A RISK COMMUNICATION CASE STUDY: THE NEVADA RISK ASSESSMENT/MANAGEMENT PROGRAM

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ABSTRACT

The Nevada Risk Assessment/Management Program is part of a national effort by the U.S. Department of Energy (Grant DE-FG01-96EW56093) to develop new sources of information and approaches to risk assessment, risk management, risk communication and public outreach as these objectives relate to the ecological and human health effects of radioactive and hazardous material management and site remediation activities. This paper reviews the innovation behind the Nevada Risk Assessment/Management Program and presents a synopsis of the effort that began in 1995 and will officially conclude on April 30, 2000.

INTRODUCTION

The primary goals of the U.S. Department of Energy (DOE) in awarding the cooperative agreement establishing the Nevada Risk Assessment/Management Program (NRAMP) were to (1) use a risk-based approach to evaluate the consequences of alternative actions in DOE's environmental remediation programs at sites in Nevada and (2) use a neutral and credible institution outside the DOE to perform the risk assessments and contribute to public education about environmental management issues at the Nevada Test Site (NTS).

These goals are action-oriented interpretations of the U.S. National Academy of Sciences (NAS, 1994) advise to DOE on how risk-based decisions could be incorporated into the DOE Environmental Management Program. The report identified certain obstacles to a risk-based management approach and confirmed the importance of stakeholder involvement in performing the risk evaluations. (*Stakeholder* is a term used to refer to any member or component of an involved group holding an interest or stake in the problem being considered. Although stakeholders include the federal, state, and local government, the term more commonly refers to the affected members of the public.)

One of the primary NAS (1994) recommendations was that the credibility of an evaluation of site-wide risks would be greatly enhanced if the evaluator were other than the DOE, and the NRC identified six criteria which an institution should satisfy in order to establish credibility: (1) it should be perceived as being neutral; (2) it should have management capability; (3) it should have the ability to conduct scientifically valid and responsible risk assessments; (4) its assessments should be subject to independent, external review by technical experts; (5) it should have the ability to plan, organize, manage, and facilitate public participation; and, (6) it should have the ability to effectively communicate complicated scientific information on potential risks and uncertainties.

The implementation of the DOE's cooperative agreement with the University of Nevada, Las Vegas is believed to be the first site-specific application of the NAS-recommended risk assessment process for supporting site-specific decision-making. As originally proposed, the NRAMP developed an integrated stakeholder, scientific peer review, and risk assessment process that tracked the goals enunciated in the DOE Notice of Program Interest (59 FR 66, 1994) which were to systematically: (1) identify and characterize, on a site-by-site basis, the risks to human health and the environment; (2) identify and characterize the data gaps and uncertainties, and identify methods for filling gaps and reducing uncertainties, in our present understanding of the above cited risks; (3) review and recommend the process by which the above cited risks will be reduced; (4) review and recommend how public participation should be involved in risk evaluation and how such risks should be communicated to non-technical audiences; and, (5) review and define the costs for risk reduction.

PRELIMINARY RISK ASSESSMENT DEVELOPMENT WITH PUBLIC INVOLVEMENT

The process of risk assessment for the DOE sites in Nevada is complicated by many contaminant types, potential land uses, exposure pathways, and public interests. The NRAMP approach to risk assessment taken during the 1995-1996 effort was designed to assist all involved parties (the NRAMP Stakeholder Working Group and technical team, a local citizen's advisory board for DOE NTS programs, and the general public) to participate in the development of a Preliminary Risk Assessment (PRA) for DOE sites in Nevada.

The PRA (HRC, 1996) provides preliminary qualitative and quantitative information about current and future public health risks from the NTS. This information is intended to assist the development of refined risk estimates, the enhancement of stakeholder communication on site restoration activities, and the prioritization of environmental activities by the DOE.

The PRA accomplished two important objectives. First, the PRA identified gaps in technical knowledge that will be useful to prioritize future risk assessment activities such as gathering additional needed data. Secondly, the procedure has been a valuable experiment in stakeholder involvement in performing a scientific risk assessment.

Site Description

The DOE Nevada Operations Office (DOE/NV) provides administrative oversight at 10 locations in five U.S. states that have been used for development and testing of nuclear devices. The NRAMP considered only those sites physically located in Nevada: (1) the Nevada Test Site, (2) the Nellis Air Force Range Complex, (3) the Central Nevada Test Area, and (4) the Project Shoal Test Area.

