FACILITY SITING AND WASTE STORAGE

PUBLIC ATTITUDES AND
PREFERENCES

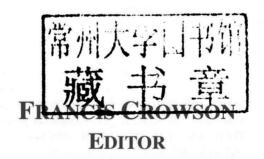
Nuclear Materials

AND DISASTER RESEARCH

FRANCIS CROWSON EDITOR

NUCLEAR ENERGY, FACILITY SITING AND WASTE STORAGE

PUBLIC ATTITUDES AND PREFERENCES





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NUCLEAR MATERIALS AND DISASTER RESEARCH

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PREFACE

The United States (US) program for siting interim storage and permanent disposal facilities for used nuclear fuel (UNF) is at a crossroads. The March 2010 request by the US Department of Energy (DOE) to the US Nuclear Regulatory Commission (NRC) for termination of the Yucca Mountain Project (YMP) license application, followed one year later by the disastrous nuclear events in Fukushima, Japan, have resulted in a fundamental reconsideration of approaches for siting interim and permanent UNF management facilities in the US. This book provides findings from a set of social science studies undertaken by the Center for Risk and Crisis Management (CRCM) and Sandia National Laboratories (SNL), which focus on public attitudes and preferences concerning the siting of nuclear repositories and interim storage facilities. This book is also a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel and high-level radioactive waste from civilian nuclear power generation, defense, national security and other activities.

Chapter 1 – This report provides findings from a set of social science studies undertaken by the Center for Risk and Crisis Management (CRCM) and Sandia National Laboratories (SNL), which focus on public attitudes and preferences concerning the siting of nuclear repositories and interim storage facilities. Overall these studies are intended to be responsive to the recommendation of the Blue Ribbon Commission on America's Nuclear Future (BRC) that US Department of Energy (DOE) learn as much as possible from prior experience. As stated by the BRC (BRC 2012: 118): To ensure that future siting efforts are informed by past experience, DOE should build a data base of the experience that has been gained and relevant documentation

produced in efforts to site nuclear waste facilities, in the United States and abroad...

Specifically, this report describes the findings from four new studies undertaken in 2012, including (1) an Internet survey conducted in June 2012, with 2017 adult residents of the continental US focused on nuclear issues and nuclear facility siting; (2) an analysis of the outcomes of 269 cases of attempted nuclear facility siting efforts globally spanning 31 countries over 50 years; (3) trend analysis of evolving nuclear sentiment in the US, employing a total 287 questions drawn from dozens of nationwide surveys from 1973 through 2011; and (4) a time-series study, utilizing the content of social media and patterns of online information searches in 2010-2011, to analyze the changes in public attention to nuclear energy and nuclear waste that followed the Fukushima nuclear event in March of 2011. These studies add to the stock of knowledge that will facilitate the transition to a consent-based siting program for interim storage and permanent disposal facilities for used nuclear fuel (UNF) and high-level waste (HLW) in the US.

Chapter 2 – The Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste is a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel and high-level radioactive waste from civilian nuclear power generation, defense, national security and other activities.

The Strategy addresses several important needs. First, it serves as a statement of Administration policy regarding the importance of addressing the disposition of used nuclear fuel and high-level radioactive waste; it lays out the overall design of a system to address that issue; and it outlines the reforms needed to implement such a system. Second, it presents the Administration's response to the final report and recommendations made by the *Blue Ribbon Commission on America's Nuclear Future* ("BRC"). It also responds to direction in the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2012, to develop a strategy for the management of used nuclear fuel and nuclear waste in response to the BRC's recommendations. Third, this strategy represents an initial basis for discussions among the Administration, Congress and other stakeholders on a sustainable path forward for disposal of nuclear waste.

