

PUBLIC COMMUNICATIONS  
ON NUCLEAR WASTE

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PUBLIC PERCEPTIONS OF RISK  
FROM NUCLEAR WASTE FACILITIES

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INTRODUCTION

Survey research on nuclear power issues has found that public concern over radioactive waste management increased sharply during the 1970s.<sup>1,2</sup> Such concern now rivals reactor safety concerns as the most important public issue regarding nuclear power. Even public opinion surveys conducted during the Three Mile Island accident in 1979 found that the public was as concerned about waste management as it was about reactor safety and the escape of radioactivity into the atmosphere.<sup>3,4</sup>

However, none of these surveys has determined what specific concerns the public has about waste management. Volunteered responses to questions about waste management have only determined that some of the public thinks that wastes are "dangerous," "poisonous," or "deadly." While these general fears do reflect concern over waste management, they are not specific enough for scientists and engineers involved in nuclear waste management to determine whether their technical programs are being responsive to the concerns of various segments of the public. These publics include the general public and other involved publics, such as nuclear scientists and environmentalists. It is also difficult to develop public information programs without knowing just what it is about nuclear waste that so concerns the public and without knowing which public segments are most concerned.

Given this need for greater specificity of public concern about nuclear waste management, the research to be reported

here had three broad objectives: (1) to determine how nuclear waste facilities compared with other potentially hazardous facilities in the perception of key segments of the public, (2) to determine what specific waste management issues were judged to be of greatest importance by the public, and (3) to determine public preferences regarding siting of high-level and low-level waste repositories.

Data were gathered by self-administered survey questionnaires mailed to respondents. The results to be reported here are drawn from three technical reports, which present the results in somewhat greater detail.<sup>5,6,7</sup> Michael K. Lindell and Timothy C. Earle, together with the authors, are original contributors to this research.

## METHOD

### Sampling

A purposive or "judgmental" sampling strategy<sup>8,9,10</sup> was used in the present study. Purposive sampling is characterized by the sampling of the memberships of established groups that would most efficiently provide the information of interest to the research. Six groups or categories of respondents were selected for the current study: (1) Nuclear Engineers (a national organization of nuclear engineers); (2) Chemical Engineers (a national organization of chemical engineers); (3) Science Writers (a national organization of science writers); (4) Environmentalists (two regional environmental groups and one national environmental group); (5) Hazardous Facility Communities (residents of six communities in which potentially hazardous industrial facilities are located); and (6) General Communities (residents of six large cities in the U.S. chosen on the basis of geographical diversity). Random samples were drawn within each of these six categories of respondents.

### Questionnaire Mailing Procedure

Following a slight variation of a standard survey mail-out procedure,<sup>11</sup> an advance notice letter was sent to all potential respondents. This was followed approximately one week later by a copy of the survey questionnaire. Two waves of duplicate copies of the questionnaire were mailed to respondents at 12-day intervals if the questionnaire was not

returned. The response deadline was three weeks following the third questionnaire mailing.

Because a large number of survey items were used, the items were divided between two questionnaires. Each of the six respondent groups was randomly divided into two subsets to receive one or the other questionnaire.

### Response Rates

There were 1,769 potential respondents for all groups and questionnaires combined and 936 total returns, for an overall response rate of 52.9%. Usable returns numbered 819. The response rates for the six respondent groups were: General Communities (40.5%), Hazardous Facility Communities (46.2%), Environmentalists (77.9%), Nuclear Engineers (86.4%), Chemical Engineers (77.9%), and Science Writers (47.8%). The two types of questionnaires were not returned at a significantly different rate. A more detailed description of these response rates can be found elsewhere.<sup>12,13</sup>

## RESULTS

### Perception of a Nuclear Waste Repository Compared to Other Hazardous Facilities

A nuclear waste repository was compared to seven other potentially hazardous facilities. All eight facilities are listed in Table 1 in order of overall perceived riskiness. Combining the judgments from the six samples of respondents, the nuclear waste facility was seen as most hazardous and the natural gas power plant as least hazardous. The entries in Table I are mean scores from thirteen, 7-point scales of severity of risk.

