

Public Opinion: It's Impact on U.S. Energy Policy and Planning-11107

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ABSTRACT

One of the most salient and problematic social factors in American History has been nuclear energy, ushered in by creation of the atomic bomb, followed by the Cold War and nuclear arms build-up, and currently creating severe security, economic, and public unrest challenges due to, among other concerns, the need to manage the radioactive waste that has accumulated from the production of nuclear weapons and energy. The Savannah River Site (SRS), on which 37 million gallons of liquid radioactive waste and thousands of tons of high level plutonium and uranium have awaited disposition since the Cold War, is described to provide the reader with an understanding of the complexity of the waste management problem. Although the Nuclear Waste Policy Act (NWPA), passed in 1982, required that the Department of Energy (DOE) develop a plan to disposition such material to a national repository, and Public Law 107-107 calls for the material to be removed from SRS and South Carolina by February 2002, DOE program and project plans continue to include only on-site disposition. It is also estimated that more than 60,000 tons of "spent nuclear fuel" (SNF) from commercial reactors, as opposed to the "legacy waste" from nuclear weapons production, is accruing at 2,000 tons per year, and stored at 104 U.S. nuclear plants. No national repository has yet been developed to which nuclear waste can be shipped and stored. New technologies are in the research and development stage to address these problems. Asian and European countries are building modern fast reactors and state of the art reprocessing and recycling facilities. A vision plan has been developed at SRS which would ultimately evolve to an Energy Freedom Center and then a National Fusion Energy Park. However, in the U.S., where democracy demands public acceptance, confidence in such new technologies, has not changed American preferences for alternative energy resources. Public opinion polls overwhelmingly indicate that Americans favor the development of such sources as wind, solar and hydrogen technology. An international multi-disciplinary social science study found that nuclear war, nuclear power and nuclear waste are at issue. Concerns over these possibilities are pressing social problems and the investigators recommend that DOE, state and local governments, and DOE site specific Citizen Advisory Boards (SSCAB) implement outreach efforts which are grounded in the reality that confronting emotion and experience-based perceptions as irrational will be counterproductive for engaging the public in what will inevitably be a multi-generational dialogue. The SRS has confronted this problem with a series of site tours, in which hundreds of local residents have participated. An SRS Citizens Advisory Board (CAB) Speakers Bureau is also planned to describe the CAB's mission to various community organizations. While these efforts have been successful sociological intervention strategies, even stronger, more pervasive programs will be required to transform current public preferences for alternative energy resources over a national nuclear energy system, with its inheritance of radioactivity waste. In order to evaluate executive responses to the social concerns for nuclear energy and waste management, White House Central Files at the Carter Research Center, recent studies, and opinion polls from 2006-2010 were reviewed and compared to federal policy and planning. The review found consistency between public preferences and concerns, recent administrative visualization of America's energy needs, and executive courses of action.

INTRODUCTION

As a social scientist, member of the Department of Energy (DOE) Savannah River Site Specific (SRS) Citizens Advisory Board (CAB), and resident of Aiken, SC (which is contiguous with the SRS), I was curious as to what effect recent public opinion, and the definition of nuclear energy and waste management as serious social problems, has had on policy and planning. Following a review of public opinion literature over the past five years, and consideration of administration actions concerning nuclear energy and waste management since the Carter administration, this paper argues that even sound nuclear waste management programs and consistent administrative nuclear policy and planning will fail without appropriate sociological intervention strategies.

"The SRS CAB is a part of the Environmental Management Site-Specific Advisory Board (EMSSAB), a stakeholder board that provides the Assistant Secretary for Environmental Management and designees with advice, information, and recommendations on issues affecting the EM program at various sites. Among those issues are clean-up standards and environmental restoration; waste management and disposition; stabilization and disposition of non-

stockpile nuclear materials; excess facilities; future land use and long-term stewardship; risk assessment and management; and clean-up science and technology activities....The board's membership is carefully considered to reflect a full diversity of viewpoints in the affected community and region. Board members are composed of people who are directly affected by DOE site clean-up activities" [1]. Clean up activities are both technical and sociological in nature.

Social problems attract the attention of major polling services and appear regularly in public opinion polls. Public opinion polls are excellent indicators of the current status of various social issues and give an indication of which are the most pressing problems. President Thomas Jefferson declared that public opinion is the Lord of the Universe. Polling results over the past four years indicate that nuclear energy production and nuclear waste management rate as pressing social problems and are seen as inextricably interrelated issues. Therefore, in addition to the technological solutions to these issues, there must also be social solutions.

There are many sociocultural variables, some lurking, which must be controlled for in developing, conducting, and evaluating public opinion polls. The answers which pollsters get can be swayed by the framework within which questions are asked, by events of the time, social reform movements, pollster bias, or by psychologically weighted wording. Demographic factors such as gender, ethnicity, education level, occupation, political views, and/or the degree to which responders consider themselves well informed about the issues can influence answers. With this in mind, however, reliably controlled opinion poll results can provide general insight into public support or opposition to issues -- in this case, nuclear energy production and nuclear waste management. In addition to the nuclear issues, the polls also provide insight into preferences for alternative energy sources, such as drilling for gas and oil or development of other options like wind, solar and hydrogen technologies.

