Chapter 8

Public Attitudes Toward Nuclear Power

Photo *credit: OTA staff*

Buttons and bumperstickers from the controversy about nuclear power

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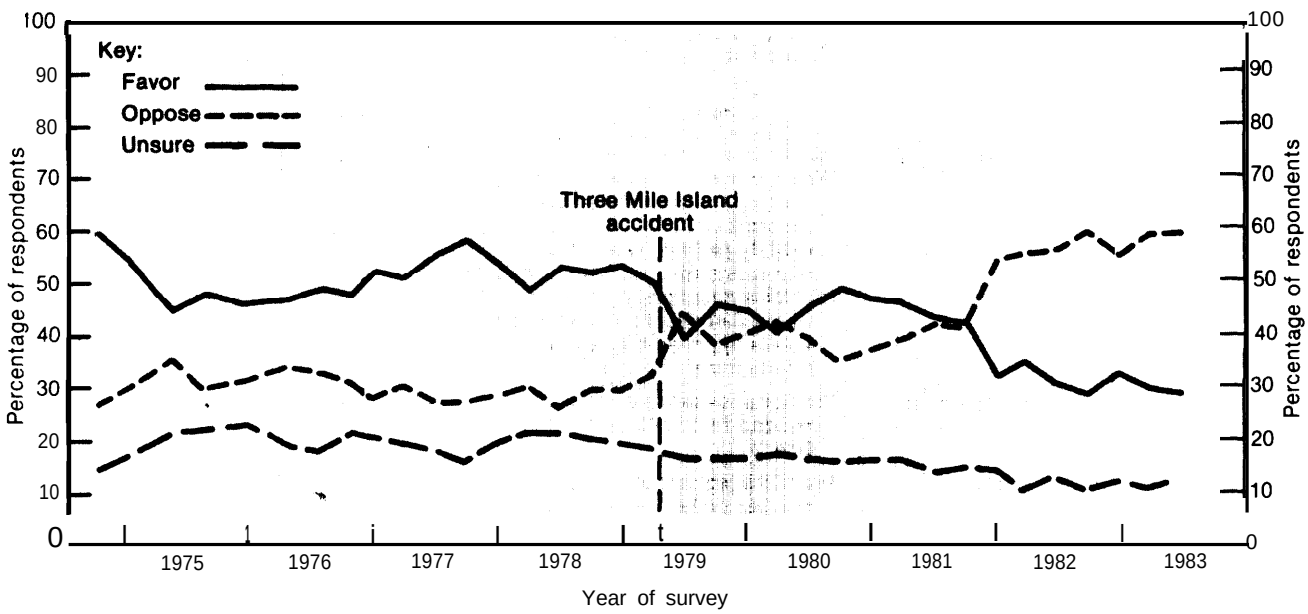
INTRODUCTION: PUBLIC OPINION AND ITS IMPACT ON NUCLEAR POWER

Public attitudes toward nuclear power have become increasingly negative over the past two decades, with the most recent polls indicating that a slight majority of Americans opposes further construction of reactors. During the 1950's, nuclear power was still in the early states of development, and pollsters did not even bother to survey the public on the issue. In the early 1960's, a few scattered protests against local plants gained national attention, but opinion polls indicated that less than a quarter of the public opposed nuclear power **(41). From Earth Day in 1970 through the mid-1970's, opposition levels averaged 25 to 30 percent, indicating that substantial majorities of the public favored further nuclear** development. However, by 1976, anti-nuclear referenda appeared on ballots in eight States.

Polls taken between 1976 and 1979 indicated that slightly over half of the American public favored continued construction of nuclear plants in the United States in general, while about 28 percent were opposed and 18 percent unsure. The accident at Three Mile Island (TMI) in April 1979 had a sudden and dramatic impact on these attitudes. As shown in figure 39, the percentage of people who had been in favor of or uncertain about continued construction of reactors decreased immediately following the accident while the number opposed increased (57). In subsequent months, there was some return to previously held opinions, but opposition levels remained much higher than they had been. National polls taken since mid-1 982 indicate a continued slow erosion in support for nuclear power. About a

Figure 39.—Trends in Public Opinion on Nuclear Power



Question asked: "Do you favor or oppose the construction of more nuclear powerplants?"

SOURCE Cambridge Reports, Inc.

third of the public now supports construction of new plants in general, while over so percent are opposed (6, 10, 18). The accident at TMI appears to have accelerated a trend of even greater opposition to construction of new plants near to where those polled live. By the end of 1981, a large majority of those polled opposed construction of new plants in or near their communities. When compared with other energy options, including offshore oil drilling and coal plants, nuclear is now the least favored alternative.

Despite the trend of declining support, the pub lic's overall current attitude toward nuclear power can best be described as ambivalent. For example, a 1983 poll indicates that about 40 percent of the public thinks currently operating reactors are "mainly safe" while slightly over half think they are dangerous and 5 percent are "not sure." There is some evidence that the public looks to nuclear power as one solution to the Nation's long-term energy problems. In a recent survey, the majority of respondents believed that most U.S. energy needs would be supplied primarily by nuclear" and solar over the next two decades, and over a third of those polled expected nuclear power to provide most of the Nation's energy after the year 2000 (14). The majority of Americans favor neither a halt to all new construction nor a permanent shutdown of all operating reactors. Opinion polls on this question have been verified by State ballot initiatives. As shown in table 31, most of the nuclear moratorium initiatives, and all referenda that would have shut down operating plants were defeated in 1976, 1980, and 1982. However, more of these initiatives have been approved in recent years, and many restrictions on nuclear waste disposal have been passed, reflecting public doubts about the technology.

Table 31.—History of Statewide Referendum Votes Dealing With Nuclear Powerplants

Year	State	Proposal	Outcome	Vote split
1976	Arizona	Would halt new construction	Defeated	30-70 %
	California	and reduce operations until	Defeated	33-66%
	Colorado	safety systems were found	Defeated	29-71 %
	Montana	effective, liability ceilings	Defeated	42-58%
	Oregon	lifted, and waste disposal was	Defeated	42-58%
	Ohio	demonstrated	Defeated	32-68%
	Washington		Defeated	33-67%
1978	Montana	Same as '76 referenda	Approved	60-40%
1980	Maine	Would shut down Maine Yankee	Defeated	41 -59%
	Missouri	Would prevent Callaway plants from operating until safety systems were found effective, liability ceilings were lifted, and waste disposal was available	Defeated	39-61%
	Oregon	Prohibits new construction until waste disposal is available and voters approve in a statewide referendum	Approved	*52-48%*
1981	Washington	Prohibits issuance of new bonds needed to complete WPPSS Unit 3	Approved	*56-44%*
1982	Idaho	Prohibits legislation limiting nuclear power unless approved by voters in a referendum	Approved	*60-40%*
	Maine	Would phase out Maine Yankee over 5 years	Defeated	*44-56%*
	Massachusetts	Prohibits new construction and waste disposal unless certain conditions, including voter approval in a referendum. are met	Approved	*66-33%*

Total restrictive referenda placed on ballots: 14
Total approved: 4

SOURCES: Atomic Industrial Forum, State Codes.

The public's ambivalent attitude toward nuclear power is due to a variety of factors including the ongoing debate among experts over reactor safety, individual perceptions of the likelihood of a catastrophic reactor accident, changing personal values, and media coverage of the technology. Underlying all of these factors is increasing doubt about the technical capabilities and the credibility of both the nuclear industry and its governmental regulators. As discussed in chapter 5, weak utility management has led to poor operating performance at some reactors as well as skyrocketing costs and quality-assurance problems at other plants under construction. These problems have led to accidents at operating reactors, causing great public concern.

As early as 1966, when large majorities of the public supported nuclear power, a design error caused blockage of coolant, leading to melting of a small part of the core at Detroit Edison's Fermi breeder reactor (3). Although no radioactivity was released, and the event received relatively little publicity at that time, nuclear critics and some members of the public became concerned. They pointed to a University of Michigan study conducted prior to construction of the plant, which indicated that if the plant had been larger and had been operating at full design power for at least a year, a complete breach of containment combined with the worst possible weather conditions might have led to as many as 60,000 deaths (26). Nearly a decade later, public discussion of the accident increased in response to the 1975 publication of the book, We ***Almost Lost*** *Detroit* (25).

In 1975, a fire started by a worker using a candle to test for air leaks spread through the electrical system of the Tennessee Valley Authority's (TVA's) Browns Ferry plant in Alabama. The fire caused some loss of core coolant in one unit of the plant, and disabled the reactor's safety systems (1 1). Because of confusion about how to put it out, the fire burned out of control for 7 hours before being extinguished. Again there was no loss of life and no release of radiation, but the incident was reported in the national media, increasing public fears of an accident. Critics felt that the Nuclear Regulatory Commission's (NRC's) news release on the event—which emphasized the safe shutdown of the reactor while downplaying the failure of the Emergency Core Cooling System— misrepresented the nearness of a disaster and ignored the lack of foresight which the accident demonstrated.

