PUBLIC ATTITUDES TOWARD RISK TRADEOFFS IN ENERGY POLICY CHOICES

FINAL REPORT

Michael K. Lindell
Timothy C. Earle

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4000 N.E. 41st Street • Seattle, Washington 98105

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IN ENERGY POLICY CHOICES

Michael K. Lindell
Timothy C. Earle

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Seattle, Washington 98104

EXECUTIVE SUMMARY

The emphasis that will be placed on each of a number of energy policy alternatives will be determined by the tradeoffs among many factors. Important among these factors are public preferences for different levels of power availability and risk to health and safety. Also important in determining support for energy alternatives is public perception of the consequences of those policies. To assess public perception and evaluation of these factors, a number of respondents were selected to answer questions about these issues.

The sample was composed of members of seventeen geographically widespread, established groups which were expected to vary from pronuclear to antinuclear in their attitudes. The seventeen groups, which were subsequently assigned to six relatively distinct clusters, differed significantly in their level of involvement in activities related to environmental concern.

Respondents' judgments of the acceptability of thirty-six hypothetical energy policies were analyzed using two complementary methods, discriminant analysis and judgment analysis. The first method is a statistical procedure that examines how well task variables discriminate among groups of respondents. The second method is a procedure which is used to construct models that describe the judgment processes used by respondents. The two methods produced different information. The discriminant analysis provided information on the relative importance of the three variables (technology [TECH], risk to the health and safety [RISK] and power availability [PA]) in accounting

for differences among clusters of respondents in their judgments of policy acceptability. The judgment analysis generated descriptive models of the judgment processes of both pro- and antinuclear respondents.

Results of the discriminant analysis showed that differences among respondents' judgments were strongly related to the TECH dimension but only weakly affected by RISK and PA. On the TECH dimension, antinuclear respondents indicated relative acceptance of conservation and solar and relative rejection of nuclear and coal. Although pronuclear respondents showed smaller differences in the acceptability of the technologies, they showed slightly greater support of nuclear and coal than conservation and solar. The six clusters differed most strongly on nuclear, followed by conservation and solar, then coal. On the RISK dimension, an increase in RISK was more significant for all clusters than a decrease. The PA dimension had more effect on the judgments of pronuclear respondents than on the judgments of antinuclear respondents.

The analysis of the data indicated that the judgments of pro- and antinuclear respondents were better fit by separate models.

$$\text{Antinuclear: } J = \bar{X}_{\text{TECH}} + \begin{matrix} 1.25 \text{ RISK if } \underline{\text{more}} \\ 1.00 \text{ RISK if } \underline{\text{less}} \end{matrix} + 1.0 \text{ PA}$$

$$\text{Pronuclear: } J = \bar{X}_{\text{TECH}} + \begin{matrix} .5 \text{ RISK if with } \underline{\text{less}} \text{ PA} \\ 1.0 \text{ RISK if not with } \underline{\text{less}} \text{ PA} \end{matrix} + 1.5 \text{ PA}$$

Both of these models produced close fits to the judgments on which they were based. The antinuclear respondents placed a slightly greater weight on the more RISK part of the RISK dimension relative to the PA dimension. That is, they placed slightly greater emphasis on avoiding more health and safety risk.

The pronuclear respondents placed a greater weight on the power availability dimension than on the risk dimension. Risk was even less important for the pronuclear respondents when power availability was less.

Respondents' judgments of the likelihood that increased risk to health and safety would result from the adoption of each of four alternate energy technologies divided those technologies into two pairs. Conservation and solar were judged to be unlikely to produce increased risk. However, the perceived risk of these two technologies was greater for pronuclear than for antinuclear respondents. Coal and nuclear were both judged likely to increase risk. The perceived risk of these technologies was greater for antinuclear than for pronuclear respondents.

Respondents also judged the likelihood that each of four energy alternatives would result in less power availability. Conservation was judged most likely to lower power availability. Solar and coal were judged not to affect power availability. Nuclear power was judged least likely to lower power availability. Among the respondent clusters, there was general agreement that conservation would produce a high likelihood of less power and that coal would produce a small likelihood of less power. There was strong disagreement among clusters on solar and nuclear. Antinuclear respondents judged both solar and nuclear to be moderately likely to produce less power. Respondents in the three most pronuclear clusters believed that there is a high likelihood that solar and a low likelihood that nuclear will produce less power.

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INTRODUCTION

As the demand for electric power increases and the capacity of any single technology to satisfy that demand decreases, it has become likely that our future needs for electric power will be met by a combination of energy and conservation technologies. Choices about the types of technologies to be included in the combination will be based on a number of factors. Two of the most important factors are risk to health and safety and power availability. Since there are no easy answers to the questions "How much power?" and "How much risk?", decisions involving those factors will require tradeoffs. In general, more power leads to greater risk; decreased risk can be achieved by increasing the probability that electric supplies fall short. Although there are many technical dimensions on which energy decision makers can compare alternate technologies, there are no firm technical grounds for deciding what is the appropriate tradeoff between risk and power availability. Such tradeoffs are based on values--public values. Decision makers therefore need to know how members of the public view the tradeoff between risk and power availability.

One method of studying public values about the relations between risk and power availability is to compare the public acceptability of alternate energy policies that vary in levels of both risk and power availability. Such comparisons could inform us, for example, about how the acceptability of a "high risk" technology changes as the power it produces varies from "low" to "high." Does the acceptability increase, or does it remain unchanged? Can "high" risk be counterbalanced by "high" power availability, or is a "high risk" technology unacceptable

regardless of the amount of power it produces? Answers to questions such as these should have a significant bearing on the decisions made by federal agencies that are involved with energy technologies. An investigation of public responses to these issues can serve as the basis for systematic examination of the differences between pro- and antinuclear respondents in the relative importance that they attach to power availability and risks to health and safety. One can look to see whether the dominance of a particular technology, whether nuclear, coal, solar or conservation, affects the acceptability of a technology mix. Moreover, one can compare the technology mixes with respect to their perceived consequences, that is, the likelihood that a particular technology mix will lead to decreased availability of power or increased risk to health and safety.