Comparing poll results to recent administration decisions on nuclear energy production and nuclear waste management can indicate the degree to which the administration responds to, or dismisses, public opinion. Toward that end, and against the backdrop of U.S. nuclear history, this study reviewed a series of public opinion polls, conducted between 2006 and 2010, along with recent White House decisions and actions.

BACKGROUND

Nuclear Waste Buildup.

Nuclear power and waste have long been salient and problematic social factors in American history. Creation of the atomic bomb ushered in the Cold War. Beginning in 1961, defense spending by the U.S. was increased some 60 percent to develop and stockpile nuclear weapons. The first commercial nuclear power plant was operating at the Shippingport Atomic Power Station located near Pittsburgh, PA. By 1965, that reactor had become the center of research for conversion into a new type of breeder reactor. The new type was called breeder because it would not only produce useful power but, at the same time, make as much or more new fissionable material as it is consumed. All types of breeders require reprocessing of expended cores and use of the recovered fuel material (e.g., uranium-233, plutonium-239, and uranium-235) in subsequent cores. Breeders also require permanent disposal of similar quantities of fission product wastes (nuclear waste). By 1977, Admiral Hyman G. Rickover was courting President Jimmy Carter for use of the technology gained at Shippingport. Rickover was committed to the development of a nuclear powered naval submarine fleet. However, even though he was being pressed by Congress for a comprehensive and consistent Administrative policy statement on the whole nuclear question, Carter had embarked on an indefinite delay policy concerning breeders and their requisite reprocessing. He was concerned that reprocessing SNF would lead to a "plutonium industry" and nuclear proliferation. At the time, there was also international controversy over reprocessing. In a letter to Dr. Zbigniew Brzezinski, Congressman John B. Anderson described the American-German Conference held in Princeton, NJ in March of 1977, where the Germans argued that their country was too small and densely populated for even intermediate storage of SNF. Germany insisted that its only option for handling nuclear waste was through reprocessing and that recycled plutonium "need not produce the proliferation danger postulated by those who seek a total ban on reprocessing" [2]. Anderson also pointed out that the U.S. Congress was split over the issue of reprocessing, nonproliferation policy, abandonment of the breeder reactor program, and legislation denying nuclear commerce even with U.S. allies unless they agreed to forego reprocessing and eventual dismantlement of their own breeder reactors. He argued that reprocessing was feasible, the technology available, and urged Carter to view the issue, involving the "back-end of the fuel cycle" in that perspective. In that same year, congressional representatives from South Carolina were petitioning President Carter

to use the "delay" period to continue research on nuclear waste management and nuclear safeguards at the Savannah River laboratory (SRS) and adjacent Barnwell plant for that purpose. Congressman John W. Jenrette, Jr. cited a letter from the International Atomic Energy Agency (IAEA) indicating approval of the Savannah River and Barnwell sites as a multinational fuel cycle center that would provide an international enrichment, waste management and safeguards program. Jenrette also recommended that the sites be seriously considered for future storage of spent fuel and uranium enrichment. Strangely, in support of his recommendation, he noted that "Savannah River and the adjacent Barnwell site have the benefits of isolation from populated centers..." [3].

Over the next three decades, thousands of tons and millions of gallons of radioactive waste, much of it weapons-grade, were left in ponds of water and various configurations of containers, both above ground and in subsurface tanks, at the originating sites. World War II and the Cold War have left hazardous nuclear and chemical waste in 34 U.S. states at over 100 locations. In 1989, DOE created the Environmental Management program to address the nuclear weapons legacy of waste. By 2007, DOE estimated that over \$70 billion had been expended but decades of research and technology development, and hundreds of billions of dollars more, would be required to manage the problems of legacy nuclear waste [4]. Some sat at national laboratories and test sites while SNF amassed in the growing stockpiles generated by commercial reactors. America still waits for a comprehensive and consistent Administrative policy on the nuclear question, including the back-end of the production cycle--nuclear waste management.

The SRS is an example of a legacy waste site. It is part of the large complex of laboratories and test sites managed by the National Nuclear Security Administration (NNSA), which were established during the era when the country was amassing nuclear weapons stockpiles. The site occupies over 200,000 acres, dates to 1950, and is often referred to locally as "the bomb plant". Today, on site at SRS, there are 37 million gallons of liquid radioactive waste in 49 underground storage tanks. Many legends abound about the pollutions, leakages, cemeteries full of exposed workers, and other dangers caused by government neglect of the radioactive materials at the site. In addition to the liquid waste at SRS, there are thousands of tons of high level plutonium and uranium in other forms awaiting disposition since the Cold War era. Processing programs and projects, including vitrification, have resulted in the safe containerization of some waste materials. Although the 1982 Nuclear Waste Policy Act (NWPA), discussed in greater detail below, specifies that DOE will develop a plan to disposition such material to a national repository, and Public Law 107-107, section 3155(c)(4), calls for a plan which specifies the means by which all such defense plutonium and defense plutonium materials will be removed in a timely manner from the Savannah River Site for storage or disposal elsewhere, program and project plans continue to result in only on-site disposition. The deadline for submission of that plan to Congress was February 1, 2002, and there is still no national repository to which nuclear waste can be shipped and stored.