While these earlier accidents had an adverse impact on popular support for nuclear technology, it was not until 1979 that a single accident had a direct, measurable impact on public opinion as reflected in national opinion polls. That spring, poor maintenance, faulty equipment, and operator errors led to a loss of coolant and partial destruction of the core at the TMI Unit 2 reactor located in Pennsylvania. Radioactive water spilled onto the floor of an auxiliary building, releasing a small amount of radioactivity to the environment, although the total radiation dose received by the population in the vicinity was far less than their annual exposure to natural and medical radiation (31). On March 30, Governor Thornburgh advised pregnant women and preschool children to leave the area within a 5-mile radius of TMI. This advisory was not lifted until April 9. Conflicting statements from authorities combined with obvious confusion at the reactor site before and during the evacuation shook public confidence in the nuclear industry and State and Federal officials. Following the accident, majority support for nuclear power was lost, a trend that continues today. Local opposition to some reactors around the country also increased after the accident, while local attitudes toward other reactors remained favorable (see Case Studies at the end of this chapter).

Opinion polls taken after the accident at TMI indicated that at least half of those polled thought more such accidents were likely. Since that time, other incidents, such as the rupture of steam generator tubes at Rochester Gas & Electric's Ginna nuclear plant in January 1982, have occurred at operating reactors. There is some evidence that the public views these incidents, along with the TMI accident, as precursors to a catastrophic accident that might kill thousands (67).

The handling of reactor safety issues by the nuclear industry and the NRC has led many people to the conclusion that both have seriously underestimated safety problems. For example,

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opinion polls indicate that a majority of the public believed government officials understated the dangers at TMI (57). In addition, since 1973 the nuclear industry has argued that the possibility of failure of reactor emergency shutdown systems is negligible. Because of industry opposition, the NRC delayed regulations requiring extra equipment to avoid an accident in the event of such a failure. However, it was exactly this type of failure that occurred not once, but twice within 4 days at Public Service Gas& Electric's Salem, N. J., plant in February 1983 (38). (See ch. 5.)

The importance of public opinion to further development of nuclear power has been recognized by government and industry but is still little understood (12,75). This chapter attempts to add to the limited understanding of public perceptions and to identify changes in the management of nuclear power that might make it more acceptable to the public. The analysis is limited to public perceptions of operating nuclear reactors and those under construction. An April 1983 OTA stud y, ***Managing Commercial High-Level Radioactive Waste,*** deals with public attitudes toward transportation and disposal of spent fuel and nuclear waste in greater depth.

Actors in the Nuclear Power Debate

As discussed in chapter 1, there area number of groups in the United States with sometimes conflicting interests in nuclear power. The apparent contradictions in public attitudes toward the technology are explained at least partially by the fact that there is not a single homogeneous "general public" in this country. Opinion polls which survey the "general public" may fail to reveal the intensity of individual opinions. For example, the phrasing of the question most frequently asked to gage national public opinion—"In general, do you favor or oppose the building of more nuclear power plants in the United States?" –leaves little room for people who are uncertain or have no opinion. When the question was rephrased in two surveys taken shortly after the TMI accident, over a third of the respondents were uncertain or neutral (45). A national poll taken in 1978 indicated that about a third of respondents were neutral; however, large percentages of respondents were also extremely pro- or anti-nuclear. Thus, it appears that different groups among the public vary in the strength of their beliefs about nuclear power.

During the 1970's, critics of nuclear power and their associated public interest groups became increasingly well-organized at the national level. As shown in table 32, today all of the major national environmental groups are critical of at least some aspects of the U.S. nuclear program (33). In addition to these environmental groups with broad agendas, several organizations, such as the Union of Concerned Scientists and the Critical Mass Energy Project of Ralph Nader's Public Citizen, Inc., focus primarily on nuclear power. Overall, about 1 million Americans belong to environmental and energy groups critical of nuclear power. Total annual expenditures for lobbying, public education, and other activities related directly to nuclear energy are estimated to be about $4 million (33). In addition, these groups rely heavily on volunteer labor and donated resources.

Partially in response to the publicity attracted by nuclear critics, proponents of nuclear technology have also formed advocacy groups, as shown in table 32. Most of the groups supporting the technology are trade and professional associations, although there are some broad-based public interest groups in this category as well. In total, about 300,000 individuals belong to professional societies and public interest groups that directly or indirectly support nuclear energy development. Some groups in this category, such as the American Nuclear Society and the Atomic industrial Forum, focus primarily on nuclear power, while others such as the Edison Electric Institute are utility trade associations with broad agendas that include advocacy of nuclear power among many other issues. In response to the accident at TMI, nuclear advocates stepped up their public education efforts through the creation of the Committee for Energy Awareness (CEA). Current plans call for expenditure of about $27 million in 1983 for CEA, a major increase over previous expenditures of about $6.5 million by all groups combined (42).

Nuclear advocates and critics, including the staffs of public interest groups, are knowledgeable

Table 32.-Major National Groups Influencing Public Opinion For and Against Nuclear Power

Groups supporting nuclear power	Groups opposing some aspects of nuclear power
Category 1: Large organizations with a focus on nuclear energy targeting a broad audience. — U.S. Committee for Energy Awareness — Atomic Industrial Forum — American Nuclear Society *Category* 2: Lobbying organizations with a primary or secondary focus on nuclear energy. — Americans for Nuclear Energy — American Nuclear Energy Council — Americans for Energy Independence *Category* 3: Trade and professional associations that support commercial nuclear energy. — Edison Electric Institute — American Public Power Association — National Rural Electric Cooperative Association — Institute of Electrical and Electronics Engineers — American Association of Engineering Societies — Health Physics Society — Scientists and Engineers for Secure Energy *Category* **4: Industry research organizations indirectly influencing public opinion.** **— Electric Power Research Institute** **— Institute for Nuclear Power Operations** **— Nuclear Safety Analysis Center**	*Category 1:* Groups with a focus on nuclear energy and alternatives to it. — Union of Concerned Scientists — Critical Mass Energy Project of Public Citizen, Inc. — Nuclear Information and Resource Service — Safe Energy Communications Council *Category* 2: Large environmental groups that participate in lobbying and public criticism of nuclear energy. — Sierra Club — National Audubon Society — Natural Resources Defense Council — Friends of the Earth — Environmental Policy Center — Environmental Defense Fund — Environmental Action, Inc.

SOURCES Terry Lash, "Survey of Major National Groups Influencing Public Opinion Against Nuclear Power, " Office of Technology Assessment contractor report, April 1983, M & D Mills, "Activities of Groups Which Influence Public Opinion in Favor of Nuclear Power, " Off Ice of Technology Assessment contractor report, May 1983

about nuclear power and much more committed to their beliefs than the general public. They act on these beliefs both in seeking to influence nuclear power policies at the State and Federal level and in attempting to convince the public of their point of view.

The nuclear establishment sometimes blames nuclear critics for the growth of public opposition to nuclear power. However, to some extent these individuals simply are reflecting the concern of the wider public which has grown in response to reactor accidents and the increasing financial problems of the utility industry. In addition, the success or failure of **both** advocates and critics depends in part on public response to their arguments. A 1983 opinion poll indicates that Ralph Nader, a leading environmentalist, is considered very believable on energy matters (9). Electric utility trade associations are considered somewhat less believable, and nuclear industry associations have much lower credibility among poll respondents. Thus, it appears that the public may be more willing to listen to and accept the arguments of nuclear critics than those of advocates.

The Impact of Public Opinion on Nuclear Power

Public concerns about reactor safety, nuclear waste disposal, and rising construction costs have had a particularly notable impact on State policies affecting nuclear power. As discussed in chapter 6, State Public Utility Commissions (PUCs) must grant a license certifying the need for power prior to construction of any type of new powerplant. Because PUCs have veto power over new plants, based on economic and financial criteria, State laws essentially can halt further development of nuclear power. While critics and advocates have been involved in voter-initiated referenda restricting further licensing of nuclear plants, it is ultimately the voters of the State (the "general public") who decide whether or not to approve these restrictions. Table 31 provides a history of State votes on nuclear energy referenda. Overall, the trend appears to reflect accurately the trends shown in public opinion polls, declining from a large margin of suppt for nuclear power in 1976 to an ambivalent position today. While all seven restrictive proposals were defeated in 1976, voters in Oregon and Massachusetts approved

initiatives limiting new reactor construction in 1980 and 1982.

In California, State legislators approved a law restricting nuclear power development in 1976 to head off a more stringent Statewide referendum with similar provisions that was then turned down only a few months later. The law passed by the legislature was upheld by the U.S. Supreme Court in April 1983. Other State legislatures and a few PUCs have limited further construction of nuclear plants by legislation or regulation. A complete list of State laws and regulations (including those enacted by voter referenda) affecting nuclear power is given in table 33. Because of these laws and regulations, utilities in 10 States cannot obtain State licensing of proposed nuclear reactors until certain conditions, such as a clear demonstration of high-level waste disposal, are met.