This information should prove particularly useful in clarifying public attitudes toward nuclear power and nuclear waste management. Polls (e.g., Harris, 1975, 1976) have shown that the general public lists health and safety concerns about reactor operations and waste management to be the biggest disadvantages of nuclear power. It has, however, been difficult to infer from these data the degree to which this concern is based upon evaluation of risk--the acceptability of consequences--or on the perception of risk--the judged likelihood of consequences--associated with nuclear power and nuclear waste. Comparison across technologies of the risk perceptions and risk evaluations of pro- and antinuclear respondents should more clearly isolate the contributions of each of these risk perception and risk evaluation conflicts over the acceptability of nuclear technology.

RESPONDENTS

This section briefly reviews the steps followed in selecting the respondents for the sample and aggregating them into clusters ranging from strongly pronuclear to strongly antinuclear in attitude. It also describes the demographic characteristics of the sample and presents some data that support the reasonableness of the clusters. For a more extensive description of the characteristics of the sample, see the companion report by Lindell, Earle, Hébert and Perry (1978).

Sampling. Questionnaires were administered to members of seventeen groups which were expected to vary in their attitudes from strongly pronuclear to strongly antinuclear. The pronuclear and antinuclear groups were identified on the basis of their public stands on the issue of nuclear power. The neutral groups were selected on the basis of interest of group members in energy issues and absence of a prior policy explicitly supporting or opposing nuclear power.

Formation of Respondent Clusters. In order to provide a clearer understanding of the factors which distinguish between pronuclear and antinuclear respondents, the seventeen groups of respondents were aggregated into six clusters. The assignment of these groups to clusters was accomplished in two steps. First, the data from all of the respondents were entered into a stepwise multiple discriminant analysis in which the predictor variables were items from another portion of the questionnaire and the dependent variable was group membership. Next the matrix of dissimilarity indices among groups was used as the basis for forming clusters. Inspection of this intergroup distance matrix indicated that some clusters of groups were readily apparent. Other

clusters, especially among the more neutral groups, were less clearly defined. Cluster sizes were made relatively homogeneous whenever this would not distort the differences among the clusters or the similarities within clusters.

Table 1 shows a list of the groups, identified by geographical region and a short label describing the group. The table also shows the cluster to which each of these groups was assigned. Clusters are assigned numbers from one to six, with cluster one being the most antinuclear and cluster six being the most pronuclear.

Demographic Characteristics of the Respondents. In comparison to probability or quota samples obtained by polling organizations, our sample more heavily represents the middle--30 to 60--age categories, has a higher proportion of males, and is characterized by higher income and educational levels. Our sample, however, was not designed to be representative of the population in general. Instead, we wished to tap those people who tend to be politically active and therefore functionally important in matters related to energy use patterns and questions of waste management. Since the sample overrepresents those who tend to be most politically active (cf. Brown & Unga, 1972; Hamilton, 1972), it appears that the sampling strategy fulfilled its purpose.

Activities of Respondents. As was the case with the sampling procedure, it is important to provide data which support the validity of the results of the clustering procedure. Data on the activities of the respondents provide a satisfactory means of resolving this issue. Aggregation of groups into clusters is supported only to the degree that relevant activity measures differentiate among those clusters.

Table 1

Cluster Assignments of
Survey Groups

CLUSTER	STATE	TYPE OF GROUP	ANTICIPATED ATTITUDE
1	Massachusetts	Public-interest research	anti
	Massachusetts	Political education	neutral
2	Texas	Environmental action	anti
	Colorado	University social science class	anti
	Illinois	Political education	neutral
	Illinois	Environmental	anti
3	Colorado	Research	neutral
	Colorado	Environmental	anti
	Colorado	Computer professionals	neutral
4	Texas	Recreational	neutral
	California	Public Safety	neutral
5	Colorado	Business	pro
	Illinois	Business	pro
	California	Business	pro
6	Massachusetts	Labor	pro
	Texas	Utility employees	pro
	California	Nuclear technologist	pro

Respondents were asked to indicate if they had in the past year engaged in any of several activities which indicated opposition to environmental pollution. The total number of different activities was computed for each respondent. This produced a score for each respondent which could range from zero activities to seven activities reported. Similar activity inventories were requested for opposition to nuclear power, support for nuclear power and support for energy conservation. Antinuclear respondents were, in general, much more highly involved in antipollution activities and antinuclear activities than were the pronuclear respondents. They were slightly more involved in conservation activities and much less involved in pronuclear activities.

In summary, the activity measures, especially those concerned with support for nuclear power and opposition to nuclear power, provided strong confirmatory evidence of the validity of the classification of the respondent clusters.

ENERGY POLICY CHOICES

Thirty-six alternative hypothetical energy policies were constructed from the combinations of four technologies (solar, coal, nuclear, and conservation) and three levels each of risk and power availability (less, same, and more). Respondents' judgments on these thirty-six items thus inform us about, among other things, the relative acceptability of a more risk and same power availability nuclear policy versus a same risk and more power availability nuclear policy. Put otherwise, this information tells us about respondents' views of the tradeoff between risk and power availability.

Respondents were given the following instructions:

On the following pages you will find some potential energy policies presented. We would like you to read carefully the descriptions of these policies and then judge the acceptability of some possible power availability/risk combinations that might result from them.

In each of the potential energy policies presented, POWER AVAILABILITY is expressed in terms of the amount of energy available per person relative to present levels. Thus an energy policy could result in either more, less, or the same availability relative to today. In general, you can consider the terms "more" and "less" to mean a difference noticeable to the average citizen, and "the same" to mean no noticeable increase or decrease in power availability.