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Chapter 1

PUBLIC PREFERENCES RELATED TO CONSENT-BASED SITING OF RADIOACTIVE WASTE MANAGEMENT FACILITIES FOR STORAGE AND DISPOSAL: ANALYZING VARIATIONS OVER TIME, EVENTS, AND PROGRAM DESIGNS*

Hank C. Jenkins-Smith, Carol L. Silva, Kerry G. Herron, Kuhika G. Ripberger, Matthew Nowlin, Joseph Ripberger, Evaristo "Tito" Bonano and Rob P. Rechard

EXECUTIVE SUMMARY

This report provides findings from a set of social science studies undertaken by the Center for Risk and Crisis Management (CRCM) and Sandia National Laboratories (SNL), which focus on public attitudes and preferences concerning the siting of nuclear repositories and interim storage facilities. Overall these studies are intended to be responsive to the

* This is an edited, reformatted and augmented version of the U.S. Department of Energy, Nuclear Fuel Storage and Transportation Planning Project, FCRD-NFST-2013-000076 SAND 2013-0032P, dated February 2013. recommendation of the Blue Ribbon Commission on America's Nuclear Future (BRC) that US Department of Energy (DOE) learn as much as possible from prior experience. As stated by the BRC (BRC 2012: 118):

To ensure that future siting efforts are informed by past experience, DOE should build a data base of the experience that has been gained and relevant documentation produced in efforts to site nuclear waste facilities, in the United States and abroad...

Specifically, this report describes the findings from four new studies undertaken in 2012, including (1) an Internet survey conducted in June 2012, with 2017 adult residents of the continental US focused on nuclear issues and nuclear facility siting; (2) an analysis of the outcomes of 269 cases of attempted nuclear facility siting efforts globally spanning 31 countries over 50 years; (3) trend analysis of evolving nuclear sentiment in the US, employing a total 287 questions drawn from dozens of nationwide surveys from 1973 through 2011; and (4) a time-series study, utilizing the content of social media and patterns of online information searches in 2010-2011, to analyze the changes in public attention to nuclear energy and nuclear waste that followed the Fukushima nuclear event in March of 2011. These studies add to the stock of knowledge that will facilitate the transition to a consent-based siting program for interim storage and permanent disposal facilities for used nuclear fuel (UNF) and high-level waste (HLW) in the US.

The key study findings from the nationwide Internet survey reported in Section 5 were the following:

• Perceived risks and benefits of nuclear energy are nearly equally balanced, and support for additional nuclear reactors is divided. Support for continued reliance on nuclear energy was suppressed by concerns raised by the Fukushima nuclear event. The most potent predictors of support for nuclear energy are perceived risks and benefits, with the risk of reactor accidents being the most prominent risk. Among the perceived benefits, the most important is reduced dependence on foreign energy sources. Greater trust in federal agencies (DOE, Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC)) to provide accurate information about nuclear risks also leads to greater public support for nuclear energy.

- Greater concerns about climate change, on average, lead to less support for nuclear energy. In part this results from the deeply held values that underlie nuclear preferences; more generalized concerns about the environment, and egalitarian worldviews, both contribute to beliefs that the climate is changing due to greenhouse gasses of human origin. Egalitarianism (indirectly) and concerns about nature (directly and indirectly) reduce support for nuclear energy.
- Public preferences for a national strategy for managing UNF favor pursuit of two permanent geologic repositories over continued on-site storage. Preference for interim storage falls between, with a plurality of respondents in support.
- Support for either a geologic repository or an interim storage facility
 is increased when the facility is co-located with a nuclear safety
 research laboratory, or would permit construction of a UNF
 reprocessing facility. More modest gains in support are evident when
 substantial financial incentives are offered to the prospective host
 state and community.
- A slight majority of respondents favored a "bottom-up" siting strategy
 wherein potential host communities nominate themselves for
 consideration over a "top-down" strategy in which experts identify
 technically optimal sites and then invite affected communities to
 consider hosting UNF storage and disposal facilities.
- Survey respondents indicated greatest trust for risk information
 provided by experts from the National Academy of Sciences (NAS)
 and national laboratories. Federal agencies (NRC, DOE, and EPA)
 also received relatively high marks on trust. At the same time,
 respondents viewed all organizations as prone to either downplay
 risks (industry groups, DOE, NRC, national labs) or exaggerate them
 (environmental advocacy groups, EPA) except for the NAS.
- When asked about the process by which consenting communities may
 consider hosting a UNF storage or disposal site, majorities of
 respondents believed that citizens (via referenda) and governors
 should be able to veto consent. Majorities of respondents opposed
 allowing other actors (federal elected officials, federal agencies,
 nongovernmental organizations, NGOs) to have a veto on consent.
- Respondents supported allowing potential host communities and states to withdraw from the siting process through the stage at which a license is submitted to federal agencies for review; majorities opposed permitting potential hosts to withdraw after a license is issued.