The 2008 NNSA Supplemental Programmatic Environmental Impact Statement describes the facilities and materials handled and stored at SRS:

The major nuclear facilities at SRS have included fuel and target fabrication facilities, nuclear material production reactors, chemical separation plants used for recovery of plutonium and uranium isotopes, a uranium fuel processing area, and the Savannah River National Laboratory, which provides technical support. The initial mission at SRS was production of heavy water and strategic radioactive isotopes (plutonium-239 and tritium) in support of national defense. Today, the main weapons mission at SRS is tritium supply management and R&D.

As an NNSA-managed activity separate from weapons activities, a mixed oxide fuel fabrication facility [MOX] is under construction and NNSA plans to build a pit disassembly and conversion facility [PDCF] at SRS to disposition surplus plutonium [5].

In terms of the spent nuclear fuel produced commercially, it is estimated that there is more than 60,000 tons of SNF stored at 104 U.S. commercial reactor plants. This total is increasing by some 2,000 tons each year.

Administrative Response.

In 1976, the Joint Congressional Committee on Atomic Energy wrote to then Governor Jimmy Carter arguing that the safe and prudent development of the peaceful atom supports the conclusion that "...the public can now have confidence that the commercial nuclear power program is being closely supervised and regulated to assure that the public health and safety is adequately protected and that the activities are compatible with our environment" [6]. However, a dramatic wake up call came in the early morning hours of March 29, 1979. The Three Mile Island nuclear plant experienced a major malfunction and the nation became gripped in fear of a "*Chine Syndrome*". (By a bizarre coincidence, the movie, *China Syndrome*, was released on March 16, 1979, just thirteen days before the Three Mile Island malfunction.)

John D'Agata suggests that prior to the Three Mile Island incident, Nuclear Regulatory Commission (NRC) officials had adopted a Titanic mentality about the possibility of a nuclear reactor meltdown. It was thought, based on probabilistic thinking that the plants were so well designed a meltdown would never happen. D'Agata notes that Lee Clark, a Rutgers University sociologist, specialized in planning for improbable possibilities, has written that "It's dangerous to concentrate so much on probabilities that we forget about possibilities" [7].

As of this writing, there has been no nuclear power plants built in the United States since the Three Mile Island incident. Jay Hakes, former head of the DOE Energy Information Administration, reports that even before the Three Mile Island incident, "The poor performance and economics of nuclear power plants led to a stop in new orders...From a long-range perspective, the major impediment to boldly moving into a nuclear future is the problem of waste" [8a]. In the year that followed Three Mile Island, the American Nuclear Energy Council (ANEC) began lobbying efforts in Congress for legislation requiring that nuclear waste produced at commercial reactor power plants be stored by the federal government at a designated national repository. Toward that end, the ANEC launched an energetic education and contributions campaign in Congress, followed by congressional action. On November 22, 1982, Senator James McClure, ranking member of the Senate Energy and Natural Resources Committee, introduced the NWPA bill which called for the disposal of nuclear waste on federal land. The bill was quickly passed.

Although a national repository would have had no effect on the near meltdown of the Three Mile Island reactor No.2, it was hoped that a plan for government control of nuclear waste would restore public confidence in nuclear energy. The social problem of nuclear power plant safety became redefined for the moment and mixed with the problem of nuclear waste management.

The NWPA was designed to provide a technically sound and fair selection process for the establishment of permanent national nuclear waste disposition sites. In order to avoid putting the entire burden on a specific community, the plan limited the first site to the storage of 70,000 tons of high level radioactive waste. A second repository would later be licensed to store another 60,000 tons. The second repository was to be located in a different area of the country and in a different geological medium, if possible. Yucca Mountain NV, Hanford WA, and Deaf Smith County, TX were selected as the three sites for evaluation. The plan also called for DOE to begin removing waste from commercial nuclear reactor sites in 1998.

Public confidence in nuclear energy met another setback in 1986 when, on April 26, a disastrous accident occurred at the former USSR's Chernobyl nuclear power plant. The accident was caused by a sudden surge of power which destroyed the reactor and reportedly released massive amounts of radioactive material into the environment [9].

Following that disaster, and the resultant international alarm and damage, in 1987 Congress amended the NWPA to name Yucca Mountain as the only candidate for a national repository site, based on its greater opportunity for retrieval of the waste at a later date, if needed. The mountain was to hold mostly spent nuclear fuel, with only 8-9 percent of its capacity set aside for legacy waste. For the next two decades, Yucca Mountain served as the monolithic symbol of government control for allaying public mistrust and fear of nuclear power and the management of its waste. Over \$10 billion was spent studying, testing and documenting Yucca Mountain's geologic soundness for the mission.

By 2002, Yucca Mountain had been deemed scientifically and technically sound and was officially designated as the national high-level waste repository by President George W. Bush. However, policy and planning met with

continuous obstacles and blocks for development of the repository inside the mountain. Even ancillary costs were significant problems. For example, failure by DOE to meet the NWPA 1998 deadline to begin removing waste from U.S. commercial reactor plants has resulted in as many as 71 breach-of-contract lawsuits by plant owners and over \$7 billion in damage awards, with more to come. DOE estimates that it will be liable for at least another \$13 billion, even if Yucca Mountain were ramped up and met schedule.