For each policy, RISK to health and safety is expressed in terms of the number of deaths that will occur as a direct or indirect result (including environmental and biological damage) of the adoption of the energy policy in question. For example, the construction of additional power generating or conversion facilities entails the risk of accidental deaths. Miners undergo certain risks which are likely to be affected by changes in the production of coal. Some energy policies could result in the release of considerable amounts of various pollutants (e.g., radioactivity, smoke, excess heat, etc.) with effects on health and thus deaths. A listing of all potential risks associated with every energy policy option is impossible, but keep in mind that every such option includes some risk which can be expressed as resultant deaths.

For the purposes of this task, these deaths are presented relative to the number of deaths caused by our current energy production economy. Thus an energy policy can result in fewer, the same, or more deaths

relative to present levels. As with POWER AVAILABILITY, "fewer" and "more" can be considered to mean differences noticeable to the average citizen and "the same" to mean no noticeable change.

Respondents' judgements of the acceptability of the various combinations of risk and power availability were made within the contexts of four alternate energy policies:

Solar Emphasis. The United States adopts an energy policy that predominantly emphasizes solar power. Generation of electric power by oil and natural gas declines and conservation efforts are only moderately successful. Hydroelectricity, coal, and nuclear power continue to produce energy at approximately their current levels.

Coal Emphasis. The United States adopts an energy policy that predominantly emphasizes coal. Generation of electric power by oil and natural gas declines and conservation efforts are only moderately successful. Hydroelectricity and nuclear power continue to produce energy at approximately their current levels. Solar power and other renewable sources receive substantial research funding but produce little (less than 5 percent of national output) additional power.

Nuclear Emphasis. The United States adopts an energy policy that predominantly emphasizes nuclear power. Generation of electric power by oil and natural gas declines and conservation efforts are only moderately successful. Hydroelectricity and coal continue to produce energy at approximately their current levels. Solar power and other renewable sources receive substantial research funding but produce little (less than 5 percent of national output) additional power.

Conservation Emphasis. The United States adopts an energy policy that predominantly emphasizes conservation. Generation of electric power by oil and natural gas declines. Hydroelectricity, coal, and nuclear power continue to produce energy at approximately their current levels. Solar power and other renewable sources receive substantial research funding but produce little (less than 5 percent of national output) additional power.

Each of the thirty-six energy-policy items consisted, then, of a three-dimensional energy-policy outcome, including: 1) the technology emphasized in the policy; 2) the resulting level of risk; and, 3) the resulting level of power availability. An item, for example, may have indicated that the technological emphasis was coal, that the resulting

level of risk was more and that the resulting level of power availability was same. Respondents were asked to judge the level of acceptability of each such energy policy profile. Acceptability levels were indicated on a nine-point scale ranging from Very Unacceptable (1) to Very Acceptable (9).

Respondents' acceptability judgments were analyzed in two complementary ways. The first analysis was based on a multiple discriminant analysis statistical procedure. The discriminant analysis produced a weighted composite of variables so that the composite discriminated maximally (i.e., better than any other composite) among the clusters of respondents. Results from the discriminant analysis provided information about differences among clusters in how judgments were related to variables. The discriminant analysis, in its classification procedure, also indicated how strongly a set of variables discriminated among the clusters. Classification, in this context, refers to the prediction of cluster membership using scores generated by the weighted composite of variables; variables that discriminate strongly produce high levels of correct classification. The upper limit of correct classification is of course 100%; the level expected by chance is, in this case, 16.7%.

The second analysis, called the judgment analysis, approached the data from the point of view of the respondents. Utilizing the findings of the discriminant analysis, an attempt was made to reconstruct the processes respondents used in generating their judgments. The judgment analysis produced models of judgment processes designed to clarify the

differences between the way pronuclear and antinuclear respondents made their judgments.

Discriminant Analysis

In order to examine the variations in acceptability associated with variations in technology, risk and power availability, composite scales were constructed based on combinations of individual items. Three scales, LESRISK, SAMRISK, and MORRISK, were constructed for the risk dimension. These consisted of the twelve items for which risk was at the less, same and more levels, respectively. Similar scales, LESPA, SAMPA and MORPA, were constructed for the power availability dimension. Four technology scales were made: NUTECH (the nine items referring to nuclear power), COTECH (the coal items), CNTECH (the conservation items) and SOTECH (the solar items). For each of the ten composite scales, each respondent's judgments were summed across the items included in the scale; the sum was then divided by the number of items in the scale to produce the respondent's scale score. The following discussion of the risk, power availability and technology dimensions is based on three separate discriminant analyses of these scale scores.

Risk. The mean acceptability judgments for the six clusters of respondents on the three levels of the risk dimension are shown in Figure 1. On both the LESRISK and SAMRISK scales there was a high degree of agreement among clusters on levels of acceptability. There were differences among clusters on the MORRISK scale, however, with the three most pronuclear clusters (4, 5 & 6) producing higher acceptability judgments than the three most antinuclear clusters (1, 2 & 3). The

MEAN ACCEPTABILITY JUDGMENTS OF LEVELS OF RISK TO
HEALTH AND SAFETY (RISK), PLOTTED BY CLUSTER

FIGURE 1

higher level of risk represented by the progression from SAMRISK to MORRISK items thus produced greater movement toward lower acceptability ratings in the antinuclear respondents than in the pronuclear respondents. The effect was not strong, however, and it was based primarily on the relatively high MORRISK acceptability ratings of Cluster 5.

As expected, all six clusters had higher acceptability judgments on the LESRISK scale than on the SAMRISK scale and higher judgments on the SAMRISK scale than on the MORRISK scale. All six clusters also agreed that the difference between LESRISK and SAMRISK was smaller than the difference between SAMRISK and MORRISK. The negative effect of producing a higher level of risk was, in other words, greater than the positive effect of producing a lower level of risk. The overall means for LESRISK, SAMRISK and MORRISK items were 5.8, 5.2 and 4.2; the LESRISK to SAMRISK difference, then, was 0.6, while the SAMRISK to MORRISK difference was 1.0. MORRISK items, on the average, thus produced 1.67 times the movement of LESRISK items along the acceptability scale.