The largest DOE/NV location is the multi-functional Nevada Test Site. The NTS encompasses approximately 3500 km^2 and is surrounded on the east, west, and north by the Nellis Air Force Range Complex that includes the Tonopah Test Range; these properties provide a 24- to 100-km buffer zone between the test areas and public lands. Radiological contamination exists from (1) 927 nuclear tests and supporting activities at the NTS that were conducted between 1951 and 1992; (2) on-site radioactive waste disposal; and (3) past and on-going subcritical experiments using special nuclear materials.

The NTS is currently a multi-program site. Major programs include the DOE Defense Programs, the DOE Environmental Management, the Office of Civilian Radioactive Waste Management, and other federal defense agencies. In addition to site remediation, the NTS is one of the primary low-level radioactive waste disposal sites for the DOE defense complex.

Method of Solution

For the sake of consistency in dealing with the complex and varied technical issues of DOE sites in Nevada, the PRA focus was limited to the Maximally Exposed Hypothetical Individual (MEHI) risk from specific land use scenarios and various contaminant source categories. Critical to this approach was the development and use of consistent assumptions and parameters. Therefore, the NRAMP technical team, with the input of the Stakeholder Working Group and the Scientific Peer Review Panel, determined five source categories and five land use scenarios given in Table 1 that formed the basis for the NRAMP technical approach to a preliminary risk assessment.

TABLE 1. Source categories and public land use scenarios used in the PRA

Source Categories	**Examples**
Industrial Sites	Chemical hazards at spill sites, waste sites, and landfills
Radioactive Waste Management Sites	Radioactive materials in disposal boreholes and trenches
Surface Soils	Plutonium deposited on soil from atmospheric testing
Transportation-Related Issues	Radioactive material in shipments to the NTS
Underground Test Areas	Residual radioactive material in test cavities
Public Land Use Scenarios	**Examples**
Cultural	Native American ceremonies
Recreational	Hiking
Industrial (Commercial)	Working at Solar Energy Generating Facility
Ranching	Ranches with cattle and home-grown crops
Residential	Isolated housing units

Public health risks were investigated in NRAMP through the evolution of two matrices shown in Tables 2 and 3 that were developed through interactions at monthly regional stakeholder working group meetings and with a scientific peer review panel composed of six national experts. These matrices were used as the basis for categorizing and evaluating risks in the development of the PRA.

Contaminants were divided into five source categories given in Table 3 that segmented concerns by location (such as underground and aboveground) and activities (such as industrial, radioactive waste management, and transportation). The components of risk assessment (e.g., source characterization, transport mechanisms, exposure pathways and dose and risk calculations) were then independently studied using the best available knowledge. Consistency between these studies was ensured by defining reference land use scenarios as indicated in Table 1 and identical risk standards and terminology for stochastic and nonstochastic effects. This was accomplished, in part, through the use of the Maximally Exposed Hypothetical Individual approach. This assumes maximum exposure to a Reference Human (ICRP, 1975) at the assumed reference receptor location, through all pathways characteristic of the contaminant under consideration.

TABLE 2. Matrix translating stakeholder risk issues into a technical framework

Source Categories	Contaminants	Transport Media	Land Use	Receptors	Time Frame	Exposure Pathways
Industrial Sites	Chemicals	Surface Soil, Atmosphere, Unsaturated Zone	Controlled Access, Surface Access, Drilling Access	Public and Worker Health, Cultural Resources, Ecology	Now, 10, and 100 Years in the Future	Inhalation, Food Chain, Dermal Contact
Surface Soils	Actinides, Fission Products, Activation Products	Surface Soil, Atmosphere, Photon Radiation	Controlled Access, Surface Access	Public and Worker Health, Cultural Resources, Ecology	Now, 10, 100, 1000, and 10,000 Years in the Future	Inhalation, Food Chain, Dermal Contact, Radiation Proximity
Underground Test Areas	Actinides, Fission Products, Activation Products	Saturated Zone, Unsaturated Zone	Controlled Access, Drilling Access, Access to Springs	Public and Worker Health, Cultural Resources, Ecology	Now, 10, 100, 1000, and 10,000 Years in the Future	Drinking Water, Food Chain, Dermal Contact
Radioactive Waste Management Sites	Transuranic waste, Non-transuranic waste	Surface Soil, Atmosphere, Unsaturated Zone	Controlled Access, Surface Access, Drilling Access	Public and Worker Health, Cultural Resources, Ecology	Now, 10, 100, 1000, and 10,000 Years in the Future	Inhalation, Food Chain, Dermal Contact
Transportation-Related Issues	Hazardous Materials and Radioactive Waste	Atmosphere	Route/Mode Options	Public and Worker Health	Now and Through End of Operations	Radiation Proximity, Mechanical Damage

