantial economic losses even if there were no immediate human casualties and few projected latent cancer fatalities. Local fears and anxieties would be amplified by national and international media coverage. Adverse economic impacts would include the cost of emergency response, evacuation, decontamination and disposal; opportunity costs to affected individuals, property-owners, and businesses; and economic losses resulting from public perceptions of risk and stigma effects.

### **NEVADA REVIEW OF DOE'S DRAFT ENVIRONMENTAL IMPACT STATEMENT, 1999-2001**

NANP staff and contractors prepared extensive comments on transportation risks and impacts as part of the State's review of the DOE Draft Environmental Impact Statement (DEIS) for Yucca Mountain. Nevada representatives presented testimony and written statements at more than 20 DOE public hearings around the country between August 1999 and February 2000. Nevada also submitted detailed written comments to DOE on February 28, 2000.<sup>c</sup>

The DEIS included an analysis of acts of sabotage against spent fuel shipping casks. The DEIS evaluated the consequences of attacks using high-energy explosive devices against a GA4 truck cask and a representative large rail cask loaded with 26-year cooled PWR fuel assemblies. Estimates of the amounts and characteristics of radioactive materials released by the attacks were derived from a 1999 study by Sandia National Laboratories. (21) DOE calculated the radiological health impacts of these release estimates using the RISKIND computer code and certain assumptions about demographic and meteorological conditions near the attack site.

The DEIS analysis estimated that a successful attack on a truck cask in an urbanized area under average weather conditions would result in a population dose of 31,000 person-rem, causing about 15 cancer fatalities among those exposed to the release of radioactive materials. The maximally exposed individual would receive a dose of 67 rem. DOE estimated that a successful attack on a rail cask would result in a population dose of 4,900

person-rem, 2.4 fatal cancers, and a maximum individual dose of 11 rem. The DEIS did not evaluate any environmental impacts other than health effects. In particular, the DEIS ignored the economic impacts of a successful act of sabotage. (3)

Nevada's initial review of the DEIS indicated that DOE underestimated by at least a factor of ten the impacts of a successful act of sabotage against a truck cask in an urban area. The Sandia study assumed that the reference weapon would not completely penetrate the cask. Full perforation would increase the release and resulting consequences by a factor of ten. Given the uncertainties about the vulnerability of the reference cask (the GA4) to the reference weapon (the M3A1 military demolition device), DOE should have used a bounding scenario approach, resulting in a range of estimated impacts between 31,000 and 310,000 person-rem population dose and 15 to 150 latent cancer fatalities. (7)

Moreover, the sabotage event evaluated in the DEIS does not represent a credible worst-case radiological consequence scenario. DOE assumed the casks were loaded with 26-year cooled SNF. DOE should have evaluated radiological impacts assuming the casks were loaded with 10-year cooled SNF. Under current NRC regulations, the worst-case truck sabotage incident could involve a GA4 cask loaded with 5-year cooled SNF. DOE also failed to assume worst-case demographic factors and weather conditions. (7)

DOE also failed to consider a credible worst-case attack scenario. There is no evidence that the Sandia study, from which DOE derived its release estimates, evaluated the weapons identified by NANP, particularly large anti-tank missiles. Sandia chose to conceal the identity of the specific weapons evaluated, citing national security concerns. It is clear, however, that Sandia failed to consider scenarios involving use of more than one penetrating weapon, use of an incendiary device in conjunction with a penetrating weapon, or use of multiple commercial shaped charges which are more efficient metal penetrators than the M3A1 military demolition device. The Sandia study damage analysis improperly extrapolated results of previous experiments to current cask designs, and relied upon a computer code (SCAP) which was not sufficiently benchmarked for modeling multi-layered targets. (7)

Nevada is particularly concerned that DOE failed to evaluate the economic impacts of the sabotage incidents described in the DEIS. NANP contractors have replicated DOE's sabotage consequence analyses, using the RISKIND model, and have estimated the economic impacts of the DOE truck and rail sabotage scenarios using RADTRAN 4 and RADTRAN 5. NANP does not yet consider the results of these analyses to be definitive. It is clear, however, that even the constrained truck sabotage incident described in the DEIS could result in adverse economic impacts ranging from about \$3 billion to more than \$10 billion. Other scenarios could result in even more severe economic impacts (22).

NANP contractors are conducting additional studies of the radiological and economic consequences of successful acts of sabotage, terrorism, and other human-initiated events. These studies are part of the State's continuing review of the DEIS. These studies will

also support the impact report which the State is authorized to prepare in the event that the Secretary of Energy recommends the Yucca Mountain site for repository development. Studies currently underway will identify alternative assumptions about weapons capabilities, spent fuel radiological characteristics, meteorological conditions, and emergency response times and evacuation procedures. These alternative assumptions will be evaluated in conjunction with location-specific demographic and economic data to develop more refined consequence assessments. Nevada expects to publish additional findings and recommendations by August 2001.

## FOOTNOTES

<sup>a</sup> The primary references for this section are the reports by Ballard and Halstead. These reports can be accessed on the web at <http://www.state.nv/nucwaste/trans.htm>.

<sup>b</sup> The primary reference for this section is the petition itself, which is extensively documented. The full text of the Nevada petition and the comments submitted to NRC are available on the web at [http://4/4/01/ruleforum.llnl.gov/cgi-bin/rulemake?source=NV\\_PETITION](http://4/4/01/ruleforum.llnl.gov/cgi-bin/rulemake?source=NV_PETITION).

<sup>c</sup> Nevada's hearing statements and written comments on the DOE Yucca Mountain DEIS are available on the web at <http://www.state.nv.us/nucwaste/eis/yucca/index.htm>.

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