The percentage of correct classifications for the risk variables was 24.5%. Since a chance level of prediction would be 16.7%, this low percentage indicates that the risk variables were not strong discriminators among the clusters. Clusters of respondents did not differ greatly in their use of the risk dimension.

Power availability. Figure 2 shows the mean acceptability judgments for the six clusters of respondents on the three levels of power availability. There were differences among clusters on the LESPA scale,

MEAN ACCEPTABILITY JUDGMENTS OF LEVELS OF POWER AVAILABILITY (PA),
PLOTTED BY CLUSTER

FIGURE 2

but the differences were primarily due to the relatively low acceptability ratings of Cluster 6. The low ratings by Cluster 6 caused the mean rating (3.6) of the three most pronuclear clusters (4, 5 & 6) to be lower than the mean (4.0) of the three most antinuclear clusters (1, 2 & 3). The variability within pronuclear clusters was too great, however, for this difference between pro- and antinuclear respondents to be reliable. There were no significant differences among clusters on the SAMPA scale. On the MORPA scale, however, the pro- and antinuclear respondents differed more clearly in their judgments. The three most pronuclear clusters (4, 5 & 6) judged MORPA items to be more acceptable (mean of 6.6) than did the three most antinuclear clusters (1, 2 & 3; mean of 6.0). The difference between SAMPA and MORPA, in other words, had greater positive effect on pronuclear than on antinuclear respondents.

All six clusters agreed that LESPA was less acceptable than SAMPA and SAMPA less acceptable than MORPA. More significantly, all six clusters agreed that the difference between LESPA and SAMPA was the same as the difference between SAMPA and MORPA. The degree of agreement was greater among the three most antinuclear clusters (1, 2 & 3) than among the three most pronuclear clusters (4, 5 & 6). For all three antinuclear clusters, the differences in the acceptability ratings between LESPA and SAMPA and SAMPA and MORPA were both equal to one unit on the acceptability scale. The pronuclear clusters varied somewhat in their assessments on the LESPA-SAMPA differences from 1.3 (Cluster 5) to 1.9 (Cluster 6) units and on the SAMPA-MORPA differences from 1.2 (Cluster 5) to 1.5 (Cluster 6) units. The average difference for the pronuclear

clusters was 1.6 units for LESPA-SAMPA and 1.4 units for SAMPA-MORPA. Variations in power availability thus produced greater acceptability scale adjustments in pronuclear than in antinuclear respondents.

The percentage of correct classifications for the power availability variables was 22.8%. That this low percentage barely exceeds chance (16.7%) prediction indicates that the power availability variables were not strong discriminators among clusters. As with the risk dimension, differences among clusters of respondents in their use of the power availability dimension should not be considered to be of major importance.

Technology. Respondents' mean acceptability judgments on the four alternative technologies are given in Figure 3. The six clusters of respondents were divided, as might be expected, into two widely separated groupings by the NUTECH (nuclear power) items. The three most antinuclear clusters (1, 2 & 3) of course had much lower acceptability ratings on NUTECH than did the three most pronuclear clusters (4, 5 & 6). The degree of disagreement among clusters was smaller on COTECH (coal) than on NUTECH. Still, there was systematic disagreement, with the three most antinuclear clusters (1, 2 & 3) giving lower ratings to COTECH than did the three most pronuclear clusters (4, 5 & 6). On the two remaining alternative technologies, CNTECH (conservation) and SOTECH (solar), the two groupings of clusters reversed themselves; the three most antinuclear clusters (1, 2 & 3) produced higher acceptability judgments than did the three most pronuclear clusters.

The relative cohesiveness of the three most antinuclear clusters (1, 2 & 3) should be noted; the mean judgments of the three clusters were

relatively close together on all four technologies. The antinuclear respondents indicated strong support for conservation and solar, strong opposition to nuclear and moderate opposition to coal. In contrast, the three most pronuclear clusters were cohesive only on NUTECH and COTECH. Cluster 6 went its own way when it indicated slight opposition to conservation and solar; Clusters 4 and 5 showed slight support for those alternatives. Another contrast between the judgments of the pro- and antinuclear respondents is in the relative variability of judgments across technologies. The antinuclear respondents (Clusters 1, 2 & 3) indicated clear support for conservation and solar and clear opposition to nuclear and coal. The pronuclear respondents (Clusters 4, 5 & 6) supported nuclear, of course, but (except for Cluster 6) also provided moderate support for the three other technologies. Cluster 4, in fact, gave a higher rating to solar than to nuclear. In sum, the less extreme antinuclear respondents (Clusters 2 and 3) acted somewhat similar to the most extreme antinuclear respondents (Cluster 1), demonstrating both support (CNTECH and SOTECH) and opposition (NUTECH and COTECH). The most strongly pronuclear respondents (Cluster 6) were alone in their indifference to conservation and solar but were joined by the rest of the pronuclear respondents (Clusters 4 & 5) in their support of nuclear and coal.

The percentage of correct classifications for the technology variables was 45.1%. This percentage indicates that the technology variables were moderately strong discriminators among the clusters. Unlike the risk and power availability dimensions, clusters of

MEAN ACCEPTABILITY JUDGMENTS OF TECHNOLOGIES PLOTTED BY CLUSTER

FIGURE 3

respondents differed substantially in their use of the technology dimension.

Judgment Analysis

The results of the discriminant analysis have shown that differences among respondent clusters in their acceptability judgments are based primarily on the technology dimension. Moreover, the differences in the slopes of the graphs in Figures 1-3 indicate that the level of acceptability of a given energy policy profile was determined to a large extent by its technology emphasis. Acceptability judgments were affected by levels of risk and power availability, but the effects of those factors were relatively small.