Examination of the ranks of overall risk severity shows the nuclear waste and toxic chemical disposal facilities virtually tied. Close behind in perceived severity of risk is the nuclear power plant. These three facilities constitute a "severe risk" group in the perception of respondents.

The bottom row of Table I (all facilities) indicates the average risk severity score given by each of the six groups. This score is an indication of the overall perception of severity of risk by each of the respondent groups. As can be

TABLE I  
Perceived Risk from Eight Types of Hazardous Facilities

Facilities	General Communities N = 184	Hazardous Facility Communities N = 229	Environ- mentalists N = 175	Science Writers N = 77	Chemical Engineers N = 72	Nuclear Engineers N = 82
Nuclear Waste Facility	4.93 (1) <sup>a</sup>	4.80 (1)	5.40 (1)	4.45 (1)	4.06 (2)	3.09 (5)
Toxic Chemical Disposal	4.65 (2)	4.54 (3)	5.10 (3)	4.37 (2)	4.09 (1)	4.36 (1)
Nuclear Power Plant	4.55 (3)	4.55 (2)	5.27 (2)	4.20 (3)	3.47 (3)	2.68 (7)
LNG Storage Area	3.35 (4)	3.42 (4)	3.82 (4)	3.60 (4)	2.89 (4)	3.38 (3)
Coal Power Plant	2.80 (6)	2.58 (6)	3.20 (5)	3.21 (5)	2.38 (6)	3.69 (2)
Oil Refinery	2.98 (5)	2.71 (5)	2.97 (6)	2.98 (6)	2.57 (5)	3.22 (4)
Oil Power Plant	2.68 (7)	2.51 (7)	2.62 (7)	2.75 (7)	2.10 (7)	2.98 (6)
Natural Gas Power Plant	2.56 (8)	2.41 (8)	2.52 (8)	2.50 (8)	1.65 (8)	2.45 (8)
All Facilities	3.56	3.44	3.86	3.51	2.90	3.23

<sup>a</sup>Rank order of perceived severity of risk from most severe (1) to least severe (8).

seen, Environmentalists (mean = 3.86) led all other groups in perceiving risk from these facilities. By contrast, Chemical Engineers (mean = 2.90) perceived the least risk. Science Writers were intermediate, as were residents of the General Communities.

Examination of the rankings of severity of risk shows all groups except Nuclear Engineers to be in quite good agreement. Nuclear Engineers differed sharply from all other respondent groups in their perception of relatively minor risk from a nuclear waste facility and a nuclear power plant. Nuclear Engineers also perceived a coal power plant as much riskier than did any of the other groups.

Judgments about the risks attributable to each of the eight facilities were made utilizing 13 risk categories. These risk categories are presented in Table II. The entries in Table II are means of 7-point scales. Higher scores indicate greater perceived risk. For instance, a higher mean on the occupational risk category indicates that workers in a facility were perceived to be at high risk as opposed to low risk. As another illustration, a higher mean on the risk characteristic "preventable" would indicate that risks from a facility are difficult to prevent by government regulation or safe industrial practices. Examination of the means in Table II shows the nuclear waste facility and toxic chemical facility were judged first or second in severity for nearly every risk category. The nuclear power plant was usually judged to present the third greatest risk.

