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Historical Application of a Social Amplification of Risk Model: Economic Impacts of Risk Events at Nuclear Weapons Facilities

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Public perception of risk is being cited as a documented reason to rethink a very contentious congressionally mandated process for siting interim storage and permanent disposal facilities for high-level radioactive waste. Rigorous survey research has shown that the public holds intense, negative images of "nuclear" and "radioactive" technologies, activities, and facilities. Potential host states and opponents claim that these negative images, coupled with an amplification of negative risk events, will potentially stigmatize the area surrounding such facilities and result in significant economic losses. At issue is whether a supporting social amplification of risk model is applicable to communities hosting facilities that are part of the U.S. Department of Energy Nuclear Weapons Complex. An initial assessment of high-profile discrete and cumulative key negative risk events at such nuclear facilities does not validate that there has been stigmatization or substantial social and economic consequences in the host areas. Before any changes to major national policy are implemented, additional research is required to determine if the nearby public's "pragmatic logic," based on practical knowledge and experience, attenuates the link between public opinion and demographic and economic behaviors.

KEY WORDS: Risk; perceptions; amplification; nuclear; behavior.

1. INTRODUCTION

The public's perception of risk has proven to be a critical barrier to the U.S. Department of Energy's (DOE's) decade-long technical and scientific effort to site facilities for the interim storage and permanent disposal of high-level radioactive waste (HLW) in the form of spent nuclear fuel from 112 commercial nuclear reactors—a task that is mandated by the Nuclear Waste Policy Act of 1982, as amended. Voluntary and involuntary attempts to site these HLW facilities have been met with claims of their potential to stigmatize surrounding areas, resulting in significant losses to the various economic sectors at risk. This siting issue appears to be one of the nation's most difficult and contentious challenges to implementing public policy. The purpose of this article is to help determine the validity of claims that HLW interim storage and repository-related stimuli or key risk events are transformed into possible massive indirect social and economic impacts.

The claims of possible significant social and economic impacts are based on two premises. The first is that the public links intense negative imagery to "nuclear" and "radioactive" technologies, activities, and facilities.[1-4] The second is that both minor and major discrete and cumulative negative risk events of a nuclear nature may trigger significant adverse behavioral responses due to the social amplification of the risk. The premise relies on a conceptual framework of social amplification of risk.[5-7]

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Validation of the potential for adverse behavioral responses can be performed by applying a social amplification of risk model to analogous DOE Nuclear Weapons Complex (Weapons Complex) facilities. The HLW interim storage and repository facilities and the Weapons Complex facilities have strong similarities: they are managed by DOE, hold radioactive wastes, and are associated with comparable minor and major discrete and cumulative risk events. It is imperative to determine whether the predictive capabilities and processes of the model (1) can be calibrated by researching the evolving behavior patterns and secondary and tertiary economic and social reactions associated with existing DOE nuclear facilities or (2) are uniquely related to hypothetical future HLW interim storage and repository facilities and cannot be calibrated until constructed.

If public and economic behaviors at existing Weapons Complex facilities do not correlate with the predictions for possible adverse impacts at future HLW storage and disposal facilities, then a possible explanation is that the nearby public's "pragmatic logic"[8] intervenes. In other words, on the basis of its practical knowledge and experience, the nearby public may attenuate its degree of concern, as expressed through negative imagery and suggested by the social amplification of risk model.

2. APPLICATION OF THE SOCIAL AMPLIFICATION OF RISK MODEL

The purpose of advancing the conceptual framework was "to begin the building of a comprehensive theory that explains why seemingly minor risks or risk events often produce extraordinary public concern and social and economic impacts, with rippling effects across time, space, and social institutions."[5] The model architects used the term "social amplification of risk" to refer to the mechanisms and hypothetical stages by which the occurrence of an adverse event can extend far beyond its direct damage, triggering rippling behavior that introduces substantial temporally and geographically extended secondary social and economic consequences. The state of Nevada's claim of economic endangerment strongly relies on the premise of social amplification of risk: that as the potential host area for a HLW repository at Yucca Mountain, it would be vulnerable to minor and major negative risk events related to "nuclear" and "radioactive" images. This premise is supported by the assertion that because of "our society's strong response to mishaps involving nuclear power and nuclear wastes,"[9] news of each nuclear mishap around the world is immediately presented in the media and quickly elevated to the public's attention, possibly as an omen for disasters wherever there are nuclear reactors and wastes.