Even in those States where nuclear power development is not limited by law or regulation, State politics can influence utility decisions about

Table 33.—State Laws and Regulations Restricting Construction of Nuclear Powerplants

State	Type of action	Year approved	Citation	Provisions
California	Law-by legislature[a]	1976	Cal Pub Res Code, Sees. 25524.1-25524.2	No licensing of new plants until Federal Government approves a demonstrated high-level waste disposal technology and fuel rod reprocessing technology is available.
Connect i cut	Law-by legislature	1979	H-5096, approved June 18	No licensing of a fifth plant until Federal Government approves a demonstrated high-level waste disposal technology.
	Law-by legislature	1983	H.B. 5237	Limits construction costs of Millstone 3 to rate-payers to $3.5 billion.
Kentucky	Resolution-by legislature	1982	HR-85, adopted March 26	Declares the State's intention to prohibit construction of plants.
Maine	Law-by legislature	1977	Me Rev Stat Ann, Tit 10, Sees. 251-256 (West 1980)	No licensing of new plants until Federal Government demonstrates high-level waste disposal and a majority of voters approve in a referendum vote.
Maryland	Law-by legislature	1981	Ann Code Md, Health-Environmental, Tit 8, Sec. 402	No licensing of new generators of nonmedical low-level waste until Federal Government demonstrates waste disposal or an interstate compact is in effect.
Massachusetts	Law-by referendum	1982	Question 3, Approved Nov. 2 (Chap. 503, Acts of 1982)	No licensing of new plants or nonmedical low-level radioactive waste disposal sites until a Federally approved storage facility is operating, and other conditions, including voter approval, have been met.
Montana	Law-by referendum	1978	Mt Code Ann, Tit 75, Sees. 20-201, 20-1203	No licensing of new plants until all liability limits for an accident are waived, a bond is posted against decommissioning costs, and other conditions, including voter approval, are met.
Oregon	Law-by referendum	1980	Measure No. 7, Approval Nov. 4	No licensing of new plants until Federal Government provides high-level waste disposal and a majority of voters approve in a referendum.
Vermont	Law-by legislature	1975	Vt. Stat Ann, 1970, V.8, Tit 30, Sec. 248c	No licensing of new plants without General Assembly approval.
Wisconsin	Regulation-by Public Service Commission	1978	Dkt No 05-EP-1, Wis Pub Serv Comm, Aug. 17	No licensing of new plants without progress on waste disposal, fuel supply, decommissioning, and other economic issues.
Washington	Law-by referendum	1981	Chap. 80.52, Rev. Code of Washington	No issuance of bonds for major new energy facilities (including nuclear plants) without voter approval.

[a]On Apr. 21, 1983, the Us. Supreme Court upheld the constitutionality Of this law

SOURCES: Atomic Industrial Forum, State Codes, NRC Office of State Programs.

nuclear plants. Whether Public Utility Commissioners are directly elected or appointed by an elected Governor, they are sensitive to State politics and broad public opinion. Public concerns about nuclear power may lead Utility Commissioners to disallow rate increases needed to finance completion of plants under construction or to simply deny a license entirely. Public opposition at the local level, too, can discourage utilities from implementing planned nuclear plants. For example, Portland General Electric in Oregon canceled its planned Pebble Springs reactor in 1982 following a lengthy siting controversy that made the project less economically attractive. The approval of a State referendum in 1980 banning licensing of new plants until waste disposal technology was available contributed to the utility's decision.

Over the past few years, public concern about reactor safety in reaction to the accident at TMI has encouraged additional NRC safety studies and new regulatory requirements, increasing nuclear power costs and making it less attractive to utilities. (A more detailed analysis of the costs of regulatory requirements is included in ch. 6.) This trend is partially a continuation of increasing public concern about environmental quality that began in the late 1960's. Translated into laws and regulations, those concerns drove up the price of both nuclear and coal-fired powerplants as utilities were required to incorporate more pollution control technology into new and existing plants. Negative public perceptions may also affect the availability of financing for new nuclear plants. The financial problems caused by the accident at TMI discouraged some investors and brokers from investing in utilities with nuclear plants underway, driving up the cost of capital for those utilities. Finally, negative public attitudes affect nuclear power's future in less tangible ways: The most gifted young engineers and technicians may choose other specializations, gradually reducing the quality of nuclear industry personnel. And, utilities simply may not choose nuclear plants if they perceive them as bad for overall public relations.

The future of nuclear power in the United States is very uncertain due to a variety of economic, financial, and regulatory factors outlined in other chapters of this report. Both parties to the nuclear debate are bringing these factors before the broader public. Some may argue that the issues are too complicated for the general public to contend with. However, as Thomas Jefferson said, "When the people are well informed, they can be trusted with their own government. " None of the conditions seen by utilities as a requirement for a revival of the nuclear industry–regulatory stability, rate restructuring, and political support-can be met without greater public acceptance. Thus, unless public opinion toward nuclear power changes, the future prospects for the nuclear industry will remain bleak.

THE EXPERTS' VIEW

In contrast to the public, most "opinion leaders," particularly energy experts, support further development of nuclear power. This support is revealed both in opinion polls and in technical studies of the risks of nuclear power. A March 1982 poll of Congress found 76 percent of members supported expanded use of nuclear power (50. In a survey conducted for Connecticut Mutual Life Insurance Co. in 1980, leaders in religion, business, the military, government, science, education, and law perceived the benefits of nuclear power as greater than the risks (19). Among the categories of leaders surveyed, scientists were particularly supportive of nuclear power. Seventy-four percent of scientists viewed the benefits of nuclear power as greater than risks, compared with only 55 percent of the rest of the public.

In a recent study, a random sample of scientists was asked about nuclear power (62). Of those polled, 53 percent said development should proceed rapidly, 36 percent said development should proceed slowly, and 10 percent would halt development or dismantle plants. When a second group of scientists with particular expertise in energy issues was given the same

choices, 70 percent favored proceeding rapidly and 25 percent favored proceeding slowly with the technology. This second sample included approximately equal numbers of scientists from 71 disciplines, ranging from air pollution to energy policy to thermodynamics. About 10 percent of those polled in this group worked in disciplines directly related to nuclear energy, so that the results might be somewhat biased. Support among both groups of scientists was found to result from concern about the energy crisis and the belief that nuclear power can make a major contribution to national energy needs over the next 20 years. Like scientists, a majority of engineers continued to support nuclear power after the accident at Three Mile Island (69).

Of course, not all opinion leaders are in favor of the current U.S. program of nuclear development. Leaders of the environmental movement have played a major role in the debate about reactor safety and prominent scientists are found on both sides of the debate. A few critics of nuclear power have come from the NRC and the nuclear industry, including three nuclear engineers who left General Electric in order to demonstrate their concerns about safety in 1976. However, the majority of those with the greatest expertise in nuclear energy support its further development.

Analysis of public opinion polls indicates that people's acceptance or rejection of nuclear power is more influenced by their view of reactor safety than by any other issue (57). As discussed above, accidents and events at operating plants have greatly increased public concern about the possibility of a catastrophic accident. Partially in response to that concern, technical experts have conducted a number of studies of the likelihood and consequences of such an accident. However, rather than reassuring the public about nuclear safety, these studies appear to have had the opposite effect. By painting a picture of the possible consequences of an accident, the studies have contributed to people's view of the technology as exceptionally risky, and the debate within the scientific community about the study methodologies and findings has increased public uncertainty.

The Controversy Over Safety Studies

The Atomic Energy Commission (AEC) completed its first major study of the consequences of a reactor accident involving release of radioactivity in 1957. Commonly known as WASH-740, the study was based on a very small (by today's standards) 165-megawatt (MW) hypothetical reactor. In the worst case, an accident at such a plant was estimated to kill 3,400 people (5). While the study itself did not become a source of public controversy, its findings contributed to concern about the impacts of an accident.

In 1964, AEC initiated a new study to update WASH-740 based on a larger, 1,000-MW reactor. The study team found that a worst-case accident could kill as many as 45,000 people but was unable to quantify the probability of such an accident. Rather than publish these disturbing findings, AEC chose to convey the results to Congress in a short letter. Nuclear critics were very disturbed by this action, which they viewed as an attempt to keep the facts away from the public (22). In recent years, awareness of AEC's handling of this early safety study has added to public skepticism about the credibility of both that agency and its successor, the NRC.

In 1974, AEC published the first draft of the Reactor Safety Study, also known as WASH-1400 or the Rasmussen report. A panel of scientists organized by the American Physical Society (APS) found much to criticize in this report. The panel noted that AEC's fatality estimates had considered only deaths during the first 24 hours after an accident, although radioactive cesium released in an accident would remain so for decades, exposing large populations to adverse effects. The most serious forms of illness resulting from a reactor accident, the APS reviewers argued, would be forms of cancer that would not show up until years after the accident. Other APS reviewers found fault with the Rasmussen report's methods used to predict the performance of emergency cooling systems (23).

On October 30, 1975, the NRC, which had assumed the regulatory functions of the former AEC, released the final version of WASH-1400. Again, there was an extensive, widely publicized

debate over the document. The Union of Concerned Scientists released a 150-page report **critiquing the study, and in June 1976,** the House Subcommittee on Energy and Environment held hearings on the validity of the study's findings **(71). As a result of these hearings, NRC agreed to have a review group examine the validity of the study's conclusions.**

Three years later, in September 1978, the review group concluded that although the Reactor Safety Study represented a substantial advance over previous studies and its methodology was basically sound, the actual accident probability estimates were more uncertain than had been assumed in the report (35). The panel also was critical of the executive summary, which failed to reflect all of the study findings. The following January, the NRC accepted the conclusions of the review panel. In a carefully worded statement, the agency withdrew its endorsement of the numerical estimates contained in the executive summary, said that the report's previous peer review within the scientific community had been "inadequate," and agreed with the panel that the disaster probabilities should not be used uncritically (47).

Two studies published in 1982 continued the debate over the validity of accident probability estimates included in the Rasmussen report. The first, conducted by Science Applications, Inc. (SAI) for the NRC, was based on **the** actual operating history of U.S. reactors during the 1969-79 period. By examining the frequency of precursors that could lead to an accident involving core damage or meltdown, SAI estimated that the probability of such an accident during the pre-TMI decade was much greater than suggested by the Rasmussen report (43). In response, the Institute for Nuclear Power Operations (INPO—a nuclear industry safety research group) published a report arguing that SAI's probability estimates were about 30 times too high, and that the actual probability of a core-damaging accident was closer to the 1 in 20,000 reactor years estimated in the Rasmussen report (28). This controversy has not yet been resolved.