These three high-risk facilities are distinguished from the other facilities particularly by the high levels of perceived threat and severity of consequences on six risk categories: (1) threat to those who work in them (occupational risk), (2) threat to the public living nearby (risk to facility neighbors), (3) threat to future generations, (4) risks not known to those exposed, (5) "dread" risk as opposed to commonly known and understood risk, and (6) perceived high overall comparative risk. Clearly, these facilities are perceived as posing very great dangers to society. Specifically, a nuclear waste disposal facility evoked dread fear of severe consequences to workers, the nearby public, and future generations. Those at risk were perceived to be relatively unaware of the danger. Moreover, risks from nuclear waste disposal facilities were judged to be relatively unknown to the

Table II

Perception of Risk from Thirteen Sources Associated  
with Eight Types of Hazardous Facilities

Risk Categories	Facilities								
	Nuclear Waste Facility	Toxic Chemical Disposal	Nuclear Power Plant	LNG Storage Area	Coal Power Plant	Oil Refinery	Oil Power Plant	Natural Gas Power Plant	All Facilities
Occupational risk	5.54 <sup>a</sup>	5.71	5.01	4.57	3.63	3.89	3.24	3.01	4.33
Risk to facility neighbors	5.42	5.54	4.93	4.44	3.76	3.78	3.12	2.64	4.20
Risk to future generations	5.67	5.64	4.93	2.91	3.26	2.86	2.64	2.25	3.77
Hazards known to those exposed	5.02	5.17	4.51	3.85	3.81	3.59	3.54	3.49	4.12
Risks known to corporations	3.60	3.47	3.13	2.38	2.54	2.31	2.26	2.07	2.72
Risks known to science	3.63	3.52	3.19	2.29	2.43	2.23	2.18	1.99	2.68
Preventable	4.53	4.21	4.31	3.58	3.09	3.15	2.94	2.92	3.59
Individual vs. catastrophic risk	4.41	4.22	5.26	5.12	2.86	3.66	3.04	3.37	3.99
Total deaths	4.54	4.67	4.14	3.41	3.12	3.09	2.72	2.51	3.52
Personal risk	2.57	2.80	3.06	2.27	2.22	1.92	1.89	1.61	2.29
Benefit risk comparison	4.38	4.30	3.82	3.08	2.58	2.25	2.36	1.99	3.10
Common vs. dread risk	5.84	5.21	5.50	3.26	2.11	2.19	1.83	1.63	3.45
Overall risk	5.29	5.37	4.57	3.76	2.57	2.64	2.16	1.75	3.51

<sup>a</sup>Average score across all respondents for a 7-point rating scale where 1 = best outcome (e.g., no risk) and 7 = worst outcome (e.g., very great risk).

corporations in charge of them and to science. Such risks were also judged difficult to prevent by government regulation. Obviously, convincing these segments of the public that a radioactive waste repository is no more dangerous than other industrial facilities will be a difficult task. It should be noted that Nuclear Engineers, as shown in Table 1, did not share this overwhelmingly negative view of nuclear facilities.

Despite the apparent concern for the high-risk facilities shown in Table II respondents did not feel themselves to be personally threatened to any great extent. The average score for personal risk across all facilities was only 2.29, lowest of any of the 13 risk categories.

In summary, these data show that different groups of respondents perceive risks from hazardous facilities differently. The technically-oriented respondents--Chemical Engineers and Nuclear Engineers--perceive less risk from these facilities than do members of the general public, and especially Environmentalists. Nuclear Engineers stand alone among the respondents surveyed in their view that a coal power plant poses relatively high risks and that a nuclear power plant and a nuclear waste disposal facility pose relatively low risks.

#### Public Concerns About Radioactive Waste Management Facilities

The previous section presented data showing that nuclear waste facilities, along with toxic chemical disposal facilities, are perceived by most groups of the public to present very high risks to the public. But what are the specific concerns about nuclear waste facilities? In this section we report data directly addressing this question. Respondents were asked to rate each of ten waste management issues culled from an analysis of previous attitude studies. Each issue was rated on a 7-point scale from "much less important than other nuclear waste management issues" to "much more important than other nuclear waste management issues."

The average importance ratings and rank order of importance given by each of the six groups to each of the ten issues are presented in Table III. The issues are ordered from top to bottom according to the overall average rank of importance given them by all six groups.