A historical application of the hypothetical stages of the model to existing Weapons Complex facilities was carried out to see if the results could assist current decision makers in better understanding and addressing public perceptions of risk. The application relies on facility-related information presented in local, state, and national news media (which are and will continue to be the primary amplifiers of negative risk events) and on existing public opinion survey data. Two major model elements (cause and effect) were investigated in this initial application:

- *Key Negative Risk Events.* Both minor and major discrete and cumulative key negative risk events occurring at Weapons Complex facilities were compared with those mentioned in HLW-related public opinion surveys.
- *Social and Economic Consequences.* A preliminary review of the social and economic conditions around Weapons Complex facilities was performed to assess possible consequences that could be related to key negative risk events.

Weapons Complex facilities offer a viable, empirical research opportunity for testing the model's theoretical assumptions and conclusions. The social amplification of risk model is a valuable but experimental step toward predicting siting consequences that could occur both now and in the future. The model developers state that their conceptualization needs "scrutiny, elaboration, and competing views."[5] In a discussion of model limitations, the developers, remarking on the model's partial testing using university students as subjects, noted that "more research is needed to determine how well intentions predict public response to risk. Similarly, the behavioral intentions university students display toward a hazardous event may be different than those of the general population."[6] Although secondary media information and survey data are often incomplete and reflect various interpretations and biases, until greater primary research is initiated, they can be used for an initial assessment of the first stage (which deals with the social amplification of key events) and the last stage (in which resulting behavioral responses are predicted to lead to impacts). It is critical to begin to stimulate a dialogue on whether the conceptual framework is repository-specific or can be applied to other DOE nuclear facilities with many strong similarities. Any divergences due to context, historical setting, previous experiences, or differential behavior of model components should be noted.

3. KEY NEGATIVE RISK EVENTS

The myriad of key negative risk events occurring at Weapons Complex facilities appear to be comparable to those events that surveys mention could accompany a repository in Nevada or an interim storage facility located elsewhere. If the key negative risk events are the same, they would be expected to have similar asymmetrical high signal strengths and amplified triggering effects, thereby causing comparable significant social and economic consequences at established and proposed DOE nuclear facilities.

3.1. Events at Weapons Complex Facilities

The Weapons Complex consists of 15 major facilities in 12 states employing nearly 100,000 people and covering approximately 3500 square miles. For more than 40 years, these facilities have been producing and fabricating uranium materials, irradiating them in experimental and production nuclear reactors, housing a variety of uranium materials in various storage containers, reprocessing some of these materials to separate weapons constituents, manufacturing and finishing weapons components, producing special parts, assembling and testing weapons, conducting research and designing new weapons, performing maintenance, and recycling or storing parts when weapons are dismantled.

DOE and its Weapons Complex facilities have been recipients of an increasing amount of site-specific and Complex-wide negative and highly emotional attention from local, regional, and national print and televised media related to past and present on-site and off-site disasters, contamination, mismanagement, spills, releases, exposures, accidents, and deaths, as well as heightened concerns about impending chemical explosions and radioactive releases. The Feed Materials Production Center (Fernald Plant) (Ohio), Rocky Flats Plant (Colorado), Savannah River Site (South Carolina), Oak Ridge Reservation (Tennessee), Los Alamos National Laboratory (New Mexico), Hanford Nuclear Reservation (Washington), Pantex Plant (Texas), Idaho National Engineering Laboratory (Idaho), and Nevada Test Site (Nevada) are the most recognized DOE nuclear weapons facilities. Since 1990, at least eight class-action lawsuits have been filed against DOE or its contractors seeking damages for possible property value losses and health impacts at weapons plants in Colorado, New Mexico, Ohio, Tennessee, and Washington.[10,11]

A 1991 report by the United States Congress Office of Technology Assessment places the blame on an overemphasis on production for national security, outdated equipment and facilities, manufacturing processes that were inherently waste-producing, lack of attention to environmental contamination, inadequate safety and health oversight, insufficient funding, and existing environmental and hazardous waste problems.[12] The public has been presented with an extensive litany of key discrete and cumulative negative risk events involving Weapons Complex facilities. Accounts are of:

- previously secret plutonium storage locations;
- potentially explosive leaking underground HLW storage tanks;
- significant deterioration of federal spent nuclear fuel kept in defective pools;
- tritium spills and leaks into major rivers and aquifers;
- large numbers of workers exposed to unacceptable levels of radioactivity;
- worker deaths from accidents;
- uranium contamination in off-site wells and aquifers;
- hundreds of intentional and unintentional radioactive releases several hundreds of thousands of times more potent than that of the Three Mile Island accident;
- transportation accidents and incidents involving nuclear materials; and
- revelations of possible and actual off-site health problems.

Key negative risk events at these facilities will continue and could conceivably increase in frequency and intensity. Additional revelations about facility environmental, safety, and health problems and off-site inferences will probably become more common under the aggressive leadership of DOE Secretary O'Leary, who advocates change in the management culture within DOE away from secrecy and a fixation on weapons production, no matter the cost, to one of greater regulatory compliance and citizen involvement in decision making. This change will be accompanied by implementation of higher standards for environment, safety, and health, including management and contractor accountability, which will further increase attention.

3.2. Risk Events Mentioned in Public Opinion Surveys

Local, state, regional, and national populations, as well as various organizations, have been asked for their opinions about key negative risk events and resulting

consequences. The public has been asked about different accident and contamination scenarios that could result from the interim storage, disposal, or transport of nuclear materials. The scenarios range in magnitude from no radioactive releases or contamination to major releases and contamination and from minor injuries to multiple deaths. The objective has been to statistically determine the extent of the public's belief in the probability of various types of risk events and its perception of the severity and duration of the consequences of these events.

Surveys related to siting a repository have focused on residents of Washington, Texas, and Nevada—past and present candidate states for repositories. They show the strength of perceived impacts. In similar national and Nevada surveys, it was found that (1) approximately 75% of both samples agreed that an accident at a repository would involve certain death; (2) more than 80% in each sample thought an accident would be catastrophic; (3) 63% perceived that large accidental releases of radiation from a repository were likely; and (4) approximately 75% believed repository wastes would leak radiation into groundwater.[13] In a survey of Texas Panhandle residents, a large majority agreed that the expected environmental risks of a repository were radiation in the water, food contamination, health problems for workers, radiation in the air, and health problems for residents.[14] Forty percent of the respondents in the Washington state Tri-Cities area felt that a HLW repository at the Hanford Nuclear Reservation would likely lead to radioactive contamination of the Columbia River, and 51% expected that people might hesitate about buying agricultural products grown in or near the area.[15]

Almost a dozen surveys have asked questions related to accidents involving the transport of nuclear wastes to a repository. A majority of respondents believe there will be highway and rail accidents. Percentages of respondents who agreed that highway and rail accidents would occur were 77% in Nevada, 69% in California, and 72% nationally.[16] In a survey of Hanford Nuclear Reservation area residents, researchers found that 50% expected dangerous accidents would occur;[15] in a Texas survey, 80% of the respondents had a similar belief.[14]

In a survey of convention planners, opinions were elicited on the potential for a negative effect from a repository by presenting a range of facility operating scenarios.[4] Subjects were asked if they would still choose Las Vegas as a convention site when confronted with each of seven scenarios, ranging in severity from benign (no accidents over the first 10 years of repository operation) to more serious (minor and moderate repository and transportation accidents involving cases of radiation exposure) and even more serious (multiple mishaps leading to 15 cases of radiation exposure and a higher-than-expected risk condition being present). Between 12% and 36% of the sample said they would change from a Las Vegas meeting location under a benign scenario; between 47% and 80% would change under the most severe scenario with amplified media attention.

