Blue Ribbon Commission on America's Nuclear Future
Disposal Subcommittee
July 7, 2010
Marriott Metro Center Hotel
Washington, D.C.

Members present:

Chuck Hagel (Co-chair)
Jonathan Lash (Co-chair)
Mark Ayers
Vicky Bailey
Susan Eisenhower
Allison Macfarlane
Per Peterson
John Rowe

Members absent:

Lee Hamilton (Ex officio)
Brent Scowcroft (Ex officio)

Speakers in order of appearance:

Chris Whipple, Principal, Environ Corporation
Jim Williams, Program Manager, Western Interstate Energy Board, speaking on behalf of the Western Governors' Association
Bruce Breslow, Executive Director, Nevada Agency for Nuclear Projects
Darrell Lacy, Department Director, Nye County Nuclear Waste Repository Project Office
John Gervers, Consultant, Clark County Nuclear Waste Division
Mike Baughman, Consultant, Lincoln County Commission
Judy Treichel, Executive Director, Nevada Nuclear Waste Task Force
Ron Curry, Secretary, Environment Department, State of New Mexico
John Heaton, Member, House of Representatives, State of New Mexico
Lokesh Chaturvedi, Former Deputy Director, Environmental Evaluation Group of the State of New Mexico
Don Hancock, Director, Nuclear Waste Safety Program, Southwest Research and Information Center
Peter Swift, Distinguished Member of the Technical Staff, Sandia National Laboratories
Frank Parker, NAE Distinguished Professor of Environmental Engineering, Vanderbilt University
Elizabeth Dowdeswell, Adjunct Professor in Public Health, McLaughlin-Rotman Centre for Global Health, University of Toronto
Daniel Metlay, Senior Professional Staff Member, Nuclear Waste Technical Review Board

About 65 others were in attendance in the course of the day.

Morning Session

The meeting was called to order at 8:02 a.m. by **Timothy A. Frazier**, the Designated Federal Officer, who reviewed the agenda.

Senator Chuck Hagel welcomed the attendees and thanked the presenters. The Subcommittee was established to determine how to develop disposal facilities in a technically, politically, and environmentally feasible manner. Are such facilities needed? What are the options? And what should such facilities look like? He opened the floor to comments by the Subcommittee members; there were none.

Chris Whipple was introduced to speak on the three questions posed to the Subcommittee. A disposal facility will be needed eventually, but pressurized-water reactors (PWRs) and dry-cask storage work well, so waste-management concerns should not push society to a nuclear power system that is not economic or technically mature. Reprocessing and actinide burning in fast reactors are not economic now.

The nation does need to get spent fuel off the sites of closed reactors. It needs to continue to convert Department of Energy (DOE) wastes to stable forms and to develop options for mixed wastes and greater-than-Class C wastes.

Deep geological disposal is still the top choice. Transmutation is too expensive.

A site should be selected with local support, as was done at the Waste Isolation Pilot Project (WIPP). The nuclear waste negotiator system did not work for high-level waste (HLW). The Finnish and Swedish voluntary siting system is working well but may not be applicable to the United States, which does not have a small, homogeneous population but rather strong state governments.

The land for a site must be acquired and a sensible standard must be set before a repository is designed. Sites (e.g., Ward Valley, California) have sometimes been selected and then a title to the land could not be obtained.

Rowe asked about dose standards versus risk standards. Whipple replied that most countries have dose-based standards. Macfarlane noted that Sweden and the United Kingdom have risk standards. Whipple pointed out that dose standards do not calculate risks. Macfarlane expressed having trouble with dose and risk standards extended out 10,000 or 1,000,000 years. Whipple stated that, over such periods, the uncertainties make them guesses.

Eisenhower asked what the Ward Valley experience was. Whipple replied that a successful attempt was WIPP, where everyone was in agreement and Congress passed the Land Withdrawal Act.

Lash noted that existing institutions include the Nuclear Regulatory Commission (NRC), DOE, National Research Council, etc. and asked what institutions should be involved. Whipple replied that the regulatory agencies should be involved. The decision by the National Research Council to choose the Environmental Protection Agency (EPA) was correct. The different institutions have different cultures. If the responsibility for operating the facility were taken away from DOE, he did not know where it would go, and large quality swings might occur.

Peterson noted that there are two types of standards: repository safety standards (one option being “risk-informed” standards toward which the NRC has moved for reactors) and waste-classification standards. For safety, Whipple commented that the uncertainties far in the future are substantial. It is a judgment call. One has to rely on defense in depth, mining-technology practices, etc. For waste classification, The U.S. waste classes are based on when wastes were brought under regulation rather than on the intrinsic nature of the waste. If one tries to change that situation, it would require great cost and effort.