DOE's purpose and need remains "to reduce the threat of nuclear weapons proliferation worldwide by conducting disposition of surplus plutonium in the United States in an environmentally safe and timely manner" [10]. However, the safety of deep geologic dispositioned nuclear waste has been continuously challenged and the timely manner issue has become a moot point. Over the almost three decades since the NWPA was passed into law, a myriad of nuclear waste management/disposition policies and plans by the federal government have been proposed, evaluated, modified, developed, delayed, implemented, and/or cancelled. In so far as the Savannah River Site is concerned, these include, but are not limited to:

--consolidation at SRS of surplus non-pit plutonium stored separately at the Hanford Site, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory

--construction of a stand-alone Pit Disassembly and Conversion Facility (PDCF) in F-Area at SRS to convert plutonium pits (the core of nuclear weaponry) and other plutonium metal to an oxide form suitable for feed as MOX fuel

--installing plutonium processing equipment (PuP) in K-Area at SRS, required to store and prepare non-pit plutonium for disposition through any of the alternative pathways (MOX fuel, H-Canyon/Defense Waste Processing Facility (DWPF), Glass can-in-canister, and Waste Isolation Processing Plant (WIPP))

--combining PDCF/PuP capability in K-Area

--use H-Canyon facility to process surplus non-pit plutonium to be sent to a sludge batch feed tank and then to DWPF for vitrification, with the potential of adding additional plutonium to the DWPF feed which would increase above historic levels the amount of plutonium in some DWPF canisters.

--establish a glass can-in-canister capability in K-Area for vitrification within small cans of both surplus pit and non-pit plutonium to be placed inside a DWPF canister and surrounded with vitrified high-level waste, which would also increase the amount of plutonium in DWPF canisters

--establish a capability to prepare and package non-pit plutonium using PuP (or combined PuP/PDCF capability) for disposal as transuranic waste at WIPP

--utilize PDCF, PuP, or combined PDCF/PuP to prepare some surplus plutonium as feed for MOX fuel, which would be irradiated in commercial nuclear reactors

--evaluate impacts of construction of any reactor facility modifications necessary to accommodate MOX fuel operation at five TVA boiling water and pressurized water reactors (no commercial nuclear reactor plants have contracted for MOX fuel)

--cancellation of proposal to evaluate ceramic can-in-can canister process.

Obstruction of SRS contractor schedules and inflation of cost estimates have also been problematic. As a case in point, DOE entered into a contract with Savannah River Remediation (SRR) to close 22 of the highest-risk liquid waste tanks by 2017, at a cost of \$3.2 billion. A recent Government Accountability Office (GAO) audit indicates that the actual cost will be increased by 44% due to inaccuracies in the DOE request for proposals (RFP), SRS worker pension plan losses, and persistent delays and short comings in the construction schedule for the Salt Waste Processing Facility (SWPF), currently planned for completion in 2013. Planning calls for the SWPF facility to remove almost all the radioactivity from salt waste in SRS tanks. "The removed radioactive component of the waste will be vitrified at the Defense Waste Processing Facility (DWPF) for disposition off-site" [11]. SRR now estimates that the delays will result in two to seven fewer tanks closed by 2017.

Regardless of the technological efforts by the government to process, containerize, and store nuclear waste, the issue of permanent disposal remains the 800 pound gorilla in the corner. In 1977, an interdisciplinary blue ribbon panel, sponsored by the Ford Foundation, completed a study of nuclear power issues and choices and concluded that "Although nuclear power is an important energy source, the United States and the world are not critically dependent on it for future energy supplies or economic development, and it can contribute little to the immediate energy problem"[12]. The study noted the poor record of waste management to date. Both President Carter and the Massachusetts Institute of Technology [13] argued against recycling SNF discharged from breeder reactors, but also noted the lack of appropriate storage sites. Hakes stated that, "From a long-range perspective, the major impediment to boldly moving into a nuclear future is the problem of waste" [8b]. In 2009, President Obama and his Secretary of Energy, Dr. Steven Chu, withdrew further funding for development of Yucca Mountain. Funding did continue for completion of the licensing application process to the NRC but that was also later withdrawn. Secretary Chu announced in January of 2010 that a blue ribbon Panel of 15 experts had been established to evaluate alternative options to Yucca Mountain. The panel was instructed to not consider Yucca Mountain as a candidate site. Lawsuits quickly followed. In February, 2010 Aiken County, SC and Hanford, WA filed suits to block the withdrawal of the license application. In March, Secretary Chu withdrew the Yucca Mountain license application to the NRC. Some critics argue that the President cannot arbitrarily cancel a law passed by the U.S. congress. The Yucca Mountain issue is now before the courts.

In the face of the science that went into testing the viability of Yucca Mountain, the time, energy, and billions of dollars involved, the declaration of President George W. Bush that the mountain had been found appropriate for the mission and ready for a license, and with no clear alternative to the planned repository, cancellation of the entire program by President Obama and Secretary Chu seems inexplicable. Review of public opinion polls on nuclear energy production and nuclear waste management, as well as new nuclear technologies, seem to shed light on the controversial decision.