Unit Weighted Model. These findings suggest that respondents may have used a simple unit weighting judgment process in producing their ratings of acceptability. In this process, respondents would use the technology (TECH) dimension as a baseline or anchor from which systematic adjustments are made for the levels of the risk (RISK) and power availability (PA) dimensions. This, it can be noted, is consistent with the order of presentation of information in the task--TECH followed by RISK followed by PA. The baseline TECH judgment is based on respondents' attitudes toward the particular technology. Respondents in the different clusters presumably have varying attitudes toward the four technologies; those attitudes could determine their starting points on the response scale. The second and third steps in the judgment process, the adjustments for RISK and PA, are made through the simplest transformations of the RISK and PA factors into the acceptability scale.

Each increment on the (qualitative) factor is treated as a unit increment on the response scale. Thus, a change in RISK or PA from less to same or from same to more, would result in a move of one unit on the acceptability scale (negative for increasing RISK and positive for increasing PA).

The results described in Figures 1-3 indicate that the simple judgment model presented above will not perfectly describe the processes used by pro- and antinuclear respondents for two reasons: 1) pro- and antinuclear respondents weighted the PA dimension differently; and, 2) both pro- and antinuclear respondents weighted more RISK higher than less RISK. However, despite these expected deviations, the unit weighted model provides a useful baseline from which to explore the deviations actually produced by respondents.

Let us first examine the task. The thirty-six profiles judged by respondents consisted of combinations of the three levels each of RISK and PA together with the four technologies. In a unit weighted judgment model, the technologies provide anchor points based on attitudes; from those anchor points adjustments are made for levels of RISK and PA. There are $3 \times 3 = 9$ pairings of the levels of RISK and PA. Those pairings can be ordered according to "expected acceptability," i.e., from the most negative combination of factor levels (more RISK and less PA) to the most positive (less RISK and more PA):

	1	2	3	4	5	6	7	8	9
RISK	M	M	S	L	M	S	L	S	L
PA	L	S	L	L	M	S	S	M	M

The judgment model transforms the levels of RISK and PA into numerical

values in the following manner: a) for RISK, $L = +1$, $S = 0$, and $M = -1$; b) for PA, $L = -1$, $S = 0$, and $M = +1$. The numerical values for the nine combinations of factor levels are:

	1	2	3	4	5	6	7	8	9
RISK	-1	-1	0	+1	-1	0	+1	0	+1
PA	-1	0	-1	-1	+1	0	0	+1	+1

Adding together the values for each combination produces its NET value:

	1	2	3	4	5	6	7	8	9
NET	-2	-1	-1	0	0	0	+1	+1	+2

Note, finally, that the range of response (combination 9 minus combination 1) is 4. The judgment model thus predicts a total difference of four units between the levels of acceptability of the worst and best cases within technologies.

Model Fit. How well does the unit weighted model describe the actual judgments made by respondents? Figure 4 presents graphs of the mean acceptability ratings for the four technologies for each of the 9 ordered RISK-PA combinations for the antinuclear respondents (Clusters 1, 2 and 3). These graphs clearly show the large distinctions made by antinuclear respondents among the four technologies. The important point in the present context, however, is the high degree of similarity among the shapes of the graphs; the only exception is the slight tendency in the nuclear judgments to greater adjustments in reaction to variations in levels of RISK. Figure 5 shows the average judgments on all thirty-six items for the three most pronuclear clusters (4, 5 & 6). In contrast to the antinuclear respondents, the pronuclear respondents made relatively

ACCEPTABILITY JUDGMENTS OF ANTINUCLEAR RESPONDENTS PLOTTED BY TECHNOLOGY
AND LEVELS OF POWER AVAILABILITY (PA) AND RISK TO HEALTH AND SAFETY (RISK)

FIGURE 4

ACCEPTABILITY JUDGMENTS OF PRONUCLEAR RESPONDENTS, PLOTTED BY TECHNOLOGY AND LEVELS OF POWER AVAILABILITY (PA) AND RISK TO HEALTH AND SAFETY (RISK)

FIGURE 5

small distinctions among the technologies. The four technology graphs were highly similar in shape for the pronuclear respondents, however, just as they were for their antinuclear counterparts. Given this lack of interaction between technologies and levels of RISK and PA, the judgments of both pro- and antinuclear respondents were averaged across technologies. Those mean judgments are presented in Figure 6 along with a graph of the judgments predicted by the unit weighted judgment model based on a mean judgment of 5.0, the mid-point of the acceptability scale (the grand means for the pro- and antinuclear respondents were 5.1 and 5.0, respectively).

A comparison between the judgment model and the mean judgments of the antinuclear respondents reveals a close fit but also several systematic deviations. The sets of items on which the antinuclear respondents differed most from the judgment model were the sets which included more RISK. With the exception of the least acceptable combination (more RISK, less PA), the two sets that included more RISK were both judged somewhat less acceptable by the antinuclear respondents than by the judgment model. The antinuclear respondents thus gave a greater than unit weight to the category more RISK. The combination (same RISK, same PA) was rated slightly higher by the antinuclear respondents than by the model, indicating that the particular set of four technologies judged was, on the average, slightly more acceptable than unacceptable.

The deviations of the pronuclear respondents from the unit weighted judgment model (Figure 6) were greater than those of the antinuclear

ACCEPTABILITY JUDGMENTS OF PRONUCLEAR AND ANTINUCLEAR RESPONDENTS,
 COMPARED TO EQUAL WEIGHTED MODEL, PLOTTED BY LEVELS OF POWER
 AVAILABILITY (PA) AND RISK TO HEALTH AND SAFETY (RISK)

FIGURE 6

respondents. The sets of items that produced the greatest deviations were those which included either more or less PA. The exception to this rule, as with the antinuclear respondents, was the more RISK and less PA set which marked the lower boundary of judgments. The two remaining combinations that included less PA were all judged less acceptable by the pronuclear respondents than by the unit weighted model; the three combinations that included more PA were all judged more acceptable by the pronuclear respondents than by the judgment model. The pronuclear respondents thus gave a greater weight to the entire PA dimension than was present in the equal weighted model. As with the antinuclear respondents, the pronuclear respondents rated the same RISK and same PA combination slightly higher than did the model, indicating again that this particular combination of RISK and PA was, on the average, across all four technologies, slightly more acceptable than unacceptable.