While debate over the SAI report was limited to a small community of safety experts, a more recent study aroused a widespread public controversy that continued for several weeks. This analysis, known as the Sandia Siting Study, was initiated to determine the sensitivity of the consequences of reactor accidents to local site characteristics (2). While the Sandia team did not study accident probabilities in depth, they estimated the probability of a "Group 1" or (worst-case) accident involving a core meltdown, failure of all safety systems, and a large radioactive release, at 1 in 100,000 reactor years. The consequences of this and other less severe hypothetical accidents were estimated for 91 U.S. reactor sites using local weather and population data and assuming a standard 1, 120-MW reactor. At the current site of the Salem, N. J., reactor on the Delaware River under the most adverse weather conditions and assuming no evacuation of the local population, a Group 1 accident at the hypothetical reactor was estimated to cause 102,000 "early" deaths within a year of the accident. If the hypothetical reactor were located at Buchanan, N. Y., where the Indian Point plant now stands, a Group 1 accident under the worst-case weather conditions (the accident would be followed by a rainout of the radioactive plume onto a population center) might cause $314 billion in property damage, according to the study estimates.

Although the Sandia report itself did not include estimates of the "worst-case" accident consequences, background information containing the estimates and a copy of the draft report were leaked to the press on November 1, 1982. Media accounts that day highlighted the high death and property damage estimates, while downplaying that part of the analysis which indicated that consequences of this severity had only a 0.0002-percent chance of occurring before 2000 (51). Some accounts suggested that the worst-case **consequences had the same probability as the Group 1 or worst-case accident, which was estimated to have a 2-percent chance of occurring before** the end of the century.

That same day, the NRC held a press conference to clarify the purpose and findings of the study, and on November 2, Sandia National Laboratory issued a statement saying that wire service accounts "seriously misinterpret the consequences of nuclear power reactor accidents. The

probability of a very severe nuclear power reactor accident is many thousands of times lower than stated in these accounts" (63). The nuclear industry took out full-page ads in major national papers to try to counteract the story. At the same time, however, nuclear critics emphasized that the Sandia draft report itself had excluded the worst-case consequence data and argued that "the NRC is once again feeding selective data to the public on the theory that they know best what information the public should have" (73). While nuclear advocates argued that the report's findings on accident consequences had been greatly overstated by the press, critics charged that data were used incorrectly in developing those estimates. Examining the same information on accident probabilities at individual plants used by the Sandia team, the Union of Concerned Scientists found that the likelihood of an accident involving a release of radioactivity might be much greater than assumed in the Sandia report (65). This debate, too, has not been resolved.

The Impact of Risk Assessments on Public Opinion

The release of the Rasmussen report raised particular concerns about nuclear power for some people because of the public disagreements among the "experts" that resulted. In June 1976 hearings held by the House Interior Committee, scientists from the Massachusetts Institute of Technology and Princeton and Stanford Universities, as well as a high-level official of the Environmental Protection Agency, testified about the methodological weaknesses and limitations of the report. Thus, as Princeton physicist Frank Von Hippel pointed out at the hearings, "Instead of dampening the fires of controversy, the publication of the Rasmussen report has had the effect of adding fuel to them" (71).

The controversy over the Rasmussen report, like the rest of the nuclear debate, contains many elements of "disputes among experts" as characterized by sociologist Alan Mazur: arguing past one another instead of responding to what the opposing expert has actually stated; rejecting data that develop the opponent's case; interpreting ambiguous data differently; and, consequently, increasing polarization (41). Both critics and supporters of the study focused on the methodology and quality of data. The debate over the study continues today, with critics arguing that NRC's 1979 statement was a "rejection of the report's basic conclusion," "repudiating the central finding of the Rasmussen report" (23). Meanwhile, INPO challenges the methodology and data of SAI's more recent safety study, arguing that the Rasmussen report's probability estimates are still valid.

Although the general public is uncertain about nuclear power, most people have more faith in scientific "experts" than in any other source on nuclear power questions (20,39,57). Because of this faith, public disputes among scientists and other energy experts, as in the case of the Rasmussen report, have a particularly negative impact on public acceptance of nuclear power. Rather than attempting to follow the debate and sort out the facts for themselves, many people simply conclude that nuclear technology has not yet been perfected. in other words, if the "experts" cannot agree on whether or not nuclear power is safe, the average citizen is likely to assume it is probably unsafe. In Austria, the government attempted to resolve the growing controversy over nuclear power by structuring a series of public debates among scientists with opposing views. Rather than reassuring the public, the debate led to increased public skepticism and ultimately to a national referendum that killed that country's commercial nuclear program.

If public debates about nuclear safety studies have only fueled the fires of controversy and added to public skepticism, what can be done to make nuclear power more acceptable to the public? In order to answer that question, we need a better understanding of the public's perceptions of nuclear power. In particular, it will be useful to compare the public's view of the risks of nuclear energy with the risks estimated by most nuclear experts. For example, if public perceptions of risk were based on misinformation, improved public education programs might be an appropriate response. However, this does not appear to be the case.

FACTORS INFLUENCING THE PUBLIC'S VIEW OF NUCLEAR SAFETY

Perceptions of Risk and Benefit

Studies of risk perception reveal a gap between lay people's judgment of nuclear hazards and the risks estimated by technical risk assessments. In a 1979 study by Decision Research two small groups of informed people in Eugene, Oreg. (college students and members of the League of Women Voters) were asked to compare the benefits and risks of a variety of activities, ranging from smoking to vaccinations to swimming. The benefits of nuclear power were viewed as negligible, and the risks were judged to be almost as great as motor vehicle accidents, which claim about 50,000 lives each year (68).

Although the two groups estimated that the number of deaths from nuclear power in an **average** year would be fewer than the number of deaths from any of the other activities or technologies, they used a very high multiplying factor to indicate how many deaths would occur in a "particularly disastrous" **year. Almost 40 percent of the respondents estimated more than 10,000 fatalities would occur within 1 year, and more than 25 percent** guessed there would be 100,000 fatalities. Many of the respondents expected such a disaster within their lifetimes, while the Sandia study suggests that there is only one U.S. reactor site–Salem, N.J.–at which an accident might cause as many as 100,000 "early" fatalities and estimates that these consequences have only a 10^{-6} or 0.000001 chance of occurring at that site. That analysis suggests that the average American (who does not live near that site) has an even lower probability of being killed within a year of a reactor accident. In general, it appears that public perceptions of the possible **consequences of an accident correspond somewhat with the findings** of the most recent technical studies, but that the **probability of such consequences is greatly overestimated.**

Data from the Netherlands confirm the public's perception of nuclear power as uniquely hazardous. Over 700 adults of varying ages, living at varying distances from industrial activities were asked to judge the "riskiness" of a wide range of activities in 1978 and 1979. Nuclear power was judged to be more risky than most of the other activities and technologies, including drunk driving, transporting chlorine by freight train, and working as a big-city policeman (74).

Several factors appear to enter into people's views of nuclear power as particularly risky. First, respondents in both the Netherlands and Oregon were concerned about the size of a potential accident and the lack of individual control in preventing an accident. In the Oregon study, nuclear risks also were seen as "unknown to the public and to science" and as particularly severe and dreaded. Both the Oregon study and opinion surveys show that about 40 percent of the American public believe that a nuclear plant can explode like an atomic bomb, even though such an explosion is physically impossible. Familiarity also played a role in people's judgments. In the Oregon study, nuclear risks were perceived as greater because they were unfamiliar. Another factor entering into risk perceptions was people's difficulty in assessing the probability of a reactor accident.

People's opinions about nuclear power and other "hazardous" activities and technologies are not determined by perceptions of risk alone. The perceived benefits offered by a technology must be weighed against the perceived risk in determining how acceptable the technology is. Most activities, including development of nuclear power, are undertaken initially in order to achieve benefits, not avoid losses, and for many activities the expected benefits far outweigh the potential losses.

in the case of nuclear power, perceptions of benefit may have played an important role in the trend of public opinion. During the 1950's and 1960's, when electricity demand was growing rapidly, the development of nuclear energy was promoted as a means to meet future demand and there was little apparent opposition to the technology. As electricity demand slowed in the 1970's and 1980's some people may have seen nuclear power as less vital to economic growth, so that concerns about risk became more prom i-

nent in their assessments of the technology. Analysis of recent survey data indicates that judgments of "beneficiality" currently have a strong influence on Americans' acceptance of nuclear power. After safety, the second most important factor in support for nuclear power appears to be the belief that nuclear powerplants are necessary to reduce American reliance on foreign oil (57).

In both the Netherlands and the United States, people living near to nuclear plants have been more receptive to the technology. However, while the Netherlands study appeared to indicate a resigned acceptance of the risks of nuclear power, some surveys in the United States indicate that those living nearby are more aware of the benefits. For example, a majority of people living near Portland General Electric's (PGE's) Trojan Nuclear Station continued to approve of the plant following the accident at TMI in 1979, while customers throughout the entire PGE service territory were ambivalent (7). The primary reason cited for local support of the plant was that it produced needed power. Similarly, residents of the town closest to Maine Yankee nuclear station, who benefit from the jobs and taxes provided by the plant, continued to support the reactor through two statewide referendum votes in 1980 and 1982 which would have shut the plant down. Defeat of the two referendum votes appears to be based primarily on the perception of Maine voters that Maine Yankee provides needed low-cost electricity (see Case Studies).