Surveys related to the possible siting of an interim storage facility in Tennessee show respondents are concerned about its harmful characteristics.[17] Similar concerns were elicited from New Mexico and Idaho residents about the likelihood of accidental releases from the temporary storage, transport, and permanent storage of transuranic radioactive (TRU) wastes and the consequences of those releases, including death and serious illness, uninhabitability of land in the vicinity of the accidents, and inability of the area to be remediated within specified time periods.[18]

4. ECONOMIC CONSEQUENCES NEAR WEAPONS COMPLEX FACILITIES

Key negative risk events with high signal strength based on negative nuclear imagery and accompanying perceptions of managerial incompetence are hypothesized to elicit strong public reaction. The current social and economic conditions around Weapons Complex facilities reflect a 40-year cause-and-effect historical context for key negative events. During that time, a multitude of discrete and cumulative key negative risk events interacted with dynamic site-specific and area-specific social and economic variables (e.g., site mission, employment characteristics, diversity and stability of regional economic sectors, demographic profiles, area amenities and disamenities, trust relationships, and community relationships with site management).

A preliminary assessment of economic conditions in the host communities based on media information showed an apparent lack of readily observable significant adverse economic effects, contrary to claims of likely behavioral responses to key negative risk events. This lack could be the result of: (1) local familiarity with risk and nuclear technology; (2) the fact that most of the more profound negative risk event stories have come to light only within the past decade; (3) the overriding attraction of employment opportunities directly or indirectly offered by the facilities; (4) personal denial of harm among the population; or (5) a subtle selectivity shift to those who acquiesce or have less aversion to the risk within the area's population. A more extensive empirical scrutiny of site host areas to find social and ec-

onomic effects that could stem from key negative risk events is necessary to corroborate the model's elements and linkages or explain this lack of evidence. Two significant economic indicators used as a preliminary measure of the effect of key risk events on host areas of Weapons Complex facilities are property values and business activity.

4.1. Property Values

Property values reveal the equilibrium relationship between supply and demand on the basis of what a purchaser decides the value of the property to be. They can also reveal an increase in demand generated by a commensurate increase in employment in both the Weapons Complex and the host area, and they can show the level of acceptance or acquiescence by area residents and those in-migrating to the area. Real estate markets, as do many markets in our society, dynamically reflect the beliefs, attitudes, and reactions of buyers and sellers. Buyers and sellers respond to market facts and information on the basis of those beliefs and attitudes, regardless of whether they are factually correct; incorrect information would not have long-term impacts if the market is an efficient processor of information.

Evaluating how a facility or transportation activity related to radioactive waste affects property values in the host areas is possible through various techniques. These can include reviewing market analyses, housing statistics, and court proceedings.

A market analysis uses a history of tax assessment records and sales prices to compare properties near a facility with similar properties that are distant and unaffected by the facility's influence. This was the case when the Fernald Plant was the subject of a 1986 lawsuit that claimed that property values within a 5-mile radius had diminished after residents learned of a release of between 200,000 and three million pounds of uranium into the environment. As part of a $78 million settlement, property owners in the vicinity of the Fernald Plant are to be compensated for any diminution of value or less-than-normal appreciation between 1984 and 1990. During that time, the facility came under intense scrutiny for a number of key risk events, including mismanagement, worker carelessness, exposure of workers, hazardous waste contamination of the underground aquifer, presence of uranium in off-site wells, and noncompliance with state safety and environmental regulations. Media accounts[19,20] report that a subsequent loss in property value was found to exist for a radius of approximately one and a half miles from the plant and for three parcels adjacent to a contaminated creek three miles away. Adjacent agricultural land values declined as much as 53%; however, dairy farming and agricultural production continues. Residence values within one mile decreased 10–21%; however, construction of new homes continues. Similar diminution-of-property-value lawsuits, whose outcomes are unknown, are in progress against the Rocky Flats Plant and the Portsmouth Gaseous Diffusion Plant.

On the basis of various housing statistics (e.g., data on median sale prices, electrical connections, building permits, and occupancy), the media has been reporting an increased demand for housing and rising housing values near some Weapons Complex facilities. For example, in the Tri-Cities area that supports the Hanford Nuclear Reservation, it was reported that homes could not be built fast enough.[21] The median price for previously owned single-family homes in Richland, Washington, jumped 21% in 1993, the biggest increase of any United States city.[22] Even with highly publicized site characterization activities continuing at Yucca Mountain, the *Pahrump Times* reported the nearby Nye County communities of Beatty, Pahrump, and Amargosa Valley continued to explode in 1993, with Pahrump gaining 200 new residents in a 45-day period.[23] The City of Oak Ridge has successfully acquired 704 acres from the Oak Ridge Reservation (ORR) for continued residential, industrial, and service sector development; the East Tennessee Economic Council has a 20-year lease on 1000 acres of ORR for private industrial development. Los Alamos County is currently negotiating to acquire several large tracts of land from Los Alamos National Laboratory for industrial, residential, and recreational purposes.