Revised Models. In view of the deviations from the unit weighted judgment model, modifications should be made to produce better descriptions of respondents' judgment processes. The antinuclear respondents (Clusters 1, 2 & 3) can more accurately be described by a slightly greater than unit weighting of more RISK. As before, the RISK and PA adjustments are made relative to a starting point determined by the respondents' attitudes toward the particular technology involved. Those attitudes are represented here by the respondents' mean judgment for that technology. The modified judgment model for the antinuclear respondents is:

$$J = \bar{X}_{\text{TECH}} + \begin{matrix} 1.25 \text{ RISK if } \underline{\text{more}} \\ 1.00 \text{ RISK if } \underline{\text{less}} \end{matrix} + 1.0 \text{ PA}$$

This particular model fits all of the items well except the more RISK and less PA set (see Figure 7). There, the respondents produced judgments that were less extremely negative than those predicted by the model. This result is most likely due to a constraint placed on judgments by the response scale. For example, the mean judgment for nuclear power by the antinuclear respondents was 3.0. According to the modified model, the more RISK and less PA judgment would therefore be 0.75. Since the lowest point on the response scale is 1.0, respondents' judgments were constrained to be less negative than they would have been had the scale been larger. Given this constraint, the modified model provides an excellent description of the judgment processes of the antinuclear respondents.

The basic judgment model needs to be modified to better fit the judgments of the pronuclear respondents (Clusters 4, 5 & 6) who place considerably more than unit weight on the PA dimension. As with the antinuclear respondents, RISK and PA adjustments are made relative to the respondents' mean judgment for the technology involved. The modified judgment model for the pronuclear respondents is:

$$J = \bar{X}_{\text{TECH}} + \begin{matrix} .5 \text{ RISK if with } \underline{\text{less}} \text{ PA} \\ 1.0 \text{ RISK if not with } \underline{\text{less}} \text{ PA} \end{matrix} + 1.5 \text{ PA}$$

This particular model fits all of the items well (see Figure 8) and highlights the interaction between levels of RISK and levels of PA. As the model shows, levels of RISK were less important considerations for the pronuclear respondents under less PA conditions than they were under same and more PA conditions.

PREDICTED AND ACTUAL ACCEPTABILITY JUDGMENTS OF ANTINUCLEAR RESPONDENTS,
 PLOTTED BY LEVELS OF POWER AVAILABILITY (PA)
 AND RISK TO HEALTH AND SAFETY (RISK)

FIGURE 7

PREDICTED AND ACTUAL ACCEPTABILITY JUDGMENTS OF PRONUCLEAR RESPONDENTS,
PLOTTED BY LEVELS OF POWER AVAILABILITY (PA) AND RISK TO
HEALTH AND SAFETY (RISK)

FIGURE 8

Summary. The value of the models is that they provide a compact yet accurate description of the process by which different types of respondents made their judgments of energy policy acceptability. The manner in which the profiles were presented, TECH followed by RISK followed by PA, may have suggested an anchor-and-adjustment process (Slovic, et al., 1977). Within such a process, respondents would have used their attitudes toward the technologies in the TECH dimension as baselines from which to make systematic adjustments for the levels of the RISK and PA dimensions. Irrespective of the order in which the information may have been integrated, the antinuclear respondents made wide distinctions among the technologies and gave greater weight to RISK (specifically more RISK) than to PA; the pronuclear respondents made narrow distinctions among the technologies and gave greater weight to PA than to RISK.

The importance of TECH in the judgmental processes of the antinuclear respondents is significant. The explanation for this effect is not clear. One possibility is that antinuclear respondents used the label as a "cue" or indicator of characteristics other than RISK or PA. Cost and environmental impact are salient evaluation factors for which the technology label might have served as a proxy.

The models, finally, inform us about the tradeoffs between RISK and PA. The simple unit weighted judgment model shown in Figure 6 represents a policy in which there are consistent, equal tradeoffs between RISK and PA. Deviations of the obtained data from the unit weighted judgment model represent differential importance of the factors in the tradeoffs. As we have seen, the relatively minor deviations of the antinuclear

respondents were due to a slightly greater weighting of the more RISK level of the RISK dimension.

The deviations of the pronuclear respondents from the unit weighted judgment model were somewhat larger and were due to a greater weighting of the entire PA dimension. The differences for pronuclear respondents between the acceptability of less RISK items and more RISK items under less PA conditions versus same and more PA conditions were relatively large and were due to the importance of less PA for pronuclear respondents. That is, the increase in acceptability from more to less RISK was smaller for less PA items (0.8) than for more PA items (1.7). Pronuclear respondents thus had unequal tradeoffs between RISK and PA. They gave greater weight to PA in all conditions and weighted RISK less when paired with less PA than when paired with more PA.

In sum, compared with their antinuclear counterparts, pronuclear respondents demonstrated an avoidance of less PA conditions regardless of the level of RISK; they also sought more PA, but their desire for more PA was tempered by levels of RISK. Antinuclear respondents, in contrast, exhibited an avoidance of more RISK conditions which took into account the accompanying levels of PA.

ENERGY POLICY CONSEQUENCES

The preceding section dealt with energy policy choices. Respondents judged the acceptability of each of the thirty-six policies generated by combining four technologies (solar, coal, nuclear and conservation) with three levels each of risk (RISK) and power availability (PA; less, same and more). The items in this section were designed to investigate respondents' perceptions of the possibility of negative consequences of alternate energy policies.