It appears that politics is now at a cross roads where energy resources and public opinion intersect, with nuclear issues caught somewhere in the middle. Over the past four years, public opinion polls have consistently indicated that responders favor alternative energy sources to nuclear energy production. The polls also indicate that there is a significant concern for management of nuclear waste. In addition to the opinion polls, there have been environmental pressures stemming from heavy reliance on carbon-based fuels. There is also growing concern over the national security issue of U.S. dependency on foreign oil sources. While continuing public support of alternative energy sources, the White House has announced the necessity of a new generation of safe, clean nuclear power plants and the release of billions of dollars in loan guarantees for the construction of such facilities. Support of both alternative energy resources and new nuclear energy plants appear to be contradictory. However, new nuclear energy production systems and waste management technologies which are safer, cleaner, and more efficient appear to eliminate the contradiction.

While technology is not likely to ever be capable of converting high level waste (HLW) into fairy dust, the growing list of new technologies that hold promise for developing safer, cleaner, and efficient systems of nuclear energy production and waste management is encouraging and may lead to an increasing level of public confidence [14a]. Asian and European technologies include Multipurpose Hybrid Research Reactor for High-Tech applications (Myrrha) transmutation of transuranium elements and mixed oxide fuels (MOX). Europe is also seeking to help solve this global problem with the development of the ACTINET research program on industrial scale transmutation.

In the U.S., MIT is conducting significant research on fusion reactors. A MOX facility is under construction at SRS and scheduled for ramp up on or before 2019. SRS is also developing a vision plan which would bridge the technology gap to fusion, beginning with implementing such projects as a BioEnergy Integration Center, a Modular Reactor Demonstration Complex, and a Modular Reactor Power Park, and ending with the long term vision of a National Fusion Energy Park. The Modular Reactor Demonstration Complex would be composed of a Hyperion Power Module, capable of burning down blended highly enriched uranium (HEU) from surplus weapons, and General Electric's PRISM, a sodium cooled fast reactor that burns surplus plutonium and recycled light water reactor (LWR) fuel. PRISM would be a potential alternative to Yucca Mountain. There are other fast reactors on the drawing board which are potential alternatives to Yucca Mountain, including the General Atomics EM2 and the

TerraPower Traveling Wave, both of which are capable of burning surplus plutonium, highly enriched uranium, and light water reactor fuel without conventional reprocessing. The TerraPower is financially supported by Bill Gates.

America would benefit from the elements of this vision plan through carbon-neutral electricity, independence from foreign oil, revitalization of the American manufacturing sector, a renaissance of science and mathematics education, and sustainable clean energy jobs. Implementation of this vision would forge a partnership between the DOE, NNSA, the Department of Defense, and the local community. It would also align with the President's agenda for nuclear nonproliferation, energy, and climate change. He has declared, "I am convinced that whoever builds a clean energy economy, whoever is at the forefront of that, is going to own the 21st Century economy" [15].

Against the backdrop of these factors, cancellation of Yucca Mountain, administrative public support for alternative energies, and simultaneous funding appropriations for modern nuclear plants appears consistent with the prospect of administrative efforts to seek a constructive pathway between societal concerns and the country's energy requirements.

Public Opinion Polls.

Confidence in nuclear energy production has somewhat increased since the widespread fears which the Three Mile Island near-meltdown generated, and subsequent congressional passage of the 1982/87 NWPAA. Still, polls conducted over the past five years suggest that the preponderance of adult Americans prefer the government to focus on and support R&D for alternative energy sources. Time and space prevent inclusion of all the public opinion literature and data referenced for this study. The following is meant to broadly frame the issues for the reader.

2006

An August Bloomberg Poll [16] asked responders (n=1,478 adults nationwide) about the best way for the U.S. to reduce reliance on foreign oil. Responders answered:

Alternative energy sources	(52%)
Relax drilling standards	(20%)
Stricter mileage standards	(8%)
More nuclear power plants	(6%)
Increase gasoline tax	(2%)
Something else	(4%)
All of these	(3%)
None of these	(2%)
Unsure	(2%).

2007

An international multi-disciplinary social science study [17] was conducted over two and a half decades to understand why the public worries about some risks more than others. This effort led to the development of the psychometric paradigm method. The psychometric paradigm method portrays public perception of risk as the product of both emotions and analytical reasoning. A consistent finding of the research was that nuclear war, nuclear power and nuclear waste are pressing social problems and among the most dreaded and unknown risks. "...it is clear that people are extremely worried about the use of nuclear technology, most obviously for war, but also to produce energy and they are concerned about managing nuclear waste". The authors remind us that nuclear technology has a history as a social problem--images of the mushroom cloud, horrible deaths, the accident at Chernobyl, and the Three Mile Island scare and these powerful negative images are not going to go away, and they are frequently reinforced by media stories and movies.

Developers of the psychometric paradigm method concluded that knowledge which goes much deeper than the broad labels of nuclear weapons, nuclear power, and nuclear waste are needed to

confront and effectively address social concerns over these issues. Risk perception information is critical for those with the responsibility of managing nuclear waste.

The international study also sought to find out what people living near nuclear waste sites are most concerned about and fear the most and what steps DOE can take to reduce the problems. The investigators also sought information on what roles the mass media and local community advisory panels (such as the SRS CAB) play in the process of risk perception. Toward that end, they interviewed 1,351 residents who lived within 50 miles of arguably the six "highest hazard DOE nuclear legacy sites": Hanford (WA), Savannah River (SC), Idaho National Engineering Laboratory (ID), Oak Ridge (TN), Fernald (OH) and Rocky Flats (CO). The method involved random digit dialing and stratified random sampling, using American Association for Public Opinion Research standards, in order to determine which risks most worried respondents and the predictors of these worries. The research period lasted from July 14 to August 2, 2005.