Ayers asked what research has been done on sub-seabed disposal. Whipple replied that such research has not been funded for many years. The bloom came off the rose when Jacques Cousteau said that he did not like it.

Bailey asked what should be done with the current waste at nuclear plant sites. Whipple answered that the waste should be removed from closed sites; centralized facilities would be easier to manage than a multiplicity of sites. It should be stored; there is no need to dispose of the waste.

Macfarlane asked if there should be technical or other criteria for a repository. Whipple replied: Do not put it near useful bodies of water or in highly populated areas. The Swedish site, if it leaks, goes directly into the ocean.

Jim Williams was introduced to speak to policies and processes for implementing a national spent nuclear fuel (SNF)/HLW strategy in the United States. The Western Governors Association (WGA) coordinates policy among western governors. It has a memorandum of agreement with DOE on transuranics (TRU) transport and cooperative agreements on transportation planning.

A strategy for the back end of the nuclear fuel cycle is of great interest, and the WGA calls for individual state participation, participation on a regional basis, and an independent inquiry to build trust.

Policy and processes for rebuilding public trust are the Blue Ribbon Commission's (BRC's) most important contribution. There must be federal-state-local interaction. The BRC should look at past experience and see what went right and what went wrong. There should be a systematic review and assessment of institutional approaches and the consideration of a management entity for a long-range approach to SNF/HLW.

There is a public dread of HLW, federal program managers are mistrusted, and there is not fair uniformity from locale to locale. The issues involve disposal; off-site SNF storage; interim HLW storage; and TRU waste generation, storage, transportation, and disposal. The Western Governors have been dealing with these issues for 25 years.

There is a daunting array of issues in the BRC's charter. The Commission needs to lead the country into a new regime after the NWPA.

Eisenhower asked what went right and wrong and why. Williams answered that many of those who went through these experiences are getting up in age, and a systematic assessment needs to be conducted to inform the new policies that need to be developed for storage, transportation, etc.

Peterson agreed that the Commission faces a daunting array of questions and asked whether it should think about processes to deal with those questions, including state oversight of state issues. The WGA has taken transportation very seriously. Would it make sense to spend time on a process to develop an oversight system? Williams responded that, if one can arrange it, yes. The process is critical. There are a lot of pieces out there, but they need to be independently pulled together and reduced to some specifics, such as a site-screening process.

Lash noted that the independent inquiry into what went right and wrong would deal with a huge amount of information. One needs to learn from the past before going forward. He asked if the Commission could get a series of questions from the WGA and take them to the individual communities. Williams said that the WGA would be glad to cooperate with the Commission in such a way. Those who have the ground-level experience should be assembled, and that assembled expertise should be assessed by an

independent group. The Commission might set the scope and expectations of such an assessment.

Rowe said that all of the commissioners agree that such trust building is necessary. He asked if the Western Governors have any confidence that there is a way to work through these issues. Williams responded that he would be foolish to say that there is a nice, simple way to do this. High-level politics will intervene in such schemes. A commitment should be made to do this, though. It is more faith than anything else. The WIPP transportation issue is an example of where years of negotiations resulted in the WIPP Program Implementation Guide (PIG) that has gone forward with little change since then. Western states agreed on routes, and the system worked. The process has to be set up carefully at the outset, the process must be reviewed, and trust must be built.

Macfarlane asked if the host state should approve a repository. Williams answered that the WGA has not considered permanent disposal thoroughly. His personal answer was, yes. It would be difficult to do without state approval.

Bruce Breslow was asked to speak on lessons learned from the Yucca Mountain experience. What went wrong was that

- DOE, with its culture of secrecy, was not the right choice to design and operate a repository.
- The NWPA created an adversarial role between DOE and the State of Nevada and would have forced Nevada to give up its legal rights and responsibilities.
- DOE ignored serious geotechnical problems, trivialized stakeholder concerns, and scrapped its own guidelines when the site would not meet them.
- DOE did not move on to a more suitable site when Yucca Mountain did not meet the criteria.

Congress shares the blame for the failure to produce a repository. If the original act had not been gutted in 1987, there might be a repository today.

How can a deep geological repository be sited and built? There must be a best site that science can find. The site must be characterized first. The state must be allowed to opt out. There must be meaningful incentives for the state, local, and tribal governments. States must not be made to give up their rights. An ample compensation package would cost less than one-half cent per kilowatt-hour.

A repository project cannot be a federal project, it must be a community project run by a federal or private entity that is joined equally with its state, tribe, county, and local partners. A successful repository project can be achieved through an open process fully involving the state, region, and local communities.