Table III  
Average Relative Importance of Waste Management Issues

Waste Management Issue	General Communities	Hazardous Facility Communities	Environmentalists	Science Writers	Chemical Engineers	Nuclear Engineers
Leakage of liquid wastes from storage tanks	5.49 (1) <sup>a</sup>	5.78 (1)	5.69 (2)	5.05 (2)	4.92 (1)	4.88 (1)
Water will get into wastes and carry radioactivity away	5.30 (2)	5.65 (3)	5.73 (1)	5.29 (1)	4.81 (2)	3.31 (4)
The permanent disposal containers for solid waste will corrode	5.26 (3)	5.68 (2)	5.52 (3)	4.72 (4)	4.31 (4)	3.24 (6)
Will reduce safety to cut costs	4.76 (7.5)	5.11 (4)	5.12 (4)	4.41 (5)	3.18 (7)	3.49 (3)
Transportation accidents	4.76 (7.5)	4.96 (6)	4.94 (6)	4.74 (3)	4.49 (3)	3.72 (2)
Workers will be harmed	4.83 (6)	5.01 (5)	4.41 (7)	4.21 (6)	3.84 (5)	3.30 (5)
An earthquake may occur and release materials	4.88 (5)	4.77 (7)	5.07 (5)	3.97 (7)	3.61 (6)	2.44 (7)
Explosion from too much radioactivity	4.93 (4)	4.76 (8)	4.16 (8)	2.56 (9)	2.36 (8)	1.47 (10)
People might accidentally dig into site	3.88 (9)	3.93 (9)	3.13 (9)	2.87 (8)	2.17 (9)	2.10 (8)
Costs too much and will raise electricity bills	2.94 (10)	3.34 (10)	2.57 (10)	2.33 (10)	1.97 (10)	2.09 (9)
All Issues	4.70	4.90	4.63	4.02	3.57	3.00

<sup>a</sup>Rank order of issue importance from most important (1) to least important (10) is presented in parentheses.

The most important concern was about leakage of liquid waste from storage tanks. Previous research<sup>14</sup> has shown that media coverage of radioactive waste topics has given very high visibility to radioactive waste leaks, particularly at Hanford. The second most important concern was with breaching of containment by water, which might carry radioactivity away. However, Nuclear Engineers rated this concern as fourth in importance. Corrosion of disposal containers was the third most important concern, although, again, Nuclear Engineers showed lower concern for this type of containment breach.

Clearly the least important issue was the impact of waste management cost on electricity bills. This finding coincides with previous findings<sup>15</sup> that cost was a relatively unimportant consideration in the eyes of the public. Concern for human intrusion was also minimal for all groups. Nuclear Engineers rated the possibility of an "explosion from too much radioactivity" as the least important issue. This issue was also rated as relatively unimportant by all other groups except members of the General Communities sample who presumably did not know the impossibility of such a nuclear explosion.

Comparison of the columns in Table III lead to several conclusions. The general public appears to be primarily concerned about breach of repository containment. The top five concerns are of this type. Leakage of liquid waste from storage tanks also fits in this group, since previous research<sup>16</sup> has shown that many members of the public apparently believe that radioactive waste will be disposed of in liquid form. Nuclear Engineers diverged somewhat from the other groups in identifying transportation accidents as the second leading concern. Together with the Chemical Engineers, they also were concerned that safety would be reduced to cut costs. Both groups of engineers also showed more concern for occupational risks than did any other group.

The ordering of issues was examined by means of a rank-order correlation technique<sup>17</sup> which shows the degree of similarity between pairs of groups in the importance they give to waste management issues. Using this measure, Nuclear Engineers were quite similar to Science Writers in their overall importance rankings ( $r' = .867$ ). The rankings by Nuclear Engineers were somewhat less like those by the General Communities ( $r' = .355$ ). The importance rankings of Science Writers were more highly correlated with the General

Communities ( $r' = .639$ ). However, the rankings by Environmentalists correlated even more highly ( $r' = .797$ ) with the rankings by the General Communities. These comparative rankings take on added significance as a possible index of the influence on the opinions of the general public. The figures above indicate that Nuclear Engineers may have little influence on the way in which the general public perceives radioactive waste disposal. Science Writers and Environmentalists are somewhat closer to the public's pattern of concerns.