Court proceedings have attempted to determine risk-related market effects. To determine losses in property values due to fear or perceptions of risk within the United States, three judicial approaches exist in state and federal circuit courts.

- The first view is that fears of prospective purchasers are generally compensable without having to prove the fears are reasonable, but evidence must support the conclusion that property value has diminished. This approach has been adopted in federal cases in two circuit courts and eight state courts.
- The second view is that fears must be shown to be reasonable, grounded in scientific observations or experience, and affect market value. This approach has been adopted in nine state courts.

- The third view is that speculative fear is not a reason for granting compensation for the alleged diminished value of property. This approach has been adopted in four state courts.

In a condemnation action related to the transport of TRU waste to the Waste Isolation Pilot Project (WIPP) site, the Supreme Court of the State of New Mexico (*City of Sante Fe vs. Komis*, 1992) adopted the first view.[24] The court ruled that compensation would be awarded for loss of market value, even if the loss were based on fears not founded on objective standards. Expert testimony by a real estate appraiser and a public opinion poll were sufficient to prove there would be a loss in value because of the public's perception that people would purchase the remaining land only at a reduced price because of the fear of living or working near a nuclear waste transportation route. In this case, no comparable sales data were provided, and the reasonableness of the fear was not an issue. The decision is applicable only to cases involving partial condemnations and only in states or federal courts where the first judicial approach is accepted. Nevada's Supreme Court has not yet been confronted with the issues of public perceptions of risk and reasonableness of fear related to property values, so the judicial approach it will follow is unknown.

4.2. Business Activities

Business activities have steadily expanded outward from population centers and now encroach on the previously remote, secret Weapons Complex facilities. Different types of businesses have varying reasons for selecting nearby sites and making operational decisions. Agricultural activities are location-dependent and directly respond to consumer demands and concerns. Manufacturing and service sector siting decisions are significantly influenced by a firm's size, product structure, functional organization, occupational characteristics, mode of transportation, and personal preferences of management. In a survey of firms, it was found that when a firm has locational flexibility, amenity factors, such as the natural and cultural environment, become more important in siting decisions.[25] Initial research by Argonne National Laboratory found that commercial and federal nuclear facilities had no significant negative economic effects on the hosting local communities; the greater the quality of the nuclear facility's participation with a host community, the better the acceptance.[26]

The media has reported that state and local government officials, supported by area economic development agencies, have aggressively sought to extend the lifespan and expand the operation of their existing Weapons Complex facilities—not to close them. Ohio business and political communities attempted to retain tritium-related work at the Mound site and uranium enrichment activities at Piketon. Eighty-five percent of Amarillo-area residents surveyed "indicated that they were favorable or leaned favorably toward expanding the Pantex Plant."[27] There has been strong state pressure to continue the underground testing of nuclear weapons at the Nevada Test Site (NTS) and to have a tritium accelerator sited there. Strong support exists for siting a new tritium reactor at the Savannah River Site (SRS) facility.

The financial community has examined the economic future of adjacent and host cities and counties and upgraded bond ratings. Two locations are the City of Las Vegas (even at the time of the passage of the 1987 Nuclear Waste Policy Act Amendment designating Yucca Mountain for characterization and continued nuclear testing)[28] and Aiken County, South Carolina, host to the SRS, which in 1994 received the highest rating available.[29]

Tourism and recreational activities continue to grow in the vicinity of Weapons Complex facilities. New mega-resorts are being constructed in Las Vegas, 65 miles from the NTS, and more are planned as the City seeks to promote a revised image as a family resort.[28] Many facilities are near flourishing vacation areas (e.g., Hilton Head, Tampa, Colorado Rockies, and Great Smoky Mountains) and annual national tournament sports events (Masters at Augusta National). Many facilities have expanded visitor centers, offer site tours, and provide special use permits for conference centers; for example, the University of Georgia will be constructing the Savannah River Ecology Laboratory Conference Center at SRS. On-site recreational areas exist for non-exclusive use by area communities and organizations. Controlled hunting for large game animals is allowed on ORR, SRS, and Idaho National Engineering Laboratory (INEL) properties.