Peterson noted that the Commission will be looking at advanced fuel-cycle technologies that might change the characteristics of the materials to be disposed of and asked to what extent the problems of Yucca Mountain result from *all* types of nuclear waste being dumped in one place. Breslow replied that the experiences from the Nevada Test Site and the dumping of waste in a number of locations eroded trust. Yucca Mountain was selected on the basis of convenience rather than science. The National Transportation Plan cost billions of dollars and resulted in a 25-page leaflet that essentially said that the federal government would not pay one dime toward infrastructure improvements. The situation was very contentious.

Eisenhower asked if science should trump local decisions. Breslow answered that one should let science drive the selection of sites, but local sites should have a veto.

Eisenhower asked whether the risks would be so great if the science were right. Breslow responded that the Yucca Mountain experience has been that the science was not what it was cracked up to be. The health risks are the most important, but politics has a great influence. To get politics to buy in, that is what the incentive package is for.

Macfarlane asked if there were criteria for repository siting. Breslow said that a nonoxidizing environment under the water table (which takes out oxygen) was needed.

Lash asked whether an opt-out process were preferable to an opt-in process at the state level. Breslow answered, yes, otherwise there is no credibility in the process.

Peterson noted that the opt-out process does not make much sense after the operation commences. Breslow said that, after site characterization and the licensing application, one still has to have state oversight, although opting out after an agreement is made is less meaningful.

A break was declared at 9:31 a.m. The meeting was called back into session at 9:50 a.m. Hagel asked a panel of Nevadans to comment on the Yucca Mountain Project.

Darrell Lacy spoke on the Nye County, Nevada, perspective. It has taken a science-based approach in construction and active engagement to protect the health, wealth, and safety of the county. The county has worked hard to have a say in activities under the local-oversight components of the NWPA. The county's data were used in DOE's license application. The citizens had to force DOE to include local governments in the process. No other local governments are seeking a repository. DOE was focused on the hard science (e.g., transport of radioactive nuclides). The controversy is political. There is no perfect site; acceptable sites have to be looked at, and engineered facilities have to be put in place. The citizens have to be protected. Today, the site is closed, and the DOE people are gone.

One must

- Finalize a fuel cycle;
- Select a regulatory basis;
- Select a site;
- Design, license, and construct the site; and
- Integrate with the state, local, and tribal governments on transportation operations.

A better level of acceptance probably cannot be found. The State of Nevada once approved Yucca Mountain. Things have changed over 30 years. Many wastes are sitting out there without a home. A geological repository is the right place for HLW. Yucca Mountain afforded retrievability. Defense wastes need a separate process. The NWPA was a good start, but it needs continuity of management, access to the Nuclear Waste Trust Fund, removal from the annual appropriations process, and isolation from political changes.

John Gervers was asked to give the Clark County, Nevada, experience on the "softer issues." Good science and technical competence are necessary but cannot substitute for public perception and acceptance. People who consider themselves marginalized will protest. There has been bipartisan opposition to the Yucca Mountain repository. In the 1960s, the Atomic Energy Commission said that fallout from tests would not hurt people. The slow cleanup of test sites has eroded confidence in management. The risks to health, safety, and the economy outweigh the benefits. The fairness of the siting decision was questionable. Clark County sees a nuclear repository as a threat to tourism. In 1987, other

sites were abandoned for a political choice of Yucca Mountain. DOE has denied the risks, dismissed objections, disrespected oversight activities of state and local governments, and delayed or reduced funding.

The NRC has made visits to local communities, made senior staff available, considered stakeholders' concerns, and cooperated with affected governments. But Congress has exhibited questionable fairness in the NWPA.

The management structure should be changed. The mission should be focused on technical and institutional terms. Safety should be foremost. Affected governments should be respected and have an inclusive role. The siting process should be guided by "risk and reward" principles. There should be adequate and consistent funding. The experiences of other countries like Canada, France, Germany, Sweden, and Finland should be considered.

Mike Baughman was asked to present the perspective of Lincoln County, Nevada. Local governments are responsible for the health, safety, and economic well-being of their citizens. About 98% of Lincoln County is managed by the federal government (primarily the Bureau of Land Management) and has a major transcontinental railway. About 150 miles of rail would be laid in Lincoln County to bring waste to Yucca Mountain.

Twenty-six years is a long time for such a decision process to take place. There is a need for a repository, and it should be deep geological disposal. With regard to this process, the overlying concern is uncertainty: political (politics has driven this process, resulting in divisiveness), local oversight (what the project means to the ordinary citizens and whether funding would be forthcoming each year), and financial (e.g., the rail link could not be committed to because of annual appropriations). The benefit has to be shared; now the eastern states get the benefits, and Nevada gets the waste. A level of compensation that would lead to engagement should be attained.