• When asked whether they would support siting a hypothetical interim storage facility or permanent repository, support was conditional on distance. Support was reduced the nearer the facility would be to the respondents' residence. However, when respondents were apprised of their current proximity to temporary UNF storage, those who currently live within 25 miles of a facility were likely to express greater support than those who lived farther from existing storage.

Among the key findings of our international study of past siting efforts reported in Section 2 are the following:

- All else being equal, the probability that a proposed nuclear facility will be completed and operational has decreased substantially over time, from near certainty in the mid-1950s to a fifty- fifty proposition for those siting efforts that had been concluded.
- Variation in the institutional frameworks for decision-making within countries explains a substantial fraction of the differences in siting outcomes: more democratic countries, and those with federal (decentralized) decision-making structures, have lower likelihoods for nuclear facility siting than countries that are less democratic and more centralized.
- Why do countries with greater democratic openness have a more difficult time siting nuclear facilities? The analysis indicates that greater democratic openness is associated an increased probability of expressed opposition to the facility. Opposition, in turn, diminishes the likelihood that the facility will be sited.
- A federal governmental versus a unitary structure lessens the probability of expressed opposition, and the direct effect of decentralized decision-making is to reduce the probability of siting.
- The analysis also suggests that the inclusion of mechanisms for public involvement in past siting programs has tended to occur in cases when there is expressed opposition, but such mechanisms have had no statistical effect on the outcome of past siting efforts.

As described in Section 3, the key findings from the study of the trend of aggregate public opinion over four decades, based on diverse questions regarding nuclear energy from multiple US nationwide surveys, include

- Widely known nuclear events, such as Three Mile Island (TMI), Chernobyl, and Fukushima, have substantial and sustained negative effects on the risk perceptions and acceptance of nuclear energy for residents of the US.
- These effects decay over time, but at different rates. Model estimates
 indicate that domestic nuclear crisis events like TMI have a
 dampening effect for approximately a decade. Events overseas, like
 the Chernobyl nuclear disaster in 1986, have a negative effect on
 nuclear attitudes lasting for roughly five years.
- Once the effects of specific nuclear events have been accounted for, our models indicate that there is an underlying decline in both perceived nuclear risks and the acceptability of nuclear energy. The rate of decline in perceived risks and nuclear acceptance has decreased over time, and may have reached a steady-state by 2011.

As described in Section 4, our time-series analysis of the content of social media analyzed (a) the content and volume of Twitter postings (tweets) and (b) Google searches that employed terms relevant to nuclear energy and nuclear waste management. These data allow analysis of shifts in public attention before, during and after major nuclear events like that in Fukushima, Japan following the March 2011 earthquake and tsunami. The key findings from this study include

- Public attention to both nuclear energy and nuclear waste management "spiked" immediately after the event.
- Attention declined approximately five weeks after the initial spike, but remained at significantly higher levels, roughly doubling the number of posts and information searches that had been made prior to the event.
- Both the Twitter and search data can be analyzed by location; the areas that experienced the largest increases in both kinds of indicators of attention were areas in which nuclear issues and facilities were present.
- The analysis of social media supports the analysis of the content of
 postings, such that issues of key importance to the public can be
 identified and addressed. This kind of information, evaluated over the
 course of a nuclear facility siting initiative, could provide important
 public input to programmatic and policy decisions.