The bottom row of Table III shows the average rating given all issues. The higher the number, the higher the average concern expressed by the respondent group. Nuclear Engineers, with a mean of 3.0, were less concerned about these issues than any other group. The most concerned groups were the Hazardous Facility Communities and General Communities samples and Environmentalists.

In summary, liquid waste leaks are still the primary public concern about nuclear waste management. The general public seems preoccupied with containment breaches, while engineers are more concerned with transportation and occupational risks. No group felt the cost of nuclear waste management or the possibility of human intrusion was very important, although engineers worried that safety may be compromised to cut cost. As was the case in judging the relative risks of various potentially hazardous facilities, the judgments of engineers about the importance of nuclear waste issues diverged sharply from those of respondents more typical of the general public.

#### Public Preferences for Repository Siting Options

Public perceptions about various risks from nuclear waste facilities and specific public concerns about nuclear waste management issues can be expected to affect directly public attitudes toward siting waste facilities. We asked respondents to state their preferences among siting strategies, both for low-level and for high-level waste disposal facilities, by responding to attitude items. Before answering the attitude items, respondents were presented with a summary of approximately 400 words. It discussed the differences between low-level and high-level wastes, the producers of low-level wastes and the producers of high-level wastes, and how

low-level wastes are presently disposed and how high-level wastes will likely be disposed.

The results regarding both low-level and high-level waste repositories are presented in Table IV. Taking the low-level siting data first, there are several important conclusions to be drawn. First, none of the choices was an overall clear favorite of any of the groups. This can be seen, for example, by the fact that majority support was given only to one of the choices (regional siting) by only one group (the Chemical Engineers). Even then, it was only a slight majority. As another example, the Environmentalists somewhat evenly distributed their choices over the four response categories.

The second important finding deals with the difference between the two community groups and the other four groups regarding the most preferred policy. Whereas the General Communities and the Hazardous Facility Communities gave fairly strong plurality support to the response that each state should have its own low-level waste disposal facility, the Science Writers, Chemical Engineers, and Nuclear Engineers gave strong plurality or majority support to the regional siting concept. While more Environmentalists favored the regional siting concept compared with the state siting concept, the difference was not statistically significant.

A third finding deals with the second most preferred choice. Both the General Communities and the Hazardous Facility Communities selected the national siting policy over the regional siting policy as the second most preferred policy. However, the Science Writers, Nuclear Engineers, and Chemical Engineers selected the state siting policy over the national siting policy. The Environmentalists least preferred the national siting plan.

"Other" responses were provided by a low of 3% of the Chemical Engineers to a high of 21% of the Environmentalists. The Engineers and Science Writers tended to offer suggestions regarding siting, and the Environmentalists often stated that the wastes should not have been produced in the first place. In other words, these environmentalists refused to choose any siting option.

Compared with the lack of consensus regarding the siting of low-level repositories, there was a high degree of consensus

Table IV

Percentage of Respondents Who Prefer a Given Siting Policy  
for Low-Level and High-Level Waste Repositories