Judy Treichel was asked to speak for the citizens of Nevada. The country needs a discussion of what the problem is and what some solutions might be. "Success" means different things to different people. Lessons need to be learned from Yucca Mountain. DOE does not want to share those lessons. At this point, the country is not ready to look to the future and is relying solely on dry-cask storage. No one has ever unloaded a dry cask; that capability should be looked at and demonstrated. *After* the nation has decided where it wants to go, standards have to be set. Sites that do not meet those standards should be walked away from. The aim should be zero releases. A repository cannot be sited near potable water. A successful program would be one with broad participation that would lead to public confidence.

Hagel asked what type of replacement there should be for DOE. Gervers replied that the longevity of the institution would be key. The institution should stay in the U.S. Government. A private group is not the way to go; the government would be more durable.

Macfarlane asked whether a public-private entity should be selected. Treichel said that the government has security and other capabilities. A profit-driven corporation would have a lot of flexibility to avoid or cut costs. The Corps of Engineers might be a good choice. Baughman added that a federal program could be legislated. However, local governments may have little recourse if that government program decided to ignore them. Ward Sproat, Director of the Office of Civilian Radioactive Waste Management, brought

a strong private industry perspective to the job, including working with local governments on their issues.

Eisenhower asked how much difference a couple of other repository sites would have made and whether a reliable flow of money would have changed Nevadans' perceptions. Lacy replied that taking money off the table heightened the perception of unfairness in regard to benefits. Gervers added that having multiple sites is a prerequisite. Three sites should have been scientifically evaluated, but that process was foreshortened by congressional action, upsetting people in Nevada. Lacy noted that, when there are multiple sites, encountering a deal-killer with a site does not kill the program. Baughman, however, did not believe that having multiple sites would have changed the outcome.

Peterson noted that the NWPA did not foresee several oversight needs, and those functions had to be funded separately. Expertise on local needs should be crafted into such a piece of legislation. Baughman said that he was not sure what stone was unturned after 30 years of Yucca Mountain and countless nuclear power plants. Gervers suggested that looking at other countries would shed light on the need for local input. Peterson agreed that oversight is critical and can improve performance of utilities and can be seen to have economic benefits on those utilities. He asked if that could be said of a repository, also. Gervers replied, yes. Treichel said that oversight is more than just the paid people; it is also the citizenry. But DOE would not have a conversation with the citizens about Yucca Mountain.

Lash asked if resources should be supplied to nongovernmental agencies as well as to state and local governments. Treichel replied, absolutely. People go in angry to begin with if they have had to pay their own way to comment on a project. Expertise needs to be added to a conversation. Baughman cautioned that the neutral position of a local government might be compromised by advocacy science. Gervers noted that Clark County has taken an opposition position to Yucca Mountain because of its threat to the tourism industry. As to the nongovernmental organizations, they should have a modest level of funding to participate in the discussions, not to conduct research. Lacy added that nongovernmental organizations should have some connection to the issues at hand and to the local governments.

Rowe asked if there should be a dose-based standard or would some other method of safety standard pass muster with real Americans on the street. Treichel replied that one first has to have a conversation with real people on the street. The standard has to meet a real need and offer protections to everybody all the way out in time. Baughman said that residents want to know that they are not going to be exposed to any more risk. DOE would not consider cumulative risks from other sources. Lacy noted that the average person has a high fear factor because he or she does not understand radiation exposure. People become more comfortable with it as they become more understanding through experience. Gervers cautioned that one has to set a standard and then not change it. The WIPP standard was changed when it was to be applied to Yucca Mountain.

Ron Curry was introduced to speak about the State of New Mexico Environment Department's experience with WIPP. The WIPP needs to remain focused on its mission. There should not be mission creep. New Mexico has a contract with the federal government, and that contract should be upheld. There are three DOE facilities in New Mexico. They need to fulfill transportation, economic, and other roles, not just to be a threat to the people of New Mexico. How waste is characterized in other states has been

difficult to manage. A strong state regulatory agency is important for an HLW facility whether publicly or privately run. DOE has failed in self-regulation. An outside regulator is key to public confidence. Siting should be done by someone other than DOE. Project management plans have failed to regulate risky operations. Partnerships can be used to stifle a state's regulatory capability. Permits allow recipients to pollute in a certain way to a certain extent. Very tight restrictions can be written into that permit, which is developed with public input. A transparent process is needed for the permitting process. The states should have a strong role in siting nuclear waste facilities.

Domenici asked to include a written statement and suggested a meeting of the subcommittee in Carlsbad, New Mexico.

Macfarlane asked what constituted non-permitted disposal. Curry replied that waste disposal was done at Los Alamos National Laboratory (LANL) in sites with no permitting review and no regard for long-term effects.

Peterson asked, if the regulatory agency were a federal agency (e.g., the NRC or the EPA), how the state would exercise oversight. Curry answered that WIPP is regulated by several federal agencies. The state can override all federal regulations. The permit allows the State to shut down WIPP operations and transport. That allows the State to ensure that the federal agencies do what they are supposed to do. The State is always looking for ways to make the regulated entity accountable. That instills public confidence in the regulated entity.