TABLE 3. Maximally Exposed Hypothetical Individual risk matrix considered in the Preliminary Risk Assessment

SOURCE CATEGORIES	PUBLIC LAND-USE SCENARIOS			
	Occasional Use	Continual Use		
	Cultural and Recreational	Industrial (Commercial)	Ranching	Residential
Industrial Sites	Exposure from cultural and recreational activities on sites with chemical contamination.	Exposure to workers at sites with chemical contamination.	Exposure to chemical contamination at agricultural locations at site boundaries and within the sites.	Exposure to chemical contamination at site boundaries and within the sites.
Radioactive Waste Management Sites	Exposure to Radioactive Waste Management Sites at the NTS boundary now and on the sites after 100 years[a]	Exposure of workers at sites after 100 years.[a]	Exposure to Radioactive Waste Management Sites at the NTS boundary now and on the sites after 100 years.[a]	Exposure to Radioactive Waste Management Sites at the NTS boundary now and on the sites after 100 years.[a]
Surface Soils	Exposure from cultural and recreational activities on sites now and after 100 years.[a]	Exposure of workers at sites after 100 years.[a]	Exposure at agricultural locations at site boundaries now and within the sites after 100 years.[a]	Exposure at site boundaries now and within the sites after 100 years.[a]
Transportation-Related Issues	*NA* [b]	*NA* [b]	*NA* [b]	Exposure from proximity to and accidents related to transportation activities.
Underground Test Areas	*NA* [b]	Exposure of workers at sites after 100 years	Exposure to well water drawn near locations suitable for agricultural activities after 100 years.[a]	Exposure to well water now and at time of peak concentration on site boundaries. Exposure to well water drawn from test cavities after 100 years.[a]

[a] The date of site release for public access is assumed to be in 100 years.
[b] *Not Applicable*: because it is assumed that there is no significant linkage of contamination source category to land use via an exposure pathway.

Hazardous chemical risks were based on EPA Methodologies and radiological risks on International Commission on Radiological Protection (ICRP) methodologies.

A radiologic source term was required for several source categories, but unclassified information on the radiological contaminant composition at the Nevada Test Site is extremely sparse. The Los Alamos National Laboratory report: "Total Radionuclide Inventory Associated with Underground Nuclear Tests Conducted at the Nevada Test Site, 1955-1992," (Goishi et al., 1995) is classified, but some information from the report has been released. The data that has been released from this report are not detailed enough in terms of site specification to provide a source term for radiological risk assessment. For the Preliminary Risk Assessment, the NRAMP technical team determined a comprehensive and locale-specific description of the radiological source term, which included all scientifically conceivable radionuclides and applied appropriate screening techniques to develop an inventory of significant radionuclides. This was in response to public desire to see a complete and open list of radioactive contaminants. A prevalent feeling among the public was that federal assessments were too limited in their contaminant inventory that often consisted of only one or a handful of radioisotopes.

Models were used for all the source categories. In many cases, commercially available codes were chosen. The majority of the NRAMP human exposure and dose response modeling used the Multimedia Environmental Pollutant Assessment System (MEPAS), (Strenge and Chamberlain, 1995). An exception was the NRAMP transportation-related issues, which also used RISKIND (Yuan et al., 1995).

Groundwater transport was not modeled by using the MEPAS code. Because of natural and anthropogenic heterogeneity in the subsurface environment, NRAMP risk evaluation was modeled by using a probabilistic framework. A semi-analytical model was used to estimate potential risks to public health at the boundary of the NTS. A time-travel transport approach was adopted. The specific computer code used by NRAMP (referred to as the Solute Flux Method) was provided by the Desert Research Institute, where the code was developed (Andricevic et al., 1994). The code allowed inclusion of the relevant physics of groundwater contaminant transport and uncertainties in modeling parameters.

PRA RESULTS

The results summarized below are focused on the NTS since this represents a majority of the potential risk for Nevada stakeholders. Table 3 lists the identified areas of concern investigated for each of the source types. No significant radiological risks to the public were identified at the present time as long as institutional control of the current combined DOE and Nellis Air Force Range complex exclusion area is maintained.