Despite these favorable local attitudes toward some nuclear plants, opinion polls at other plants show that local support shifted to majority opposition following the accident at Three Mile Island (24). Analysis of survey data at one host community suggests that Federal safety standards are now seen as being too weak. It appears that national events which increase perceived risk can offset local perceptions of benefit.

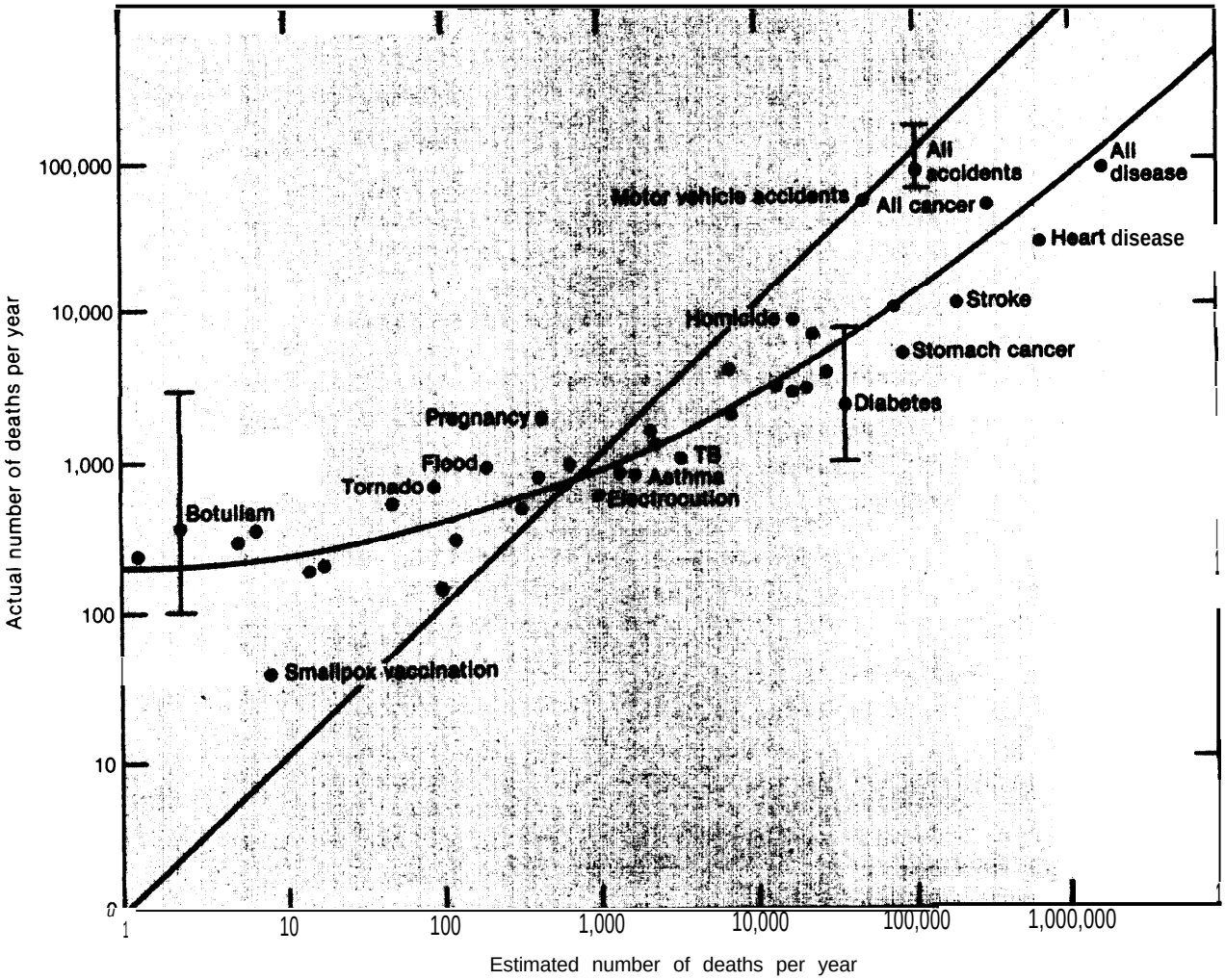
Psychological Factors

The apparent gap between technical studies of nuclear power risks and people's perceptions of those risks has led some observers to suggest that there is little thought involved in the public's view of nuclear power. instead, they argue, people react to nuclear energy on a purely emotional basis. For example, psychiatrist Robert DuPont argues that public concern about nuclear power is a "phobia" resulting from irrational psychological factors (1 7). Geographer Roger Kasperson cites frequently voiced concerns about genetic damage and cancer as evidence of the "emotional roots" of opposition to nuclear power, and psychiatrists Philip Pahner and Roger Lifton have suggested that fears of radiation from nuclear weapons have been "displaced" or "extended" to nuclear power (30,36,55).

Although there can be little doubt that emotional factors enter into the public's assessment of nuclear energy, further analysis of the public's view of risk indicates that the reasoning behind these opinions is more rational than first appears. First, while people may be inaccurate in their assessments of the probability of a catastrophic nuclear accident, they do not appear to overestimate the seriousness of such a catastrophe. Both proponents and opponents of the technology have an equally negative view of the deaths, illnesses and environmental damage that would result from a reactor accident (66). People who are concerned about nuclear safety do not view a radiation-induced death from a nuclear plant accident as significantly worse than a death from other causes, and they do not perceive genetic effects or other non-fatal consequences of such an accident as worse than death. The central area of disagreement between the experts and the concerned public lies in the area of greatest uncertainty even among the experts: the probability and impacts of a major accident (21).

Secondly, lay people appear to rely on somewhat logical internal "rules of thumb" in assessing the magnitude of various risks. As shown in figures 40 and 41 people's assessments of the risks associated with various diseases and technologies correlate fairly well with statistical estimates of the risks. While the **relative riskiness of the various activities was judged somewhat accurately, respondents in the Decision Research study tended to overestimate the risks of low-frequency events. According to the research team, this error results from people's assumption that an event is likely to recur in the future if past instances are easy**

Figure 40.— Relationship Between Judged Frequency and the Actual Number of Deaths per Year for 41 Causes of Death



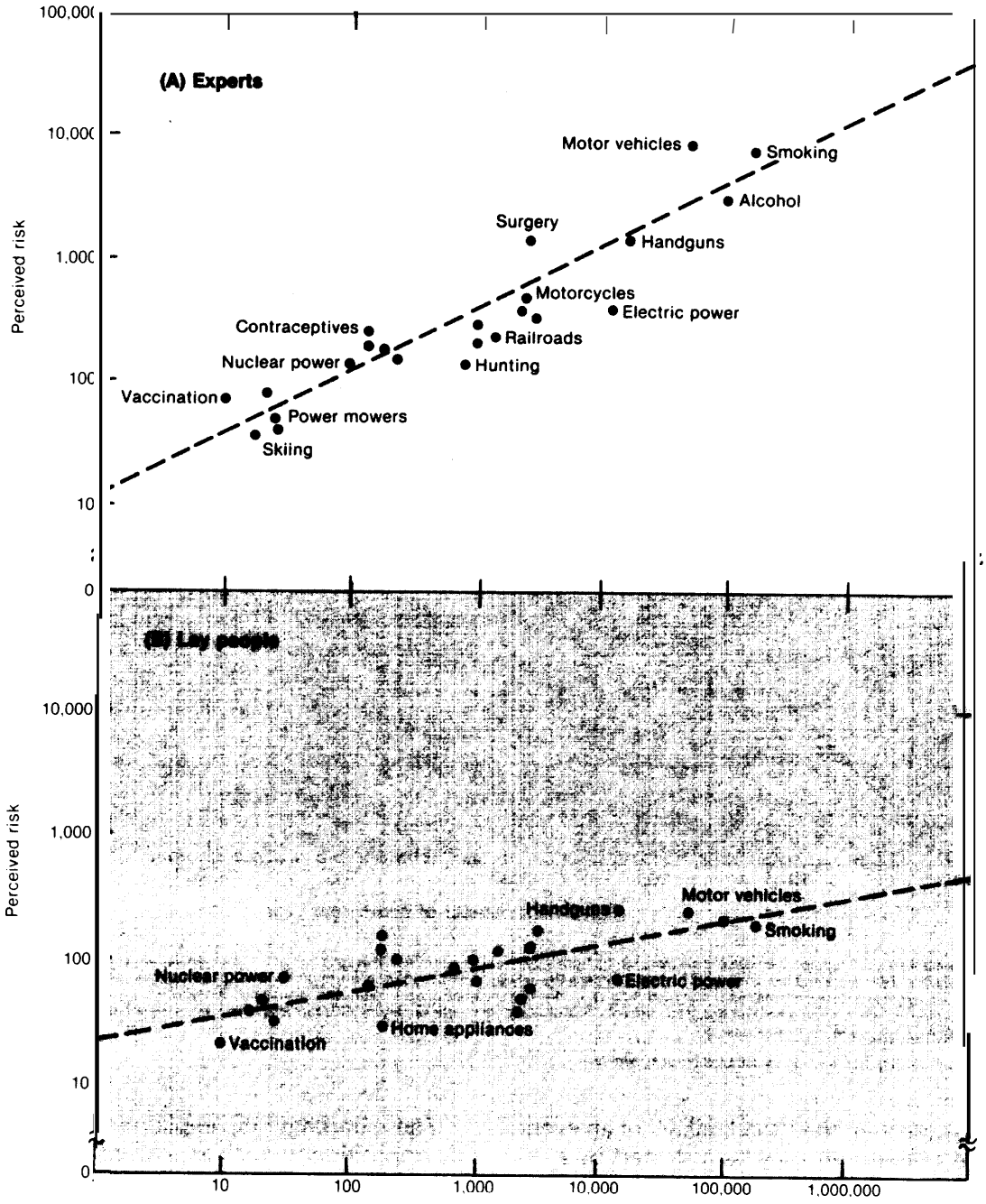
NOTE Respondents were told that about 50,000 people per year die from motor vehicle accidents. If judged and actual frequencies were equal, the data would fall on the straight line. The points and the curve fitted to them represent the averaged responses of a large number of lay people. While people were approximately accurate, their judgments were systematically distorted. To give an idea of the degree of agreement among subjects, vertical bars are drawn to depict the 25th and 75th percentile of individual judgment for botulism, diabetes, and all accidents. Fifty percent of all judgments fall between these limits. The range of responses for the other 37 causes of death was similar.