Bailey asked where that authority lies. Curry replied that, in the State of New Mexico, it lies with the Environment Department. Bailey asked what kind of financial incentives were offered in New Mexico. Curry said that the public process has been important, lasting more than 20 years. A draft permit is written and publicly released. Public comment is used to identify and resolve issues, and the draft permit is revised. A lot of money came from the federal government for transportation. DOE has been asked for money whenever possible for health and safety training, road maintenance, etc. The three DOE facilities in New Mexico are economically important, and the federal government treats the state with the respect due a facility host.

Domenici said that this person uses the term "we" but has never been elected to any office. "We" as a government must see that the interests of the nation are upheld. The WIPP was a success because the elected officials at the local, state, and national levels supported it. A lot of local people realized that this project could be operated safely and could provide jobs for one-third of the community and $50 million per year for highways.

Curry contended that a strong state regulatory oversight that has instilled a lot of confidence in the public has allowed the project to go forward.

Lash asked if the state had statutes. Curry answered that the state has hazardous-waste, air-quality, and groundwater acts that can come into play.

Peterson asked if the State's regulatory responsibilities have influence on operational aspects or the long-term operation of WIPP. Curry replied that the influence is predominantly on the operational aspects.

A panel was asked to describe the New Mexico experience with WIPP.

John Heaton, in whose district WIPP resides, noted that energy and its delivery is an important issue. A deep geological repository is an absolute must.

In 1957, the National Academy of Sciences (NAS) concluded that the most promising disposal option for radioactive wastes was in salt deposits. Project Salt Vault was

successfully tested in Lyons, Kansas, but the project was rejected by the Lyons community in 1972. Salt is self-healing and encapsulates any waste emplaced in it. Carlsbad had a good sense of how salt behaves because potash was mined there since the 1930s. Carlsbad looked back and followed the science. No anti-WIPP legislation has passed, a state environmental group was established, and a legislative radioactive-waste oversight committee was established. In 1980, the shaft was put in place, and experimental rooms were excavated and studied. The WIPP Land Withdrawal Act of 1992 withdrew 16 mi^2 of land from public use, limited disposal to defense-related transuranic waste, and prohibited disposal of high-level radioactive waste and spent fuel.

Safety was the number-one issue discussed. WIPP was based on the best science, and education efforts were made throughout the state. WIPP has now had 11 years of safe operations with more than 8,600 shipments, more than 68,000 m^3 of waste disposed of, and more than 133,000 containers placed in the repository. Early experiments at WIPP showed that salt is suitable for disposal of HLW, and the waste-handling facilities have a hot cell for HLW. Sandia National Laboratories modeled heat distribution.

Steps to success would include establishing a desired repository medium; finding a willing community; assuring that the state is in agreement; committing to incentives; signing a long-term agreement based on science; completing a rigorous education of the community and state; designing a transportation system with the disposal site in mind; moving the Civilian Radioactive Waste Fund to a private/public partnership like the Tennessee Valley Authority (TVA); guaranteeing the host community and the state the interim storage facility, reprocessing facility, MOX plant, and fuel production; and beginning defense HLW cleanup quickly.

Carlsbad and its leaders fought for WIPP for 30 years. New Mexico and other states need to be looking at a repository for the future.

Lokesh Chaturvedi was part of a group set up in the New Mexico university system. Reviews of the Yucca Mountain license application reasonably showed that that was a good site, and the NRC would have approved it.

WIPP owes its success to the group that garnered credibility for it. It was never intended to be a pilot plant but a permanent repository. The decision to put waste in it and to study the effects to see if the regulatory requirements were met led to the project's success.

The area has been exploited for oil and now contains many wells. The heat produced by the radioactive waste enhances water migration. Retrieval is more possible in the Yucca Mountain site than in a salt bed.

Don Hancock has been dealing with legal, regulatory, and educational aspects of WIPP for 35 years. Some lessons learned:

1. WIPP is not a suitable site for high-level waste; WIPP's role was extensively discussed in the 1970s and 1980s; if WIPP's role were changed, it would be a violation of state laws and regulations as well as of the contract governing WIPP's operations.
2. The next 20 years will demonstrate the government's commitment to (a) starting clean and staying clean, (b) transporting without accidents and releases, (c) committing to clean up nuclear waste sites across the nation, and (d) safely closing and decommissioning WIPP.

3. Certain limits should be placed on the amount of waste and length of time of operation.
4. WIPP was developed before standards for health and safety were set.
5. The lack of a state veto and regulatory oversight should be restricted to only WIPP.
6. A technically, politically, and socially acceptable disposal program must have continuing input from affected communities as well as from critics and opponents.
7. Spent fuel will stay at its current reactor locations and must be safeguarded there.