Responses	General Communities	Hazardous Facility Communities	Environ- mentalists	Science Writers	Chemical Engineers	Nuclear Engineers
<u>LOW-LEVEL OPTIONS</u>						
Each state should have its own facility	43.9%	39.1%	27.3%	25.6%	37.8%	32.6%
Six to ten sites should be chosen on a regional basis	19.4	20.9	29.5	48.7	51.4	41.9
Two or three sites should be distributed nationally	28.6	27.8	22.7	12.8	8.1	18.6
Other	8.2	12.2	20.5	12.8	2.7	7.0
<u>HIGH-LEVEL OPTIONS</u>						
Each state should have its own facility	21.4	20.0	8.0	2.5	16.2	2.3
Six to ten sites should be chosen on a regional basis	15.3	17.4	18.2	27.5	21.6	34.9
Two or three sites should be distributed nationally	49.0	47.0	38.6	50.0	56.8	48.8
Other	14.3	15.7	35.2	20.0	5.4	14.0

on the most preferred high-level repository siting policy. A plurality to majority of all six of the groups selected the national siting policy. Again, the Environmentalists showed some ambivalence regarding a preference on a siting policy, as indicated by low plurality selection on the national siting policy and by the large percentage of "other" responses. Again, these largely involved stating that the wastes should not have been produced in the first place.

The other major difference among groups dealt with the second most preferred siting policy for high level waste repositories. The Science Writers, Nuclear Engineers, Chemical Engineers, and Environmentalists showed a fairly strong preference for the regional siting concept as a second choice. However, the Hazardous Facility Communities and General Communities showed a slight preference for the state concept over the regional concept for second choice. This seems to indicate a reservoir of feeling that each state should take care of its own wastes, as was strongly indicated in the low-level waste policy choices.

#### CONCLUSIONS

Several conclusions can be drawn from these data that bear on public acceptance of waste management facilities. Most respondents did not see the risks from nuclear waste management facilities as being comparable to the risks from most other hazardous facilities. Nuclear waste facilities were grouped with nuclear power plants and toxic chemical disposal facilities as subjecting workers and the public to high risks. Moreover, these risks were perceived as somewhat mysterious in that the involved corporations and even science were not very familiar with them. Possible accidents from these facilities are expected to be catastrophic with dread effects involving many deaths. In contrast to the general opinion of scientists and engineers involved in radioactive waste management that the risks are not unique nor overly severe compared to other technologies, these results indicate that large segments of the public view radioactive waste management as dangerous and uniquely threatening.

Unless these perceptions can be modified, most people who live near a potential site for a radioactive waste facility are likely to believe they would face unusual risks. Arguments

that they accept the facility in the spirit of accepting their fair share of industrial risks are unlikely to be successful.

Problems from past waste management practices are still of great concern to many of the publics interested in waste management. In general, leakage of liquid waste from storage tanks is (still) the biggest concern of the public. Until the various publics are aware that this problem has been solved, this concern will continue to affect acceptance of waste management facilities. From the standpoint of the general public samples, the most important issues involved the possibility of containment breaches. This was true even for breaches resulting from a nuclear explosion, an event judged relatively unimportant (or impossible) by technically-oriented respondents. These technical respondents showed greater concern for workers' safety and risks related to transportation. They also were concerned that safety would be jeopardized in the interest of cutting costs. This last concern may signal limited confidence on the part of the technical community in the social/political decision mechanisms that will help to determine how radioactive waste is dealt with. However, since all groups indicated that the impact of waste management costs on electricity bills was relatively unimportant, perhaps this concern of the technologists is not justified.

Some of the concerns of the general public are apparently based on misinformation that needs to be corrected. This was best exemplified by the large amount of concern shown by general community members regarding an explosion at a high-level waste repository because of too much radioactivity. Another example involves the relative importance the general public accords to integrity of disposal containers. This would seem to indicate lack of understanding of the technologists' contention that long-term containment relies largely on geological barriers.

Regarding siting, there is not yet a strong public consensus on the number and general location of both low-level and high-level waste repositories. The general publics' belief that each state should take care of its own nuclear waste, especially for low-level waste but also to some extent for high-level waste, coupled with a general lack of consensus on a siting strategy, is likely to hinder the acceptance of any siting approach. It was also evident that many respondents

could not bring themselves to choose among the siting approaches because they were angry that the problem even exists.

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