ACRONYMS

AIC Akaike Information Criterion (model aptness measure)
BIC Bayesian Information Criterion (model aptness measure)
BRC Blue Ribbon Commission on America's Nuclear Future

CRCM Center for Risk and Crisis Management

DOE Department of Energy

EPA Environmental Protection Agency

GCC Global Climate Change

IAEA International Atomic Energy Agency

IP Address Internet Protocol Address
LULU Locally Unwanted Land Use
NAS National Academy of Sciences

NEI Nuclear Energy Institute

NGO Nongovernmental Organization

NIMBY Not in my Back Yard NPP Nuclear Power Plant

NRC Nuclear Regulatory Commission

OLS Ordinary Least Squares

PRIS Power Reactor Information System

SD Standard Deviation

SEM Simultaneous Equation Model SNL Sandia National Laboratories

TMI Three Mile Island

TVA Tennessee Valley Authority

UNF Used Nuclear Fuel

US United States

WIPP Waste Isolation Pilot Plant YMP Yucca Mountain Project

YV Yankee Vermont

1. Introduction

The United States (US) program for siting interim storage and permanent disposal facilities for used nuclear fuel (UNF) is at a crossroads. The March 2010 request by the US Department of Energy (DOE) to the US Nuclear Regulatory Commission (NRC) for termination of the Yucca Mountain Project

(YMP) license application, followed one year later by the disastrous nuclear events in Fukushima, Japan, have resulted in a fundamental reconsideration of approaches for siting interim and permanent UNF management facilities in the US. The final report of the Blue Ribbon Commission on America's Nuclear Future (BRC) (BRC 2012) constituted a major milestone in that reconsideration. It called for abandoning the top-down, primarily technically driven facility siting approach outlined in the original Nuclear Waste Policy Act 1982 (and the subsequent Congressional selection of the resulting top-ranked Yucca Mountain site in the 1987 Amendments) in favor of a "new, consent-based siting approach to siting future nuclear waste management facilities" that is flexible and dependent on potential host communities, in collaboration with states and tribes, volunteering to be considered as candidates for choosing technically and socially acceptable sites.

In the DOE response to the BRC report, DOE endorsed the key principles of the BRC recommendations and proposed a strategy that "includes a phased, adaptive, and consent-based approach to siting and implementing a comprehensive management and disposal system" (DOE 2013: 1). Hence, the BRC recommendation and DOE response constitutes a fundamental change in approach that may be considered by Congress in the future. This new process will be well served by a clear understanding of the trends, conditions, and program design elements that have shaped prior siting experience and that will influence public support for UNF facility siting in the future.

This report provides the results of a package of on-going social science studies undertaken by the Center for Risk and Crisis Management (CRCM) at the University of Oklahoma in collaboration with Sandia National Laboratories (SNL). These studies have been designed to test some of the widely held assumptions about the conditions under which siting does and does not work; to further understanding of when and how major nuclear events (like that in Fukushima, Japan) focus public attention and reshape public understanding and support for nuclear facilities; and to evaluate how the design features of siting programs can facilitate the legitimacy of and support for a siting program among the US public.

While the studies and results described here will be of broad interest to those involved in siting nuclear facilities, each of the studies focuses on different aspects of the problem and therefore may be of particular interest to individual readers. For those chiefly interested in public preferences for future siting efforts within the US, the survey results reported in Section 5 will be of chief interest. For readers interested in rigorous analysis of the global history of the outcomes of nuclear facility siting efforts, Section 2 will be of particular

interest. Section 3 traces the trends in the US public's sense of the risk and acceptability of nuclear energy over the past four decades, with a central focus on the magnitude and duration of the effects on public opinion of the disastrous nuclear events at Three Mile Island (TMI), Chernobyl and Fukushima. Section 4 utilizes data from new sources – social media (Twitter) postings and Google search patterns – to trace the changes in public attention to nuclear issues before, during and after the Fukushima event.