Peter Swift spoke of his personal experience with WIPP as a staff member of Sandia National Laboratories. There was continuity in leadership for science programs from 1975 to the present that went through phases on site selection, site characterization, and design from 1975 to 1993 that shifted regulatory certification from 1994 to 1998. The science goes on today, supporting operations and recertification from 1998 to the present.

The WIPP site characterization and design efforts included geological studies, geophysical surveys, hydrologic testing, geochemical sampling and analysis, seal design, geochemical testing, and numerical modeling.

The generic regulation 40 CFR, Part 191, bases compliance on "reasonable expectation" that standards will be met with a 10,000-year containment standard that focuses on human intrusion (e.g., drilling for oil and gas). 40 CFR, Part 94, was written specifically for WIPP and accounts for multiple human intrusions.

Within 50 years, the salt will close in, encapsulating the waste. Essentially no 10,000-year releases are anticipated from undisturbed performance. Modeled performance is most sensitive to assumptions about future human actions. The estimated releases from human intrusion are well below the EPA containment standard.

In developing a disposal system, a regulatory framework should be developed first. Confidence in the scientific foundation should be built through a viable concept, a good site, sound science, sound analysis with full documentation, and independent external review. The regulator has a critical and dominant role.

Macfarlane asked what type of entity is appropriate for managing a repository. Hancock replied that a siting program should be run by scientists. Operating the facility should be entrusted to a different entity with a lot of state and citizen involvement.

Macfarlane asked what the 176,000 m^3 volume limit was. Heaton said that it referred to the waste; that limit will be pretty much on target for TRU. Hancock said that those limits are looked at regularly. DOE says that there is more room for more waste; the issue is whether the law and contract are adhered to.

Macfarlane asked what a standard should look like. Swift replied that they should look like the guidelines offered by the International Atomic Energy Agency (IAEA).

Lash asked how one would know whether DOE would live up to its commitments. Heaton said that DOE has never violated any of the promises it made to the community and has been very open in its activities.

Eisenhower asked why DOE has such contradictory images. Heaton replied that New Mexico has two national laboratories; as a result, it did not have preconceived ideas about DOE.

Peterson noted that behavior at depth is more predictable than at the surface and that society is even less predictable and asked if there were some merit in considering preempting extraction. Chaturvedi replied that the EPA decided that they should ask

WIPP to assume that drilling rig expansion would increase at the same rate in the next 100 years even though all the oil and gas will have been extracted. Despite the fact that all the oil and gas will be gone, the regulation was developed that way, nonetheless. It is an intensely drilled area now.

Domenici asked Heaton if he had said that there will be many communities that will welcome nuclear waste repositories. Heaton replied affirmatively. There are a lot of salt formations that could be used. One needs to decide what medium is suitable, identify communities, and then prove out the capabilities. In southeastern New Mexico, there would be wide acceptance; 95% of Carlsbad's population would approve of a geological repository in Carlsbad.

Bailey asked what the bases or assumptions of the contract were. Hancock answered that, with all the drilling, a site would be difficult to find. Hot waste will mobilize water and cause corrosion. Brine pockets under the repository will float to the surface if penetrated. There are several reasons why WIPP does not work for HLW. Heaton noted that WIPP is isolated on 16 mi^2 that will be closed to drilling. There is only a very small amount of water in the salt to be mobilized, and some engineering approaches can be used to counter that water's effects. As time goes by (e.g., for 300 years), heat production decreases. Chaturvedi said that, if integrity is desired, salt is not the medium. It will crush the containers. But, if one wants to ensure irretrievability, it is the medium of choice.

A break for lunch was declared at 12:45 p.m.

Afternoon Session

The meeting was called back into session at 1:40 p.m., and **Frank Parker** was asked to speak on a new paradigm for high-level radioactive-waste disposal.

The first reports of successful laboratory-scale studies of vitrification and immobilization of high-level waste occurred in 1959. Fifty years later, no high-level waste has been vitrified, and no new Compact waste disposal sites have received any waste, so there is no place to dispose of Class B and Class C waste.

The U.S. program, as conceived and implemented during the past decades is unlikely to succeed. A more flexible and experimental approach for repository development is needed. The biggest challenges to geological disposal and disposition are societal, not technical.

Limiting proliferation has become more important as the terrorists have become more sophisticated, opportunities have increased, and the terrorists have become more martyr inclined. Reducing human exposure to radiation has become more important as the average dose in the United States has almost doubled to 6.2 mSv/y.

It is not necessary to solve the nuclear waste problem immediately, but it cannot be left for future generations. Systems should be planned, designed, and built based upon how far one can plan for the future with some confidence, say 100 years.