Three main questions were asked of respondents: (1) What DOE actions at the sites most worry the public; (2) How worried are residents about DOE's cleanup of nuclear weapons related waste compared to other environmental risks in their area; and, (3) What factors predict the public's worries about DOE's activities?

Overall, the study indicated that the public was more worried about waste management threats to water supply, workers, and transportation-related accidents than they were about impacts on jobs, archaeological sites and ecological systems. Most people who live within 50 miles of one of these six nuclear weapons sites were mildly to moderately concerned about the legacy materials. Other environmental issues in their counties were considered slightly more worrisome. The exceptions were Hanford and Savannah River where the nuclear legacy ranked second and third in priority. The residents living near these sites were extremely worried about the management of legacy waste.

The social scientists conducting these studies recommend that DOE, state and local governments, and the DOE SSCABs increase outreach efforts which are grounded in the reality that confronting emotion and experience-based perceptions as irrational will be counterproductive for engaging the public in an on-going multi-generational dialogue. Since cleaning up and securing built up nuclear waste will take decades, such dialogue is essential. These challenges, the researchers suggest, "are as difficult and perhaps more sobering than the scientific, engineering, economic and legal challenges the DOE faces in managing these waste sites in perpetuity".

Against this backdrop of communal apprehension, SRS and CAB efforts are ongoing to assure the public that safety and health are high priorities where policy, planning and site management are concerned. Over the past two years, hundreds of local residents have participated in site tours which familiarize the public with SRS programs, projects, and the function of site facilities. The CAB is organizing a Speakers Bureau, composed of CAB members, in order to describe its mission to various community organizations.

2008.

Public opinion polls indicated a preference for alternative energy options such as drilling for oil, and other energy options when compared to construction of nuclear power facilities.

A June NBC News/Wall Street Journal poll [18a] asked responders (n=900) which of the actions they most supported as a way of addressing the rise in energy and gas prices. The responders answered:

Encourage the development of wind and solar power	(27%)
Open up protected areas in Alaska for oil and gas exploration	(24%)

Encourage American consumers to conserve energy	(19%)
Encourage offshore exploration for oil and natural gas	(16%)
Increase the federal tax on gasoline	(13%)
Encourage construction of nuclear power facilities	(10%)

In July, an ABC News/Planet Green/Stanford poll [18b] asked responders what actions they favored where American energy sources were concerned. They responded:

Increase drilling for oil in the U.S. immediately	(76%)
Drilling for oil in the Gulf of Mexico	(77%)
Drilling for oil in a small area of the Alaskan Wildlife Refuge	(53%)
Relaxing some environmental standards	(46%)
Building more nuclear power plants	(43%)
Rationing gasoline and oil	(30%)
Increasing the federal tax on gasoline	(13%).

2009

Although building nuclear power plants had gained support in the polls, responses (n=1,012 adults nationwide) did not indicate sustained and significant changes in public opinion of nuclear energy. A March Gallop poll [18c] showed that 77% preferred the government increase financial support and incentives for producing energy from alternative sources such as wind and solar. The "*China Syndrome*" seemed to follow the nuclear energy industry.

The Sacred Heart University (SHU) Polling Institute completed a national survey of 800 responders between May 27 and June 9. The survey found a nearly even split between those suggesting that nuclear energy was very or somewhat safe (46.1%) and those who said it is somewhat or very dangerous (44.7%). The two dangers cited by responders in the survey are "the problems with radioactive waste storage, a top criticism of nuclear power, and possible plant meltdowns" [19]. The survey also indicated that a majority of the responders (58.4%) felt that nuclear waste is a danger which humans will face for thousands of years to come. Reflecting other public opinion polls, the SHU survey also found that 94.6% of responders saw wind energy as very or somewhat safe, followed by river and tidal energy (80.0%), geothermal energy (68.5%), fossil fuels such as coal, oil, and natural gas (56.1%), and biofuels (55.6%). Significantly, while over half of the responders (55.6%) were concerned about the danger of future nuclear energy plant meltdowns, nearly the same percent (54.2%) felt that nuclear power plants will be safer in the future because of new technologies making plants meltdown proof.

An August ABC News/Washington Post poll [20] asked whether responders (n=1,100 adults nationwide¹) approved or disapproved of the way that President Obama was handling energy policy, with 55% approving and 30% disapproving.

2010

A March Pew Research Center poll [21] asked whether responders favored or opposed certain government policies to address America's energy supply. Responders favored:

Increasing federal funding for research on wind, solar and hydrogen technology	(78%)
Spending more on subway, rail and bus systems	(70%)
Allowing more offshore oil and gas drilling in U.S. waters	(63%)
Increased use of nuclear power	(52%)

A February poll by Angus Reid Public Opinion, questioned 1,010 randomly-selected adult Americans in an online survey. "Almost half of Americans are in favor of new nuclear power plants being built in the USA, but the majority said they are concerned about radioactive waste management, plant safety and nuclear material falling into the wrong hands..." [22]. In the survey, 48% of respondents favored constructing new power reactors in the USA, with 21% indicating strong support. However, 34% opposed building new power plants, with 18% strongly opposed and 18% not sure on the issue. When asked if respondents were concerned about management of radioactive waste,

81% said they were, with 51% being very concerned. With regards to safety, 72% reported concern that an accident could occur at a nuclear power plant and 74% were concerned that nuclear technology could fall into the hands of terrorists.