Respondents were asked to make two judgments, the first about the likelihood that a given energy alternative will produce more RISK than the current mixture of energy technologies, the second about the likelihood that the same technology will result in less PA. As in the previous section, more RISK referred to "an increase in the number of deaths and disabilities that is noticeable to the average citizen," and less PA meant "a decrease that is noticeable to the average citizen."

The context within which the four energy alternatives were judged was specified by the four energy policy scenarios presented in the section on energy policy choices. Judgments of the likelihood that a given policy will produce more risk or less power than the current mix were made on a seven point scale ranging from 1) Very Unlikely, through 4) Even Odds, to 7) Very Likely.

All four energy policy scenarios, it should be noted, presented respondents with essentially the same situation; identical types of judgments were required for the four energy alternatives. On the Risk dimension, respondents made judgments of the likelihood that the risk produced by increased emphasis on the given energy alternative will be

greater than the risk reduction resulting from decreased use of oil and natural gas. On the Power Availability dimension, respondents judged the likelihood that increased use of the given energy alternative will not make up for the decline in energy produced from oil and natural gas. Both the risk and the power availability likelihood judgments were thus based on comparisons between the perceived future consequences of the four energy alternatives and the perceived current consequences of oil and natural gas. Respondents' likelihood judgments of risk are discussed first and are followed by the power availability results.

Risk

Respondents produced likelihood judgments of risk for four energy alternatives; the results for each alternative are presented separately (see Figure 9).

Conservation. Since conservation is not an active technology that produces pollutants and creates situations in which persons are injured, it would seem unlikely that an energy policy with an emphasis on conservation would result in increased risk. Such appears to have been the reasoning of most respondents when they gave conservation an average risk likelihood judgment of 2.4 (Unlikely). Within this overall agreement, however, there was room for fairly strong differences in opinion. Judgments ranged from the 1.4 (Very Unlikely) of Cluster 1 to the 3.3 (Even Odds) of Cluster 6. In general, the more pronuclear the cluster, the higher the likelihood judgment of increased risk. The one exception to this rule was Cluster 5 which considered a conservation policy Very Unlikely (1.7) to result in increased risk.

MEAN JUDGMENTS OF LIKELIHOOD OF MORE RISK, PLOTTED BY CLUSTER
AND TECHNOLOGY

FIGURE 9

Solar. Somewhat surprisingly, respondents rated the solar policy slightly less likely to cause increased risk than conservation (2.1 for solar to 2.4 for conservation, both Unlikely). The differences among clusters on the risks of a solar policy were similar to the differences for the conservation policy. The range of judgments was from 1.5 (Very Unlikely) for Cluster 5 to 3.1 (Even Odds) for Cluster 6. As with conservation, Cluster 5 was the exception to a rule relating relatively low judged likelihood of risk to antinuclear respondents and relatively high judged likelihood of risk to pronuclear respondents.

Coal. By giving coal an average rating of 5.0 (Likely) the respondents indicated their belief that a coal policy would be much more likely to result in increased risk than either conservation or solar. While the range of judgments went from the low of 4.1 (Even Odds) for Cluster 5 to the high of 5.4 (Likely) for Cluster 1, there was less disagreement among clusters on coal than on any of the other energy alternatives. What disagreement there was among clusters was related to nuclear power attitudes: pronuclear respondents considered coal to be less risky than did antinuclear respondents.

Nuclear. Respondents judged the nuclear policy to be the most likely to result in increased risk; the average nuclear rating of 5.3 (Likely) was slightly higher than the rating given coal (5.0, Likely). Unlike coal, however, there was little agreement among clusters. In fact, there was more disagreement among clusters on the riskiness of nuclear power than on any of the other energy alternatives. The ratings for clusters ranged from 3.1 (Even Odds) for Cluster 6 to 6.6 (Very Likely) for Cluster 1. The judged riskiness of a nuclear policy was very much higher for antinuclear than for pronuclear respondents.

Power Availability

As with risk, respondents produced likelihood judgments of power availability for four energy alternatives. The results for each alternative are presented separately (see Figure 10).

Conservation. Under the conservation policy, power from oil and natural gas was to decline and the balance between production and consumption was to be regained through reduction in consumption of power. Although aggregate power availability was certain to decline respondents may have believed that the level of personal power availability would be more uncertain. All clusters agreed that less power availability was at least likely. The range of judgments was narrow, from the 5.0 (Likely) of Cluster 4 to the 6.2 (Very Likely) of Cluster 6. What little disagreement there was among clusters was due to the relatively high likelihood judgment produced by Cluster 6. Power availability likelihood judgments for conservation were not strongly related to respondents' support for or opposition to nuclear power.

Solar. Respondents judged a solar policy to be less likely than conservation to result in reduced power. The average rating was 4.5 (Even Odds), but there was more disagreement on solar than on any of the other alternatives. The power availability judgments ranged from the 3.7 (Even Odds) of Cluster 3 to the 6.0 (Very Likely) of Cluster 6. The general pattern of judgments showed that support for nuclear power was positively related to judged likelihood of decreased power availability from solar technology: the stronger the support, the higher the judged likelihood.

Coal. There was a greater degree of agreement on the likelihood of less power resulting from a coal policy than for any of the other

alternatives. The range of judgments was very narrow, from 2.8 (Unlikely) for Clusters 3 and 5 to 3.5 (Even Odds) for Clusters 1 and 4. The average rating was 3.2 (Even Odds); coal was thus judged somewhat less likely than solar to result in reduced power. As with conservation, there was no relation between power availability likelihood judgments for coal and attitudes toward nuclear power.

Nuclear. An energy policy based on nuclear power was judged less likely than the other alternatives to result in reduced power. The average rating for all respondents was 2.7 (Unlikely). As would be expected, there was strong disagreement among clusters. Cluster 1, the most antinuclear cluster, judged the likelihood of less power to be 3.5 (Even Odds), while Cluster 6, the most pronuclear cluster, put the likelihood at 1.5 (Very Unlikely). Nuclear power attitudes were consistently and strongly related to power availability likelihood judgments: the greater the support for nuclear power, the lower the judged likelihood that reduced power would result from a nuclear policy.