The amount of natural radioactivity in the oceans is orders of magnitude greater than what would have gone into Yucca Mountain.

Half of the radiation that people are exposed to comes from background, 48% of it comes from medical, and another 2% comes from consumer-product and occupational/industrial exposure.

At the community level, poverty and lack of socioeconomic opportunity are the biggest dangers for the Chernobyl-affected areas 20 years after the event. Laws and regulations need to be harmonized because some are contradictory and illogical. No mathematically optimal solutions are possible, so societally acceptable solutions must be sought. As Niccolo Machiavelli wrote about 500 years ago, the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order. There are no guarantees for success. Without a new approach, failure is almost assured.

Peterson said that to project people into the distant future is reasonable to do. The use of fossil fuels will lead to acidification of oceans, and climate change will raise global temperatures. He asked to what degree generational concerns should govern nuclear technology. Parker responded that the mining of uranium ores leaves big social and political problems. Future generations should not be left off any worse than the current generation is.

Macfarlane asked how the NRC regulations for different materials differed. Parker said that they vary from 4.0 to 25 mrem/y. One has to consider accessibility. There is more radioactivity in sewage sludge in the United States than will ever go into WIPP, and no one worries about that.

Lash asked what the rules were for EPA, DOE, and NRC. Parker responded that the structure leads to contradictions. All three agencies need to sit down and agree (e.g., on how to predict flux in the future) so they are all talking about the same thing.

Rowe asked if one of Parker's first conclusions was that waste should remain retrievable for at least 100 years. Parker said that that was not what he meant to say. Unless there are major breakthroughs, there would be no purpose to retrieve it, and he would be opposed to retrievability.

Elizabeth Dowdeswell was asked to describe the Canadian experience with its repository program and the current status of that program.

The National Waste Management Organization (NWMO) was established in 2002 to investigate the long-term management of spent nuclear fuel (SNF) after a lengthy environmental assessment of geological disposal.

The selection of an approach was viewed as the development of a social contract: it must be socially acceptable, technically sound, environmentally responsible, and economically feasible. In addition, people had to be involved in the policy decisions that they would be affected by. Society at large will determine what risk it will accept. The Organization was looking for a social license. The process had four phases, after each of which a report was issued and the public asked if this report was correct. Acceptability would only come from dialogue. The Organization experimented with a variety of means of communication (e.g., a roundtable of ethicists and aboriginal dialogues). More than 18,000 people were involved in these dialogues, and 50,000 viewed them on the website.

Each technical approach considered had pluses and minuses. The discussions started with the issues raised by the Canadian citizens themselves. This process allowed common ground:

- Canadians are willing to accept responsibility for nuclear waste now.
- Any approach has to be fair.
- Safety and security are preeminent.
- The approach has to be flexible.

Adaptive, phased management was agreed upon that included commitments to:

1. A centralized deep geological deposition in a suitable rock formation
2. Monitored and retrievable storage for generations
3. A phased management approach with explicit decision points that allows for adaption to social learning and technological advances and that is based on collaborative decision making

The Organization could not be prescriptive on when these approaches would be adopted.

Calls for strong governance, accountability, and continued citizen involvement were made. Process and site selection are now under way, starting in the four provinces involved in nuclear technology.

The Organization was guided by two assumptions:

1. Discerning and understanding the values of Canadians
2. The wisdom of a systems approach

No private or public institution has fully understood all the aspects of the problem, and the future may change the direction of the process.

Eisenhower asked how long the process took. Dowdeswell replied, 2 years and 11 months.

Macfarlane asked what the NWMO was. Dowdeswell responded that it is a public corporation. It is taking over waste-generation responsibilities. Its work was monitored closely by government agencies, and it must submit regular reports.

Rowe asked whether the adaptive approach put waste in a retrievable stage that could become permanent. Dowdeswell answered, yes. Retrievability and monitoring were demanded by the public.

Hagel asked Dowdeswell to comment on the reason that the Organization took a holistic approach and whether the Canadian government is structured to assume oversight responsibilities, with one agency handling all energy compliance. Dowdeswell answered, no; the provinces decide what energy mix they will use. The federal government has responsibility for all nuclear waste management through its Department of Environment and Ministry of Natural Resources, and its Nuclear Safety Commission issues licenses.

Hagel asked Dowdeswell to describe the teams involved in the discussion sessions. Dowdeswell replied that the Organization knew that it could not answer the questions if it just looked at the technical aspects. It had eight people take one week each month for six months to go through the multivariate analyses. One of those people was an ethicist. There was no grand design, just common sense based on an ethical framework.