Weapons Complex facilities have taken on a new responsibility related to supporting economic diversity both on site and within area communities. Site land, buildings, infrastructure, and research facilities are sought for alternative development, optimizing their reuse by university, private industry, and entrepreneurs, thereby bolstering local economies. The City of Miamisburg, Ohio, is actively working with DOE to commercialize the Mound site and make use of the facility's resources, such as requesting a portion for an industrial park. DOE and a consortium of local agencies at Hanford have joined to open the Agribusiness Commercial-

ization and Development Center to assist in moving agriculture-related technology from the laboratory to the private sector. Industrial parks are being developed by the private sector on land adjacent to the SRS facility and on land secured from the ORR facility. The former Clinch River Breeder Reactor Project site, adjacent to ORR, was a finalist in the Mercedes-Benz siting derby.

Although regional business activities have been disrupted because of regulatory agency actions following a risk event at a facility, no lasting economic effects have been evident or reported. For example, the restart of an SRS reactor in December 1991 resulted in a very publicized second spill of tritium into the Savannah River.[30] This event led to a State-enforced, several-day closure of river-using industries and water companies. DOE disputed the closure and the State's interpretation of health standards. Four downriver companies were compensated for their documented costs to acquire alternate sources of water, provide overtime pay to make engineering adjustments, and purchase equipment during the closure period. Despite this, the media[31] reported that since 1989, relocating companies and on-going business expansions have created 1200 new jobs in the SRS host county—Barnwell County, South Carolina. At Hilton Head, South Carolina (100 miles southeast), Del Webb Corporation recently announced development of a new 5300–acre adult community. Meanwhile, Barnwell County officials recently offered to host an interim storage facility for spent nuclear fuel from the State's commercial reactors.

There is a public perception that consumers might develop a belief that agricultural products from host areas of nuclear facilities are contaminated. *The Dallas Morning News* in 1993 reported that farmers worry that "Pantex's growing plutonium reputation will chase produce buyers from the High Plains, where agriculture provides a $3 billion industry annually."[32] However, agriculture continues to be practiced on and in the vicinity of several Weapons Complex facilities with no evidence of economic harm. Dairy herds graze on leased site property and in close proximity to the Fernald facility, and the milk (rigorously tested) is sold to area markets. Livestock graze on designated portions of the INEL site, on property leased from the state of Colorado that adjoins the Rocky Flats facility, and on property owned and leased by Texas Tech University at the Pantex facility. Agricultural enterprises involving orchards, vineyards, forage crops, and farm produce also exist in close proximity to most facilities. In fact, agricultural interests presently covet several Complex properties; for example, area farmers and local politicians are countering a proposal to designate the northern part of the Hanford Nuclear Reservation, formerly a buffer area, as a wildlife refuge, proposing instead it be divided into both farmland and a nature preserve.

A "halo effect" of positive attitudes by residents appears to surround Weapons Complex facilities and the technologies present. The effect can be attributed to several factors, such as people's familiarity with the facility over time, the fact that they volunteered to locate there, their heightened safety training, and the fact that they have more information engendered through their or their neighbors' employment at the facility. Those living near the INEL facility feel that there is less likelihood of an accidental release from TRU waste storage or transport and that any accidental contamination could be cleaned up quickly than do their counterparts residing elsewhere.[18] Proximity is also an issue at SRS, where approximately 40% of those residing within 50 miles had a good attitude toward the facility, while less than 25% of those residing within 50–100 miles and about 12% of those residing more than 100 miles had good attitudes.[33] The media[34,35] have stated, "knowledge, faith keep DOE neighbors at ease" and "Oak Ridge residents comfortable with legacy." These reasons may explain why no significant social and economic effects are apparent in areas surrounding Weapon Complex facilities. This local faith, accompanied by strong caveats for local oversight, financial guarantees, impact mitigation, economic diversity, environmental compliance, rigorous monitoring, emergency preparedness, and science education, caused the Clinch River Monitored Retrievable Storage (MRS) Task Force (1985), composed of local governments, to accept the siting of the MRS facility at the Clinch River site, a decision overturned by the state of Tennessee.[36]