A March Gallop poll [23] asked responders (n=2,014 adults nationwide) about the use of nuclear energy as one of the ways to provide electricity for the U.S. with the following results:

In favor	(28%)
Somewhat favoring	(34%)
Somewhat opposed	(17%)
Strongly opposed	(16%)
Unsure	(04%)

In May, an Ipsos/McClatchy poll [24] asked responders whether they supported or opposed government policies to address America's energy supply: They favored:

Increased funding for research on wind, solar and hydrogen technology	(73%)
More spending on subway, rail and bus systems	(63%)
More offshore oil and gas drilling in U.S. waters	(49%)
Increased use of nuclear power	(46%)

Another May survey, by Pew Research Center [25], asked responders whether they supported or opposed government policies to address America's energy supply. They favored:

Increasing federal funding for research on wind, solar and hydrogen technology	(73%)
Spending more on subway, rail and bus systems	(65%)
More offshore oil and gas drilling in U.S. waters	(54%)
Increased use of nuclear power.	(45%).

A June Pew Research Center survey [26] indicated increased support in all categories, with nuclear energy least favored::

Increasing federal funding for research on wind, solar and hydrogen technology	(78%)
Increasing spending more on subway, rail and bus systems	(70%)
Allowing more offshore oil and gas drilling in U.S. waters	(63%)
Increased use of nuclear power	(52%)

In that same month another Pew Research Center survey [27], for the Society for Human Resource Management, showed that an overwhelming majority of responders (72%) favored development of alternative sources of energy. Fifty-six percent felt that protecting the environment should take precedence over keeping energy prices low.

An ABC News/Washington Post poll [28] in the same time frame asked whether responders supported or opposed certain alternative resources and oil and gas drilling over more nuclear plants. An overwhelming majority of responders favored alternatives to nuclear plants:

Developing more solar and wind energy	(87%)
Increasing oil and gas drilling	For (52%)
	Against (45%)
Building more nuclear plants	For (49%)
	Against (46%)

While support for developing alternative energy, such as solar and wind continues to lead public opinion polls, support for nuclear energy has increased. However, that support is at constant risk. Another major reactor

malfunction could seriously erode national and international public confidence in the industry. Passage of the NWPA bill originated with a disastrous nuclear plant malfunction that was thought to be improbable but turned out to be possible. It is less likely to happen again with today's technology, but it is always possible given such factors as human error, the old age of U.S. plants, and the global spread of nuclear energy production. While the technology applied in the U.S. is under tight control, the proliferation of nuclear energy production to politically unstable regions of the world holds the same threat and possible consequences as Three Mile Island and Chernobyl.

Public opinion polls also indicate what a double edged sword nuclear energy production and legacy waste management is. A March, 2010 poll [29] in the US showed support for the use of nuclear power reaching the all-time high of over 60%. However, a separate poll of two different groups, "informed public" and "opinion leaders", in the US and six European countries was conducted on behalf of AREVA. This poll shows that, while nuclear support is high, a substantial percent of the populace remain very concerned over nuclear waste management. The poll among informed public support for use of nuclear power was:

France	82%
Germany	51%
Italy	62%
Spain	71%
Belgium	73%
UK	84%
US	81%

However, these respondents also expressed wide consensus (82-96%) that used/spent nuclear fuel "remains radioactive and thus potentially dangerous for a very long time".

The "opinion leaders", also shared this concern (between 72-100%). They also shared a concern that radioactive waste will impact the environment:

France	49%
Germany	41%
Italy	49%
Spain	47%
Belgium	41%
UK	25%
US	39%

When asked whether used nuclear fuel is a fundamental problem which is hindering the development of nuclear energy, respondents indicated:

Informed public	66%-79%
Opinion leaders	42%-77%

Among the informed public there is overwhelming support for their respective governments to begin recycling spent/used fuel immediately, using extant industrial solutions which will save a significant percentage of uranium, reduce the volume and toxicity of nuclear waste, and recover energy, as follows:

France	86%
Germany	62%
Italy	67%
Spain	80%
Belgium	85%
UK	75%
US	76%

In stark contrast to US public opinion on the urgency to begin recycling spent/used nuclear fuel, the Nuclear Regulatory Commission (NRC) [30a] has just passed a regulation extending the period which such radioactive waste

can be left at the originating commercial reactor plants. Due to the fact that some plants are approaching the expiration dates of their operating permits, NRC has extended the temporary storage period from 30 years to 60 years. Unfortunately, such official actions are in direct contrast to administrative posturing to prioritize modernization of nuclear reactors and environmental cleanup of spent/used and legacy waste.

Developing nations, such as China, are actively pursuing the development of new nuclear energy technologies involving reprocessing and recycling. China and Belgium are reported to have signed a framework agreement for the construction of a pilot MOX fuel fabrication plant in China, along with a research collaboration agreement covering development of the Myrrha hybrid research reactor project [14b].