Peterson commented that the NWMO report lists issues raised by citizens that provide a great perspective. The reactors used in Canada are heavy-water moderated and differ from the light-water reactors of the United States, producing substantially larger volumes of more dilute spent fuel. He asked to what degree having three storage means, on-site, centralized, and deep geologic storage, were important and whether the United States needs to think of such flexibility. Dowdeswell answered that the selection of the three options and the management approach were driven by the public discussions. The Canadian people said that they did not want to talk about disposal but about isolation and containment.

Hagel asked if the Organization was criticized because of its industry-laden board of directors. Dowdeswell said that it did, but it had to focus on completing its work

effectively. The board of directors left the Organization alone, did due diligence, and signed off on the report at the end.

Daniel Metlay was asked for an overview of the international experience in developing deep geological repositories. The Nuclear Waste Technical Review Board (NWTRB) is an independent federal agency "to evaluate the scientific and technical validity" of activities undertaken under the NWPA. There are 11 board members nominated by the NAS. The Board reports to Congress and the Secretary of Energy on its findings, conclusions, and recommendations at least twice a year.

The Board has conducted a survey of national programs for managing high-level waste. A geological disposal facility is needed. A deep geologic repository provides a unique level and duration of protection of public health and safety. It is technically feasible. The United States, Sweden, and Finland will have early operation of such a facility. They will be followed in mid-century by Belgium, China, and Switzerland. No official decision has been made by several other countries.

Deep geologic repositories can be designed to isolate and contain a wide variety of waste forms, and countries have made the decision to develop a deep geologic repository in a variety of ways: adopting disposal without a formal comparative analysis and adopting disposal after a formal comparative analysis. The Swedes several decades ago only had to go through one environmental agency. The European Union now has an environmental court that also has to be satisfied. There are fundamental prerequisites that they must meet, and the focus here will be on the site-selection process. In the United States, there are very prescriptive qualifying conditions for a repository.

Nontechnical filters vary from country to country, from volunteer communities to informal regional participation to no decision at all. Some countries use serial technical and nontechnical filter processes, and some use parallel. The implementation is sometimes a government agency, a government-owned corporation, a utility-owned corporation, or a public-and-private partnership.

He offered a series of personal observations: There is no simple solution to complex problems. Those pushing institutional forms tend to oversell those institutions. The Swedish model (seeking volunteer communities) works very well in Sweden but has not worked in any other country. The United States uses a consultation-and-concurrence approach.

There is a connection between "new build" and long-term management of HLW and SNF. The public will never believe that there is a permanent solution until there is evidence of one. At least outside of the United States, the imperative to develop waste-management solutions is independent of the future of nuclear power.

Macfarlane asked about Russia and India. Metlay replied that Hungary, Taiwan, and Ukraine are also missing. He did not have credible information from the excluded countries.

Rowe asked what country is the closest to having evidence of a permanent solution. Metlay answered, Sweden and Finland will have repositories in 2011 to 2012; the French will have one in 2015.

Hagel questioned whether Spain and Scotland had decided not to go forward with a geological repository. Metlay responded that Spain expects to have one, but there is no national policy; the United Kingdom has a commitment, but Scotland has not signed on to that document.

Peterson asked how the NWTRB compares to other independent oversight organizations around the world. Metlay replied that it is not unique; six countries (including the United States) have such an independent board. The use of this form of organization is growing.

Bailey asked if there were a question that the Commission should have asked. Metlay said that there is a false sense of permanence among groups like the Commission. One thinks that one's recommendations make a lot of sense. But there is randomness. One needs to consider the intransigence that one's recommendations will come up against.

The floor was opened for public participation. Rowe said that the Commission had heard convincing arguments for public confidence. The industry itself has shattered trust to deal with, also.

Brian O'Connell of the National Association of Regulatory Utility Commissioners (NARUC) said that that organization's earlier testimony focused on money. NARUC would like to see the license review of Yucca Mountain continued. That is the preferred site of NARUC. One-million-year standards boggle the mind and should be reviewed and reconsidered. A risk-based standard should be considered. For safety of monitoring, retrievability should be considered. SNF will not be needed for reprocessing. Under Senator Voinovich's bill, the $24 billion stays where it is; some of that money should be returned. An advisory committee for stakeholders should be established. There is no cost estimate for a 70,000-ton Yucca Mountain repository.

Steven Frishman said that safety standards acceptable to Americans on the street need to be developed; there has to be some answer to this question. People cannot conceive of one million years. It has got to be understandable. The exposure for Yucca Mountain should be 100 mrem/y, which is 10 times the exposure received from a chest X-ray. 100 mrem/y means there is a 1-in-273 chance of dying from an excess case of cancer. For the Amargosa Valley in Nevada, that means five excess cancer deaths. That would be understandable. It would put the risk in context.

There being no further business, the meeting was adjourned at 3:24 p.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
recording secretary
July 23, 2010