Summary

In this section of the survey, respondents were asked to make separate judgments of the likelihood of more risk and of less power as consequences of the implementation of each of four alternate energy policies, conservation, solar, coal and nuclear. The primary results can be summarized in four points:

1. Judged likelihood of more risk, averaged across all respondents, was relatively low for conservation and solar and relatively high for coal and nuclear.

MEAN JUDGMENTS OF LIKELIHOOD OF LESS POWER, PLOTTED BY
CLUSTER AND TECHNOLOGY

FIGURE 10

2. Judged likelihood of less power, averaged across all respondents, was high for conservation, about even odds for solar and coal, and was low for nuclear.

3. Risk was a more salient dimension for antinuclear respondents (Clusters 1, 2 & 3) than for pronuclear respondents (Clusters 4, 5 & 6). Antinuclear respondents produced lower risk judgments for the "low risk" technologies (conservation and solar) but higher risk judgments for the "high risk" technologies (coal and nuclear).

4. Power availability was a more salient dimension for pronuclear than for antinuclear respondents: pronuclear respondents produced high (solar), moderate (coal) and low (nuclear) judgments of the likelihood of less PA, while antinuclear respondents produced moderate judgments for all three technologies (conservation is not included in this summary because it was certain to produce less power).

Comparisons between the RISK and PA dimensions indicate that:

5. RISK was a much more salient dimension for the antinuclear respondents than was PA: the range of RISK judgments was 4.6, while the range of PA judgments was 0.7.

6. PA was a more salient dimension for the pronuclear respondents than was RISK: the range of PA judgments was 3.2, while the range of RISK judgments was 2.1.

DISCUSSION

The data presented here are quite consistent with results reported in other research reports. The effect of the technology label on judgments of acceptability is consistent with data from a national poll conducted by Cambridge Reports (cited in Melber, et al., 1977, Table 5.11) which showed generally very favorable attitudes toward solar power. It is noteworthy that the Cambridge data do not show strong differences between pronuclear and antinuclear respondents. This is due to the difference between the present study and the Cambridge poll in the way that pro- and antinuclear sentiment is measured. As is the case with most other national probability polls, Cambridge inferred overall attitude toward nuclear power from response to a single item, "Do you typically favor or oppose the construction of more nuclear power plants?" This is a much weaker indicator of global nuclear attitude than is membership in an organization which has taken a stand on nuclear power. Consequently, the stronger differences between the opposing groups, found here, is to be expected.

The present results, like the Cambridge data, show that coal is substantially less popular than solar. Unlike the Cambridge results, we found stronger acceptability differences among technologies for antinuclear than for the pronuclear respondents. The antinuclear respondents in our sample rated conservation almost as highly acceptable as solar. In the Cambridge sample, however, conservation was little more highly regarded than coal.

Other studies have indicated that pronuclear respondents are more concerned about benefits of nuclear power, such as power availability, and that antinuclear respondents attach much importance to risks to health and safety. Melber, et al., (1977) cite two polls by the Harris organization (1975, 1976) which indicate that, when asked the reasons for their position on nuclear power, pronuclear respondents typically mention the use of nuclear power for needed energy (p. 137). Antinuclear respondents indicate that they oppose nuclear power for health and safety reasons (p. 124). Unfortunately, due to the way in which most of these questions has been asked in the polls, it has not been possible to determine whether the difference in overall attitude has been due to differences in perception or evaluation of risks and benefits. A difference in perception would imply that respondents differ in their beliefs about whether nuclear power does--or will--produce a given level of risk or benefit. A difference in evaluation means that they differ in acceptability of that given level of risk or benefit. Such a distinction was made in a study by Otway and Fishbein (1977), who found that pro- and antinuclear respondents in an Austrian sample differed less in their evaluation of risks and benefits than they did in their perception of the risks and benefits associated with nuclear power. There were, however, significant differences between groups in both perception and evaluation. The present results appear consistent with those of Otway and Fishbein in finding reliable differences in risk perception. In the present study, differences in evaluation of risk and benefit of nuclear

power are more important than are the differences in perception of risk and benefit.

It may seem surprising, perhaps, that in light of the bitter disputes over nuclear power and nuclear waste, that the evaluation functions of pro- and antinuclear respondents are as similar as they are. Figure 6 shows a substantial degree of similarity between pronuclear and antinuclear respondents. This figure is, of course, an average of the plots for four different technologies. In the case of the antinuclear respondents, this is an average of two very favorably evaluated and two much less favorably evaluated technologies. In spite of the separation of the four evaluation functions--indicating that the technology label had a significant effect upon favorability judgments--the four curves are approximately parallel.

The important differences appear to be in the role of the technology label and in the perception of risk and benefit. With regard to the latter, it should be emphasized that the differences in beliefs about the likelihood of both types of undesirable consequences (less Power Availability and more Risk) accentuate the differences in evaluation or risk and benefit. Pronuclear respondents believe that nuclear power is the least likely of the technologies to produce less power, the factor which was of more concern to them. Antinuclear respondents, on the other hand, believe that nuclear power is the most likely to produce more risk, the factor that is of more concern to them. Moreover, antinuclear respondents clearly do not believe that there are significant differences among the three power generation technologies--solar, coal and

nuclear--in their ability to avoid the possibility of less power. Since nuclear power is believed to be far more likely to produce increased levels of risk than the present energy production mix, the internal consistency of the attitudes of antinuclear respondents is clearer. The same can be said of pronuclear respondents as well. If, as these respondents believe, nuclear and coal technologies are more likely to avoid the possibility of a future situation in which there is less power available, then it is reasonable, especially considering the greater importance that they attach to this factor, that they support nuclear power.

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