The definition of risk levels are given in Table 4 without discussion of the subjective terminology used: *Negligible*, *Low*, *Medium*, and *High*. In fact, these terms are arbitrary because risk numbers do not carry subjective values such as *good, bad, allowable, not acceptable, significant, low, medium,* and *high*, although technical experts may feel these are appropriate.

The risk evaluation terms in Table 4 were determined through a process in which stakeholder groups all participated through many written and verbal comments on the draft version of the PRA document. The table took several different forms, as it evolved, in response to suggestions made at invited forums and a weekly university-sponsored evening class. The final version shown in Table 4 appeared to be the most agreeable gradation of risk levels to the diversity of views expressed by stakeholders on the definition of risk.

TABLE 4. Definition of terms for the Maximally Exposed Hypothetical Individual risk evaluations used in the Preliminary Risk Assessment

Term	Lifetime Risk[a] Range	Comment	Hazard Index	Comment
Negligible Risk	Less than 1 in 1,000,000	Negligible risk level by federal regulations	Less than 1	Below threshold for harm
Low Risk	Between 1 in 1,000,000 and 1 in 1000	Below ICRP [b] recommendation to public		
Medium Risk	Between 1 in 1000 and 1 in 10	Above ICRP recommendation to public		
High Risk	Greater than 1 in 10	Above ICRP tolerable level	Greater than 1	Above threshold for harm
No Result	No value	Only subjective assessment is possible	No value	Only subjective assessment is possible

[a] *Risk* is the incremental lifetime probability of the Maximally Exposed Hypothetical Individual contracting a fatal cancer from the exposure and assumes a linear, no-threshold dose response.
[b] International Commission on Radiological Protection (ICRP, 1991)

The intent of presenting MEHI risk results using subjective terminology is to enhance effective communication and understanding of the PRA results. With this intent, many commentators stated that the sequence of negligible, low, medium, and high gave an intuitive gradation that could be understood by all parties involved. In addition, it was suggested by many that the risk values calculated in this study could be better understood if values were compared to risks from other human activities. This aspect of risk communication is more fully presented and discussed in HRC (1996).

Industrial Sites

Little information was available on the location or composition of contaminants present at the industrial sites on the NTS. Based on analysis of the limited available information, there is currently negligible MEHI risk to the public at the NTS boundary from industrial site contamination. Subjective analysis of risks inside the NTS boundaries indicated there are two categories of industrial sites which present negligible risk (Radiation and Housekeeping), four categories which present low risk (Waste Disposal Sites, PCB's and Lead, Land Fills, and Oil Related Sites), and one category that presents potentially high MEHI risk (Chemical Storage Sites).

Surface Soils

At the present time, medium-level MEHI risk could result from radioactively contaminated surface soil sites at the NTS boundary. Risks from radioactive surface contaminants at the Nevada Test Site are medium-level (above recommended limits) on at least eight percent of the Nevada Test Site at the present time. This declines to about three percent in the next 100 years.

Underground Test Areas

Risks from contaminants at DOE sites in Nevada are high-level for the MEHI in public land use scenarios requiring underground access, such as drilling a well near a nuclear test cavity. High-level MEHI risk could exist near the detonation cavities and near the Pahute Mesa through the next 100 years if these areas are released for public land use. Radioactive contamination from an underground test at the border of the NTS has migrated off the NTS in groundwater into the Nellis Air Force Range. The possibility exists that underground contaminants may move beyond the Nellis complex to accessible private and public lands in the future.

Radioactive Waste Management Sites

Negligible radiological risk to the public exists from the Radioactive Waste Management Sites (RWMSs) at the publicly accessible border of the Nevada Test Site at the present time. Currently there is negligible risk to the off-site public from the two operational radioactive waste management sites on the NTS. Medium-level MEHI risk could exist in the future from shallow radioactive waste burial if the NTS were released to the public. High-level MEHI risk could exist at the Area 5 Greater Confinement Disposal facility if the area were released for public use.

Transportation-Related Issues

Transportation-Related Issues associated with radioactive waste suitable for shallow land burial pose low radiological risks. In fact, risk assessment in this area is relatively mature and risk management decisions can immediately impact risks from this ongoing activity. Risks from Low-Level Radioactive Waste transportation and disposal are linked since the dominant existing and projected waste management activity is the disposal of waste imported from other DOE sites. Transportation risks may be dominated by the risk of mechanical harm, not radiation contamination. However, the full range of possible materials that could be shipped to and from the NTS is not currently known and is therefore not included in the NRAMP Preliminary Risk Assessment.