SOURCE: Slovic, et at. (68). Reproduced by permission of P. Slovic.

to recall. Moreover, the "availability" of an event in people's memories may be distorted by a recent disaster or vivid film. Because life is too short to actually experience all the hazards shown in figures 40 and 41, people tend to focus on dramatic and well-publicized risks and hence to overestimate their probability of occurrence (68).

These findings help explain the increased public opposition to nuclear power reported in opinion polls over the past decade. Nuclear power's historic connections with the vivid, imaginable dangers of nuclear war lead people to associate the technology with catastrophe. Accidents such as the fire at Browns Ferry and the near-meltdown

Figure 41.—Expert and Lay Judgments of Risk Plotted Against Technical Estimates of Annual Fatalities



NOTE: Each point represents the average responses of the participants. The broken lines are the straight lines that best fit the points. If judged and technically estimated frequencies were equal, the data would fall on the solid line. The experts' risk judgments are seen to be more closely asociated with technical estimates of annual fatality rates than are the lay judgments.

SOURCE: Slovic, et al., (68). Reproduced by permission of P. Slovic.

Photo credit: ***William J. Lanouette***

In May 1979, 2 months following the Three Mile Island accident, there was a demonstration of about 200,000 people on the U.S. Capitol Grounds. Speakers urged the U.S. Congress to curtail further nuclear construction

at TMI have added to the image of disaster in people's minds. The publicity surrounding these events, movies and books such as "The China Syndrome" and We *A/most Lost Detroit,* and the estimates of deaths in various safety studies have further enhanced the "availability" of nuclear power hazards in people's minds, creating a false "memory" of a disaster that has never occurred at a commercial nuclear reactor. Public education about nuclear safety systems, by identifying the various hazards those systems are designed to guard against, may only serve to increase the perceived risks of the technology.

The Decision Research analysts also compared lay judgments of risks with the judgments of nationally known professionals in risk assessment (see fig. 41). The judgments of experts were much closer than those of the lay people to statistically calculated estimates of annual fatalities associated with various risky technologies and activities (21). However, while the experts knew more facts, their risk assessments also were found to be greatly influenced by personal judgment. Thus, expert studies also are subject to errors, including overconfidence in results and failure to consider the ways in which humans can affect technological systems. This latter problem was demonstrated clearly during the TMI accident, which was caused in part by human error.

Because technical experts, like the general pub lic, face limitations in evaluating the risks posed by nuclear power, it appears that there may be no single right approach to managing the technology. instead, it is most appropriate to involve the public in order to bring more perspectives and knowledge to bear on the problem. There

are at least two other reasons for involving the public in decisions about nuclear energy. First, without public cooperation, in the form of political support, observance of safety rules, and reasonable use of the court system, nuclear power cannot be managed effectively. Second, as a democracy, we cannot ignore the beliefs and desires of our society's members (2 I).

While public perspectives already are reflected to some extent in NRC decisions, further efforts could be made to involve the public. More research could be conducted to define and quantify public opinion, and dialog with nuclear critics could be expanded with more attention paid to the substance of their concerns. Perhaps the most important step in reducing public fears of nuclear power is improved management of operating reactors to eliminate or greatly reduce accidents and other operating difficulties. Even though accidents at commercial reactors in the United States have never caused a civilian death, the public views both accidents and less serious events at operating reactors as precursors to a catastrophe. An accident with disastrous consequences already is viewed as being much more likely than technical studies and experts project, and any continuation of accidents or operating problems will tend to confirm that perception. Approaches to increasing public acceptance are discussed in the conclusion of this chapter.

VALUES AND KNOWLEDGE

Which is More Important?

Some analysts of public opinion have argued that basic values—those things that people view as most morally desirable—play a relatively small role in influencing people's attitudes toward nuclear power. For example, Mazur has argued that most of the general public, unlike energy activists, do not "embed their positions for or against a technology in a larger ideological framework of social and political beliefs" (41). In addition, nuclear advocates sometimes suggest that it is primarily a lack of knowledge which leads people to oppose nuclear energy, and that better education programs would increase public acceptance (1 3,42). However, as discussed below, the available evidence calls both arguments into question.

Although energy experts who are very knowledgeable about nuclear power generally support the technology, studies of the effects of slightly increased knowledge on attitudes among the broader public have yielded mixed conclusions. Two studies found greater support for nuclear power among more knowledgeable persons, but another found the opposite, and several studies have found no significant relationship (46). For example, a 1979 survey conducted just prior to the TM I accident revealed only a very weak relationship between knowledge about nuclear power and support for the technology among the general public. These findings supported a "selective perception" hypothesis in which those strongly favoring or strongly opposing nuclear energy selected and used information to bolster their arguments. Attitudes toward nuclear power among all respondents were influenced heavily by preexisting political beliefs and values (58). These results could help to explain why the accident at TMI appeared to have little impact on some people's opinions about safety. For those who already were firmly convinced that nuclear power was safe, the accident confirmed the effectiveness of safety systems. For those who were skeptical, it reinforced uncertainties.

A recent analysis of national survey data provides additional evidence that people's values and general orientations may be stronger determinants of nuclear power attitudes than specific knowledge about energy or nuclear power issues. In this study, sociologist Robert Mitchell tested the strength of the correlation between various "irrational" factors—such as belief that a nuclear plant can explode–and people's assessments of reactor safety. While the analysis showed that the public was generally misinformed about energy issues, this lack of knowledge appeared to have little effect on attitudes toward nuclear safety and

hence on overall attitudes toward nuclear power. When Mitchell went onto test the correlation between values and attitudes toward reactor safety, he found a much stronger relationship. Environmentalism was associated closely with concern about nuclear safety among women, while skepticism about whether the future benefits of scientific research would outweigh the resulting problems appeared to have a strong influence on men's concerns about reactor safety (46). Several other studies also indicate that values have played an important role in both the growth of the antinuclear movement and continued support for nuclear power (8,27,32).

Values

A value has been defined as "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferred" (61). While all people share the same values to some degree, each individual places different priorities on different values. This ordering of the absolute values we are taught as children leads to the development of an integrated set of beliefs, or value system. Because values have their origins in culture and society, changes in societal expectations can, over time, lead to changes in an individual's value system.

During the 1960's and 1970's, the emergence of new social movements both reflected and *en*couraged changes in the priority some Americans placed on different values. Values that appeared to become more prominent to many people included equality of all people, environmental beauty, and world peace. Critics of nuclear power (and, to a lesser extent, proponents) were successful in attracting broader public support by appealing to these emerging values, and by linking their organizing efforts with the related peace, feminist, and environmental movements. Until a convincing case is made that nuclear power is at least as consistent with these values as other energy sources, it will have difficulty gaining acceptance with those who place a high priority on these values.

Overall, Americans are very supportive of science and technology, viewing them as the best routes to economic progress (39). The public's enthusiasm is reflected in the current computer boom and in the emergence of a flood of science magazines such as Omni, ***Discover, Science*** 83, and Technology as well as new television programs including "Cosmos," "Life on Earth," and "Nova," and the reliance on high technology by both major political parties. However, this support is tempered by a growing concern about the unwanted byproducts of science, including accelerating social change, the threat of nuclear war, and environmental pollution. The National Opinion Research Center recently compared a national poll of adult attitudes toward science taken in 1979 with a similar survey conducted in 1957. They found that, over the 20-year period, an increasing number of survey respondents believed that "science makes life change too fast" or "breaks down people's ideas of right and wrong." The percentage of respondents who believed that the benefits of science outweigh the harms declined from 88 percent in 1957 to 70 percent in 1979 (46). This curious duality of attitudes may help to explain the public's ambivalent attitude toward nuclear power. While acceptance of the technology has declined, the rate of change has been slow, and votes on referenda have demonstrated that Americans are unwilling to forego the nuclear option entirely.

One of the most undesired products of modern science is the threat of nuclear war. Because of the technological and institutional links between nuclear power and nuclear weapons, opposition to buildup of nuclear weapons leads some people also to oppose development of civilian nuclear energy. AEC, which developed and tested weapons after World War II, was the original promoter of commercial nuclear power. In the late 1950's and early 1960's, growing public concern about radioactive fallout from AEC's atomic bomb testing provided a context for increasing fears about the possibility of radioactive releases from nuclear powerplants. Some prominent scientists spoke out against both nuclear power and nuclear weapons, and links developed between groups opposing the arms race and nuclear power (48). However, after the United States and the Soviet Union signed the Nuclear Test Ban Treaty in 1963, concerns about both nuclear fallout and nuclear power temporarily subsided.