In combination, the studies described in this report provide a broad, empirically grounded assessment of past nuclear facility siting efforts, the changing long-term patterns of public perceptions of the risks posed by nuclear energy in the US, and a detailed analysis of current American preferences for the design of fair and effective processes for siting UNF storage and disposal facilities. The research is informed by over two decades of experience in studies of the social and public policy aspects of nuclear programs by the research team, based at the University of Oklahoma².

The first study, described in Section 2, provides a first of its kind analysis of the historical pattern of success-and failure-in siting nuclear facilities (primarily nuclear reactors because of their prevalence). Using a global database of the siting initiatives for 269 nuclear facilities in 31 countries that have become either operational or were cancelled, the study permits quantitative modeling of some of the key factors that shape the probability that a facility will be become operational. The results of the model indicate that the most important factors conditioning siting success are structural - consisting of the openness and responsiveness of the political system to public (and opposition) input. Perhaps most sobering is the finding that, regardless of the nature of the institutional system (that is, the structure of the governing legal system and organizational allocation of authority) within which siting is taking place, there is a statistically significant long-term global trend in the direction of decreased probability of siting facilities. Additional findings, based on a subset of the siting data for which more extensive information was available, are that the addition of traditional mechanisms for public involvement (such as public hearings) have had little independent effect on probability of siting past facilities. It is important to note that these findings are based on historical data, and the trends and patterns that are described here led to the call for an overhaul of the UNF facility siting approach in the US by the BRC. A key contribution of this analysis is that, consistent with the BRC's recommendations, the conditions that influence siting outcomes are tested statistically using compiled data on efforts to site nuclear facilities, and the magnitude of the effects of key variables are estimated.

The second study, as described in Section 3, focuses more directly on the US experience, analyzing the long-term evolution of public preferences for nuclear energy and the response to major nuclear events such as the TMI, Chernobyl, and Fukushima accidents. The study employs a unique time-series dataset constructed from an array of indicators of public perceptions of the risks posed by nuclear energy, and support for nuclear energy, over the period from 1973-2011. These data are constructed using an innovative method for detecting larger underlying trends in public perceptions and preferences over past decades by combining an array of distinct but correlated indicators of "public mood" concerning nuclear issues. These data permit quantitative analysis of the history of how the US public has perceived the risks posed by nuclear energy, and their support for continued reliance on nuclear energy sources. The analysis of changes over time provides an empirical assessment of how historical events at nuclear installations have influenced public perceptions and preferences about nuclear energy, with direct implications for understanding the current post-Fukushima environment.

The third study, discussed in Section 4, examines how public attention shifts to (and from) nuclear issues, and how those changes can re-shape public concerns for the management of nuclear waste. For this study we employ two distinct kinds of real-time indicators of public attention: supply-based indicators, as measured by posted messages using social media, and demandbased indicators, as measured by the frequency of terms used in Internet web searches. The continuous feed and large volumes of these kinds of data streams permit analysis of changes in interest and attention on a moment-bymoment basis, such that both near-term and longer-term changes in attention are evident. It is also possible, with the social media data, to evaluate the content of the messages obtained in ways that indicate the directional change of public attitudes. We use these data to focus on the shifts in public attention that occurred with the onset of the crises at the Fukushima nuclear reactors, following the Tōhoku earthquake and subsequent tsunami that struck Japan on March 11, 2011. The analysis shows that both demand- and supply-based attention to issues associated with nuclear energy spiked shortly after the onset of the event, and that while attention declined following the event it has remained at a notably higher level than prior to the event. Attention to nuclear waste management also spiked; however, public attention settled to the same levels that had been evident prior to the event.