Project Shoal Site and Central Nevada Test Area

Based on available data, there is negligible risk currently and in the future from surface contamination in these areas. There is negligible risk at the boundaries of Project Shoal from groundwater contamination at the present time. High-level MEHI risk could exist from groundwater contamination within the boundaries of Project Shoal if the site were released to the public in the future. There is high-level MEHI risk from groundwater contamination at the Central Nevada Test Area at the site boundary now and through the next 100 years.

DISCUSSION

The results given above are more fully discussed in HRC (1996) and have been characterized by the NRAMP Scientific Peer Review Panel and DOE reviewers as "not surprising" and have been presented to several stakeholder audiences. These results are preliminary and risk management conclusions should not be drawn until the quality of the data and the modeling used in this study have been refined. However, the PRA accomplishes two important objectives. First, the PRA identifies gaps in technical knowledge that will be useful to prioritize future risk assessment activities such as gathering additional needed data. Secondly, the procedure has been a valuable experiment in stakeholder involvement in scientific risk assessment. The following sections will discuss some implications from the PRA results and activities and provide some suggestions for future work.

Data Quality and Availability

The worst example of available information for the PRA was the data available for Industrial Sites. Of the 968 chemical Industrial Sites considered in the PRA, 740 sites did not have information about their location. In addition, most sites also lacked information on their chemical constituents. Therefore, the PRA could not evaluate the risk from most of the Industrial Sites. In order to perform a meaningful risk assessment of Industrial Sites, data would be needed on identification of location, identification of waste category, and contaminant levels. A prioritization model for identifying, characterizing, cleaning, and closing Industrial Sites would be helpful for risk assessment if it included the following considerations: future land use, public and worker risk, available resources, mortgage reduction, and mission impact.

The other source categories also have data deficiencies associated with estimating the amount and distribution of the contamination. In particular, the Surface Soil evaluations relied on the Radionuclide Inventory Distribution Program data (McArthur, 1991) even though more recent data exists from a 1994 aerial survey and more current, but not yet released, surface contamination analyses performed by DOE contractors. This information would help validate the McArthur (1991) estimates and provide a better understanding of the spatial distribution of the contamination.

The Underground Test Area evaluations relied on modeling of a radiologic source term derived from publicly-available literature. The DOE has released more information on the inventory of radionuclides that could be used to refine the PRA source term.

Risk evaluation at the Radioactive Waste Management Sites relied on DOE Performance Assessments. However, these Performance Assessments were not required to include waste buried before 1988 and much of this waste is uncertain because of poor historic record keeping. The DOE is in the process of finalizing composite analyses that will include radioactive waste buried before 1988. With this information, more complete analyses can be performed for the RWMSs.

Finally, the risk evaluation for transportation-related issues relies on projected shipments to Nevada. Therefore, the risks will depend on the political and regulatory climate at the time of a shipment. The PRA has only assumed that solid low-level radioactive waste suitable for shallow land burial from DOE facilities will be transported to the NTS in amounts projected from current reports.

Limitations

Several important public issues were not covered in the scope of the Preliminary Risk Assessment. These issues are briefly identified below:

Issues that cannot be addressed directly in a scientific risk assessment

- Native American claim to the land
- Ruby Valley Treaty
- State of Nevada equity issues regarding out-of-state radioactive waste
- Ethical matters related to nuclear waste
- Public mistrust of the DOE and its contractors

Issues that are outside the scope of the PRA

- Risk management
- Remediation technologies
- Cost/benefit analyses of remediation technologies
- Application of regulations and compliance standards
- Yucca Mountain high-level waste repository
- Interim storage of high-level waste
- Storage of commercial waste
- A probabilistic risk assessment that considers scenario frequency

Issues that are within the scope of the PRA but were left for later studies

- Ecological risk assessments
- Effects on cultural resources
- Archaeological site assessments
- Refined land use scenarios, such as mining activities for the Commercial Industry land use scenario
- Refined land use scenario parameters, such as indoor/outdoor frequency and age-dependent factors
- Worker risk assessments
- Subsurface contamination from nuclear tests that did not affect the groundwater
- Long-term (greater than 100 years) risk assessment time frames
- Chemical hazards in all source categories identified in Table 1
- Refinement of radiological source term modeling

Recommendations

The NRAMP technical team noted that risk assessment models (such as the linear no-threshold dose response assumption) and risk assessment parameters need refinement in order to increase confidence in risk assessment results. The PRA relied mostly on the MEPAS code that was not developed specifically for NRAMP nor Nevada terrain and lifestyles. Therefore, refinement to modeling may include modification of the MEPAS code or cross-utilization with other codes to provide a more appropriate simulation for Nevada. Many default model parameters were used in the PRA because Nevada-specific information is sparse and difficult to find. Refinements should include incorporation of detailed land-use scenario parameters such as indoor/outdoor frequency and age-dependent factors that were not considered in the PRA.