Since the mid-1970's, rapid international development of nuclear power and growing global tensions have led to increasing concern about the possible proliferation of nuclear weapons from nuclear power technologies. Organizers in the peace movement and nuclear critics have built on this concern in an attempt to renew the early linkages between the two movements. Case studies of the Maine Yankee and Diablo Canyon nuclear plants indicate that concern about nuclear weapons contributed to opposition to these plants during the late 1970's and early 1980's (see Case Studies).

Today, a single Federal agency–the Department of Energy—still is responsible for research and development of both nuclear weapons and commercial nuclear power. in addition, some private firms are involved in both nuclear energy and nuclear weapons. These connections encourage a linkage in people's minds between the peaceful and destructive uses of nuclear energy. Due to growing concern about the rapid buildup of nuclear weapons, some groups critical of nuclear energy are shifting resources toward weapons issues. However, most local groups and national organizations continue their efforts to improve the safety of nuclear power as they expand their focus to include nuclear weapons. The linkages between environmental and energy groups and anti-nuclear weapons groups may strengthen the environmental groups and help them maintain their criticism of commercial nuclear power (33).

On the pronuclear side of the debate, organizers have emphasized the importance of nuclear power to national energy independence which is in turn linked with national security. Analysis of 10 years of public opinion polls indicates that a view of nuclear power as an abundant American resource which could reduce foreign oil dependence is a very important factor in favoring continued development of nuclear power (57).

One of the most important values to affect opinions on nuclear power is environmentalism. A 1972 poll by Louis Harris&Associates indicated that many Americans believed that the greatest problem created by science and technology was pollution (46). Polls taken in 1981 indicate that most Americans continue to strongly support environmental laws despite recessions and an increasing skepticism about the need for government regulation of business (4).

The role of the environmental movement in coalescing and leading the criticism of nuclear power has been well-documented. The first national anti-nuclear coalition (National Interveners, formed in 1972) was composed of local environmental action groups (40). By 1976, consumer advocate Ralph Nader, who later became allied with the environmental movement "stood as the titular head of opposition to nuclear energy" (30). Today, all of the major national environmental groups are opposed to at least some aspects of the current path of nuclear power development in the United States. While some of the groups do not have an official policy opposing nuclear power, their staffs stay in close communication, and there is substantial cooperation and support on nuclear energy issues (33). A list of these groups is shown in table 32.

Both sides of the nuclear debate have emphasized environmental concerns to influence public opinion. in the late 1960's and early 1 970's, opponents of local nuclear plants most frequently pointed to specific environmental impacts, such as thermal pollution, low-level radiation, or disruption of a rural lifestyle as reasons for their opposition. During that same period, nuclear proponents increasingly emphasized the air-quality benefits of nuclear power when compared with coal (41). Today, environmentalist opponents of nuclear power are more concerned about broad, generic issues such as waste disposal, plant safety, weapons proliferation, and "a set of troublesome value questions about high technology, growth, and civilization" (30). This evolution of concerns is demonstrated in two case studies of local opposition to nuclear plants. In these cases, environmentalists at first did not oppose the local nuclear plant because it offered environmental benefits when compared with a coal plant. However, those positions were later reversed (see Case Studies).

Along with environmentalism, people's general orientations toward economic growth appear to influence their attitudes about nuclear power. In

1971, political scientist Ronald Inglehart identified a shift in the value systems of many Americans away from a "materialist" emphasis on physical sustenance and safety and toward "post-materialist" priorities of belonging, self-expression, and the quality of life. At that time, he hypothesized that this shift could be attributed to the unprecedented levels of economic and physical security that prevailed during the 1950's and 1960's. Based on analysis of more recent surveys, Inglehart argued in **1981 that, despite economic uncertainty and deterioration of East-West detente, post-materialist values are still important to many Americans. And, he says, those who place a high priority on post-materialist values "form the core of the opposition to nuclear power" (27).**

Like Inglehart, psychologist David Buss and his colleagues have observed two conflicting value systems or "worldviews" among Americans (71). Using in-depth interviews with a random sample of adults from the San Francisco area, they identified "Worldview A" which favors development of nuclear power as an important component of a high-growth, high-technology, free enterprise society, and "Worldview B" which includes concern about the risks of nuclear power along with an emphasis on a leveling off of material and technological growth, human self-realization, and participatory decisionmaking.

While different priorities within Americans' value systems appear to influence attitudes toward nuclear power, it is important to recognize that the public is not completely polarized. Inglehart noted that "post-materialist" values can only be given priority when basic human needs are met, making both priorities essential to individuals and to American society (27). An extensive national survey of attitudes toward growth conducted in 1982 indicates that the public may be developing a new perspective that includes **both** a desire to ensure opportunities for development and concerns about environmental quality (60). In this survey, few respondents could be classified as totally favoring either resource preservation or resource utilization, and the majority appeared to be quite balanced in their views on economic growth. Those who leaned toward resource preservation were more opposed to nuclear power than those who favored resource utilization. **However, even among those who most strongly supported resource utilization, so percent indicated that** no more nuclear powerplants should be built.

Views about "appropriate technology" as defined by the British economist, E. F. Schumacher, may also affect attitudes toward nuclear energy. Most members of mainstream environmental groups share this view, which endorses technologies that are inexpensive, suitable for small-scale application, and compatible with people's need for creativity (44,64). In 1976, Amory Lovins brought nuclear energy into the middle of this technology debate with publication of his article, "Energy Strategy: The Road Not Taken" in ***Foreign Affairs*** magazine. In that article, Lovins argued that America's energy needs could be met by the "soft energy path" of conservation, renewable energy and other appropriate technologies, and rejected nuclear energy as unneeded, centralizing, and environmentally destructive (37). These concerns were found important in the local opposition to one case study plant (see Case Studies). Residents of that rural area at first objected to the plant on the basis that its electricity was not needed locally, and that the locality should not have to bear the impacts of plant construction when it would not reap the benefits. Later objections were based on the contention that the electricity produced would not be needed anywhere in the surrounding three States.

Advocates of the appropriate technology philosophy fear that increased use of nuclear power will lead to a loss of civil liberties and individual freedom, and decreased world stability due to weapons proliferation. The extent to which these views have been accepted by the American public is difficult to ascertain. National opinion polls showing that the majority of Americans prefer solar energy to all other energy sources and view nuclear power as the least-favored energy option would appear to reflect such values (57). A recent survey conducted in the State of Washington shows that large majorities there share Lovins' view that it is possible to have **both** economic growth and energy conservation (54). In addition, many people, even those skeptical of renewable energy, share Lovins' distrust of large centralized organizations (utilities and the government) that promote nuclear energy.

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Another shift in American value systems that may help to account for increased opposition to nuclear power is a growing distrust of institutions and their leaders in both the public and private sectors. The Vietnam War and the Watergate investigation contributed to growing public cynicism about the Federal Government during the 1960's and 1970's. By 1980, an extensive survey of Americans revealed a dramatic gap between the public and leaders in both government and industry on questions of politics, morality, and the family. Religious values were found to be of profound importance to the majority of Americans, and respondents indicated that they placed a greater emphasis than before on the moral aspects of public issues and leadership (59).

Some early supporters of nuclear power, including prominent environmentalists, felt betrayed by the nuclear establishment when new information about the uncertainties of the technology became known. The nuclear industry's early denials of the possibility of accidents, and the Government's handling of safety studies have contributed to the critics' and broader public's skepticism. Some critics have expanded their activities from examination of technical safety issues to include critiquing the nuclear regulatory process, and groups that formerly were concerned primarily with "watch dogging' Federal agencies have entered the nuclear debate. These activities, and Daniel Ford's recent book, The ***Cult of the Atom,*** which focuses primarily on regulatory "misdeeds" in the early nuclear program, may contribute to the public's disillusionment with government in general and the NRC in particular.

The American public's growing concern with leadership applies to business as well as government. Americans increasingly are skeptical of the ability of both the public and private sectors to produce quality work. According to Loyola University professor of business ethics Thomas Donaldson, survey data indicate that, despite an improving corporate record, the public has become increasingly disappointed with corporate ethics over the past 20 years. Corporations now are viewed as "part of the overall social fabric that relates to our quality of life," not merely as providers of goods and services (1 5).

This growing skepticism about industry and government was reinforced by the accident at Three Mile Island. Post-TMl polls indicate that less than half of the public were satisfied with the way the accident was handled by Pennsylvania State officials and the NRC, and Americans were even less pleased with the utility (General Public Utilities) and the plant designer (57). One observer has described public reaction to the accident as "essentially a crisis in confidence over institutions" (30). A feeling that the nuclear utility was being dishonest helped spark the first referendum to shut down Maine Yankee, and events at Diablo Canyon led to nationwide doubts about the credibility of the nuclear industry (see Case Studies).

A final societal change that has been closely intertwined with negative attitudes toward nuclear power is the growth of the women's movement. Public opinion polls over the past 20 years have shown a strong correlation between gender and attitudes toward nuclear power: Women are consistently more opposed (41). While the strength of this correlation is well-known, the reasons for it are not clear. Environmental values and having young children have been linked with women's opposition to nuclear power (46). Sociologist Dorothy Nelkin argues that women's distrust of nuclear power cannot be attributed to a greater aversion to risk **in general.** Instead, Nelkin's analysis of women's magazines and the feminist press suggests that women's opposition begins with the specific risk of cancer in the event of a major radioactive release from a reactor. personal value priorities, including some women's view of themselves as nurturers or "caretakers of life, " also lead them to oppose what they view as a life-threatening technology (49).