Distance is also a factor in Nevada with regard to risk concerns over the NTS and support for siting the repository at Yucca Mountain. The average concern of residents of the rural Nevada communities of Amargosa Valley, Beatty, Indian Springs, and Pahrump (all in the vicinity of NTS) about the consequences of activities at NTS is low.[37] Similarly, perceptions of risk concerning the repository are weakest in the four rural communities nearby and strongest in urban communities farthest away from the site. This decreased concern and actual support for a repository by nearby rural communities is the result of a complex set of factors, including unique sociocultural settings, divergent NTS experiences and perceptions, a positive risk perception shadow of being upwind of NTS, and cross-generational concerns when addressing long-term hazards. There is also an anticipation of further positive economic opportunity, not to be equated with economic desperation. At this point, predictions of

potential adverse economic effects have not been confirmed; development officials from Nevada have stated in the media that the "prospect of Nevada someday becoming the home of a nuclear waste repository has not been an issue among companies considering whether to locate in the state. . . ."[38] Local support for repository site characterization activities at Yucca Mountain has been overridden by the state of Nevada, just as every other state governor has overridden desires by local communities to host an MRS facility.

5. CONCLUSIONS

It is imperative that public opinion and the public's perception of risk associated with facilities for the interim storage and permanent disposal of HLW be addressed by Federal policy makers and that the public continues to be involved in the debate. The Nuclear Waste Technical Review Board, in a February 24, 1994, letter report to Congress, recognized the importance of this very emotional and controversial public concern and recommended that "public perceptions about the potential risks associated with nuclear power and the waste it generates must be addressed."[39]

At issue is whether the social amplification of risk model's hypothetical stages are applicable to nuclear facilities on a universal basis and are not unique to an HLW repository. The established Weapons Complex facilities have strong similarities to the HLW facilities currently being sited because they are managed by DOE, have radioactive waste present, and have been subject to high-profile discrete and cumulative risk-related events. Most events at Weapons Complex facilities have been greatly amplified by the media and cross-referenced with an extensive litany of risk events involving nuclear technology at other nuclear facilities. Therefore, it could be assumed that significant social and economic consequences should be readily observable in areas hosting Weapons Complex facilities associated with these negatively perceived events. However, these consequences have not been found to be readily apparent, possibly because of the nearby public's pragmatic logic, based on practical knowledge, experience, and personal context.

The answer to understanding and addressing public perceptions of risk may reside in focusing on the dynamic interactions of perceptions and behavior. Perceptions must be assessed in the context of this nation's nuclear "omnipresence" (several hundred nuclear facilities and continual movement of nuclear materials along its rail and highway networks).[40] In addition, the public does have some very positive feelings toward nuclear technologies that are used in the medical field and could serve as an important energy source for the nation's future.[8]

To have researchers extrapolating policy recommendations from frequency distributions of survey responses and images and a partially tested conceptual model diminishes public involvement in the HLW decision-making process. Comprehensive research is necessary to explain: (1) what the complex causes of these perceptions are; (2) how the perceptions are differentially acted upon; (3) why paradoxes exist between claims and reality; (4) why people acquiesce or accept the risk; (5) how risks can be managed in a participatory manner; (6) what the relationships between facilities and host communities are; (7) whether the public understands the policy issues in context with alternative storage and disposal solutions; and (8) what the public prefers as alternative solutions.

Before proposing changes to a major national policy, the research community must be able to systematically identify and validate the model's amplification and behavioral linkages between (i) the occurrence of minor and major discrete and cumulative negative nuclear and radioactive risk events and (ii) the potential for significant social and economic consequences. The debate is not on the magnitude of the potential stigma problem but on whether substantial stigma-related problems would accompany the siting of a future repository, interim storage facilities, or transportation routes, with resulting significant social and economic impacts.

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