PRA calculations indicate that risks from plutonium inhalation may not be the only significant contribution to MEHI risks from surface contamination as often assumed. A research program needs to supply the missing parameters for both mechanical (such as resuspension factors) and radiological parameters (such as slope factors and dose conversion factors) to refine MEHI risk estimates for all the important human-made radioisotopes in the surface soil of the NTS.

Several ways exist to improve risk assessment at the Underground Test Areas, specifically, more site-specific investigation of the hydraulic properties, physical site characteristics, and source term data. Another improvement would be to conduct more complex modeling by inclusion of relevant physical processes affecting the transport, exposure, and dose at the site and by calibrating the existing models. The high-level risk predicted from the Pahute Mesa underground nuclear tests may be unreasonably high because of poorly characterized hydrogeology combined with prudent and conservative assumptions. More characterizations made in the area between the Pahute Mesa and the Oasis Valley area would reduce uncertainty.

The groundwater flow directions are not well known. The difficulties of modeling the regional-scale flow include uncertainties in the hydrogeology and the flow parameters. Much of the flow at the NTS appears to be dominated by fracture flow. Characterization and monitoring are both highly complex in regions of fractured flow.

In addition to model and parameter refinements, a rigorous uncertainty analysis and probabilistic risk assessment are required to quantify confidence levels in risk values and consider scenario realism.

In addition to these scientific activities, further involvement between the scientific community and stakeholders is important to strive to enhance risk communication between the various involved groups. This can be accomplished through established means such as the university-offered course and involvement with interested regional organizations, or through innovative means such as multimedia or special workshops.

Post-PRA Activities

Stakeholder Activities

Following the completion the PRA, NRAMP conducted three focus groups at the university on Groundwater Contamination, Radioactive Waste Management, and Probabilistic Risk Assessment to focus attention on major areas of concern. NRAMP staff were also frequently requested to present technical information as an independent and informed expert on topics of radioactive waste, transportation, groundwater migration, etc. Often, when issues regarding radioactive contamination or waste management arise, NRAMP experts are interviewed or sought out by the media for explanation and opinion. Presently, informational documents are being generated at the request of DOE-independent community organizations on (1) transportation risks based on community-generated scenarios and (2) radiation risk in relation to other daily risks.

Support Activities for DOE

The development of the PRA gave the university experts experience and knowledge of DOE programs that equipped the staff to remain an important third-party reviewer of DOE/NV Environmental Management programs. For example, the university was placed as a core member organization on a radioactive waste management Technical Working Group to conduct detailed reviews of draft DOE documents. In addition, the university has developed a radiation detection laboratory to perform basic research addressing environmental issues. Presently, informational documents are being generated at the request of the DOE regarding atomic energy and its historical importance and benefit to society.

CONCLUSIONS

The NRAMP's primary mission is to increase and apply the scientific knowledge base as it relates to the human health and ecological risks associated with nuclear weapons testing and radioactive and hazardous waste management activities at the Nevada Test Site and other DOE sites in Nevada. It is now being generally recognized that the evaluation of risk requires the assistance of stakeholders, which includes members of the interested public. The large scope of this work is accomplished through various stages and various forms of public interaction. The first phase of NRAMP concentrated on the development of the Preliminary Risk Assessment. The second phase implemented communication and interactions with stakeholder groups.

The Preliminary Risk Assessment had the primary objectives of obtaining screening-level risk assessments, identifying the data gaps for improving future risk assessment activities necessary to understanding the NTS, facilitating further discussions with stakeholder groups on acceptable risk levels, and obtaining comments from the NRAMP Peer Review Panel on the general approach to risk assessment at the NTS. The PRA formed the initial basis for additional evaluations of planned site remediation activities, the development of additional risk management concepts, the identification of data and model needs to better understand and manage risks from DOE activities, and for informed public communication. Site remediation and associated costs were not considered in the PRA screening level effort.

The second phase of NRAMP utilized this experience to enhance effective communication as an objective independent scientific research support resource for the DOE and a well-informed authoritative and trusted information resource to the local community.

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