Belgium has a wealth of experience in MOX fuel development and production which dates back to 1960. MOX fuel has been used in Belgium nuclear power plants since 1995. The Chinese pilot MOX plant would produce recycled fuel for use in Chinese nuclear reactors. The MOX would be fed from reprocessing facilities which recover useful uranium and plutonium from used fuel. A 50-ton per year pilot plant to reprocess used nuclear fuel was opened in 2006. Subsequently, China and France's AREVA agreed on a feasibility plan to build an 800-ton per year reprocessing plant employing French technology and operations management.

Myrrha will be a sub-critical assembly relying on accelerated neutrons to achieve periods of criticality in a low-enriched uranium core. As well as being able to produce radioisotopes and doped silicon, Myrrha's research functions would be particularly well suited to investigating transmutation. China is reported as seeing Myrrha as a research infrastructure for preparing the solution to treat their nuclear waste. The Myrrha process involves certain radioactive isotopes with long half lives which are made to 'catch' a neutron and thereby change into a different isotope that will decay quickly to a stable form with little or no radioactivity. If achievable on an industrial scale, transmutation could greatly simplify the permanent geologic disposal of radioactive waste. The achievement of such technological breakthroughs, without U.S. involvement, could once again find America dependent on foreign sources where energy resources are concerned. However, the question of public confidence in nuclear power has yet to be resolved. As Jeffrey Jones has written:

President Obama has said that nuclear power is part of his overall plan to expand the use of alternative energy in the United States, and if public support for it continues to grow, it would seem likely that more Americans would come to rely on nuclear energy....There are clearly challenges to expanding nuclear energy use in the United States and there remain concerns among a substantial minority of Americans about the safety of nuclear power plants. Indeed, in prior years, Gallup has found Americans reluctant to support the construction of nuclear power plants in their local communities [31].

Conclusion.

A review of public opinion polls indicates that waste management concerns obfuscate increases in public acceptance of growing reliance on nuclear plants and energy. The polls overwhelmingly signify that Americans favor the development of alternative energy sources, such as wind, solar and hydrogen technology. The polls also indicate that the public's second preference is drilling for on and off-shore gas and oil. Increased spending on such infrastructure elements as rail, subway and bus systems runs third in the polls and, lastly, building new nuclear power plants.

Almost 30 years after the ANEC successfully lobbied Congress to pass the NWPA, the current administration has cancelled plans for the deep geologic national repository at Yucca Mountain and has enacted policy and/or plans which seem to respond to public concerns over nuclear energy plants, nuclear waste management, and alternative energy sources. President Barak Obama appointed as Secretary of Energy, Dr. Steven Chu, a 1997 recipient of the Nobel Prize for Physics. Dr. Chu is charged with implementing President Obama's ambitious agenda to pursue clean energy research and development, find solutions to the U.S. dependency on foreign oil, address the current crises of global warming, and help diminish America's high unemployment rates. Following the cancellation of plans to continue work on Yucca Mountain, Dr. Chu has appointed a blue ribbon panel to search for alternative solutions to the traditional nuclear energy production cycle and nuclear waste management.

Inside the alternative energy scene, however, are complex factors implying that there are no simple answers where these energy sources are concerned. In a recent article entitled "Beyond Oil", Bill McKibben, contributing editor of the Natural Resource Defense Council publication, *Onearth*, claims that there are far more capital and brainpower currently invested worldwide in technologies designed to prolong the oil age than there are to transition the world to the next energy peak. He also describes the risks and trade-offs with natural gas. Although the U.S. has large domestic reserves of natural gas, the latest technology for extracting it, called hydraulic frac'ing, is suspected of contaminating groundwater with chemicals. Renewable-energy technologies require some trade-offs and risks, as well. The motors in electric vehicles, the generators in wind turbines, and the white LEDs in efficient products require rare minerals such as lithium and rare earths such as europium, lanthanum, and neodymium, all of which are ultimately depleting resources. Further, "These minerals and elements come from South America and China where they are mined in an almost totally unregulated environment, producing large amounts of toxic waste and consuming and contaminating scarce water supplies....we must develop and exercise smarter ways of assessing risk, as an antidote to our historical disease of letting our knowledge of technology outstrip our ability to use it wisely [32].

In this respect, where nuclear waste management is concerned, there are indications of potential technological solutions to even the most troublesome issues, such as transmutation of transuranium elements, MOX fuels, irradiation in fast reactors, plutonium-thorium fuels, secure storage of residual fission products which have a shorter half-life, and, ultimately, fusion energy.

However, public acceptance of increased use of nuclear energy systems will require a three-level approach: consistent administrative nuclear policy and planning; the technical solutions currently in development or construction; and, sociological interventions which eliminate public concerns and fears of nuclear energy production and nuclear waste management. As indicated by the Psychometric Paradigm Method study, the SSCABs as conduits of communication between the public and DOE, the SRS CAB Speakers Bureau, and the SRS site tours are social strategies critical to building public confidence in nuclear energy policy and planning. With respect to a future national repository, the NRC reports that "confidence in the technical feasibility of a repository alone is not sufficient to bring about the broader societal and political acceptance of a repository. Achieving this broader support for construction of a repository at a particular site requires a broad outreach program" [30b]. Following the logic of the NRC, we can predict that even a sound nuclear waste management program, along with a consistent administrative nuclear policy, will contain the seeds of its own destruction if devoid of comprehensive sociological intervention strategies.

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