These connections have helped to bring nuclear power as an issue into the mainstream of the women's movement. Women's magazines ranging from Redbook to ***Ladies Home Journal*** to ***Ms.*** have questioned nuclear safety, and the national Young Women's Christian Association (YWCA) took a public stand against nuclear power in 1979. The League of Women Voters has developed a national policy favoring only limited construction of new reactors, and the League's local affiliates have taken even stronger anti-

nuclear stands. In 1980, the National Organization for Women (NOW) recommended a resolution opposing the "use of nuclear power in favor of safer energy methods" (49).

While changing value priorities appear to have contributed to increasing public concern about nuclear power over the past 20 years, those priorities could change again in the future. In addition to values, knowledge about accidents at nuclear plants has played a major role in shaping public attitudes. In the future, new information on improved management of nuclear power could lead to a reversal of the current trend of increasing opposition to the technology.

THE ROLE OF THE MEDIA

Both the amount and type of news coverage have played an important role in shaping public attitudes toward nuclear power. As noted previously, people tend to overestimate the probability of certain hazards, including nuclear powerplant accidents, in part because these hazards are discussed frequently in the media.

The Extent of Media Coverage of Nuclear Power

The most detailed analysis of print media coverage of nuclear power currently available is based on the number of articles on the subject indexed in the yearly Readers' Guide to ***Periodical Literature.*** In this study, sociologist Al Ian Mazur compared trends in media attention with trends in public opinion as revealed by national opinion surveys, numbers of plant interventions, and size of protests. This analysis suggested the following three hypotheses (41):

1. The greater the **national concern over a major issue** that is complementary to a particular protest movement, the more easily resources can be mobilized for the movement, and therefore the greater the **activity of protesters.**
2. As the **activity of protesters increases, mass media coverage of the controversy** increases.
3. As **mass media coverage** of the controversy increases, the **general public's opposition** to the technology increases.

At the time of the first citizen intervention against a nuclear plant in 1956, there was a great deal of positive mass media coverage of president Eisenhower's "Atoms for Peace" program. In the early 1960's, most coverage was still positive, but a few protests against local plants—particularly the large demonstration at a proposed nuclear plant site on Bodega Bay, Calif., in 1963–received national publicity. During the mid-1 960's, there was a decrease in both the number of periodical articles on nuclear power and in public opposition as measured in opinion polls. This decline reflected a shift in public concern and media attention away from nuclear issues and toward civil rights and other domestic issues. Beginning in 1968, magazine articles on nuclear power increased to cover local plant siting disputes. Print media coverage rose even higher in 1969, and opinion polls showed a similar peak of opposition the following year.

From 1974 to 1976, anti-nuclear activism and media coverage again increased, with a great deal of national publicity given to the 1976 California referendum. After 1976, both negative public opinion and media coverage fell off, then rose slightly in 1978 and early 1979 and finally rose massively following the accident at TMI in the spring of 1979. Trends throughout 1979 appeared to confirm the linkage between media coverage and public opinion: Public opposition rose sharply immediately following the accident, subsided within 2 months as media attention diminished, and then increased slightly during October and November, coinciding with media coverage of the final Kemeny Commission report **(41).**

Mazur argues that opposition to a technology such as nuclear power will snowball with increased media coverage, whether that coverage is positive or negative (40). The fluoridation controversy of the 1950's and 1960's, like the cur-

Photo credit: Washington Public Power System

A crowd of about 10,000 people protest the mothballing of Nuclear Power Plant No.1 of the Washington Public Power System

rent nuclear power debate, involved complex scientific judgments and pitted the "established order" against advocates of local self-control. During this period of public debate, persons exposed to both positive and negative arguments about fluoridation were more likely to oppose the practice than persons who had heard neither argument, and communities where there had been heated debate were most likely to defeat fluoridation in a referendum. The prominence given to disputes between technical experts over the risks of a technology appears to create uncertainty in people's minds, which in turn raises concern and opposition, regardless of the facts under discussion. If this is true, the media play a key role in encouraging public opposition by giving extensive coverage to the experts' disputes.

Analysis of the extent of **television** news coverage of nuclear power has been much more limited than analysis of print media coverage. Television nightly newscasts made relatively little mention of nuclear power over the decade preceding the accident at TMI. Within the overall low level of reporting, the trends were somewhat similar to those in the print media: Coverage increased in 1970, and then dropped off again until 1976, with greater coverage between 1976 and 1979 *(70).*

The Content of Media Coverage

Just as there can be little doubt that media coverage influences public opinions toward nuclear power, there also is little doubt that jour-

nalists, like most Americans, are ambivalent about this technology. In a 1980 survey, similar percentages of media personnel and the public (about 55 percent) viewed the benefits of nuclear power as greater than the risks, while other "leadership groups" were much more supportive of nuclear energy (59). In another study, attitudes toward nuclear power were measured on a scale ranging from -9 to +9, with a higher score indicating greater support for nuclear power. While scientists were quite supportive of the technology with an average score of 3.34, science journalists were much more skeptical, with an average score of 1.30, and journalists reporting on general issues for major national newspapers *were* slightly less supportive of nuclear power than science journalists, with an average score of 1.16 (62).

Following the accident at TMI, the Kemeny Commission found that the public's right to information had been poorly served. Confusion and uncertainty among the sources of information combined with a lack of technical understanding by the media personnel were identified as contributing to the problem. Many of the reporters "did not have sufficient scientific and technical background to understand thoroughly what they heard." As a result of these difficulties in reporting on emergencies, the commission recommended that all major media outlets hire and train nuclear energy specialists and that reporters educate themselves about the uncertainties and probabilities expressed by various sources of information (31).

The media's need for balance in coverage of many issues, including nuclear power may lead to understatement of the scientific consensus that the technology is acceptably safe. Media personnel are expected to bring various viewpoints before the public, and in the case of a controversial technology such as nuclear power, this generally means quoting both an advocate and a critic in any given story. One analysis of television news coverage showed that over the decade prior to Three Mile Island, most news stories dealing with nuclear power began and ended with "neutral" statements (70). However, among the "outside experts" appearing most frequently in the stories, 7 out of 10 were critics of nuclear power. Thus, while meeting the requirement of presenting opposing views, these stories may have oversimplified complex issues and failed to convey the prevailing consensus among scientists and energy experts. Psychiatrist Robert DuPont, after viewing the same 10 years of television stories used in this analysis, suggested that fear, especially of nuclear accidents, was the underlying motif in all of the stories (16). Another study of 6 years of television news stories about various energy sources found that the risks and problems of nuclear power were emphasized, coal was given neutral treatment, and solar power was treated euphorically (56).

While these studies suggest that television coverage of nuclear power emphasizes the risks of the technology, there is no evidence that media personnel deliberately bias their coverage of nuclear power due to personal convictions. The Kemeny Commission found that overall coverage of the TMI accident was balanced although at times confused and inaccurate. One of the biggest factors in inaccurate reporting at TMI was found to be the lack of reliable information available to the media. For example, national reports that the hydrogen bubble inside the reactor could explode within 2 days were an accurate reflection of the views of NRC's Washington office. Reporters, trusting these views and wanting to "scoop" other reporters, tended to disregard the onsite NRC officials who argued that the bubble could not possibly explode. However, overall, the Commission found a larger proportion of reassuring than alarming statements in both television and newspaper reporting of the accident.

Media coverage of nuclear power maybe influenced by the fact that journalists are trained to be skeptical of news sources, including the nuclear establishment. Informed critics have been successful in publicizing many cases in which the nuclear industry, the Department of Energy, and the NRC have not been completely open about safety problems. For example, during the first 2 days of the accident at Three Mile Island, Metropolitan Edison withheld information on the situation from State and Federal officials as well as the news media *(72).* According to the Kemeny Commission, the utility's handling of information during this period "resulted in the loss of its credibility as an information source" (31). Experiences

such as this have led reporters to be particularly skeptical of nuclear industry sources and look to the critics for the other side of any given story.

Proponents of nuclear power are likely to view media treatment of nuclear plant safety issues as biased because of the inherent complexity of those issues. It is important that problems such as construction errors, skyrocketing costs, and operating difficulties be reported to the public. However, since few people (including reporters) understand nuclear technology well, problems may appear more threatening than they actually are. Considerable expertise is needed to sift the facts and accurately interpret them to the public. By comparison, the media are not considered anti-airplane, even though most coverage of that industry focuses on crashes. Because the public is unlikely to view a single plane crash as an indication that the entire airline industry is unsafe, the airline industry is confident that all airplanes will not be grounded. With no such assurances for nuclear power, the nuclear industry may view coverage of accidents as a threat to its survival.

Finally, it is important to note that journalists did not create the nuclear controversy. During periods of greatest public concern, their coverage of nuclear power has increased, which in turn has contributed to still greater public uncertainty. If the media are more critical of nuclear power now than they were in the 1950's, they may be reflecting public opinion as well as influencing it.

WHAT WOULD IT TAKE TO INCREASE PUBLIC ACCEPTANCE OF NUCLEAR POWER?

It is unlikely that utility executives will order any new reactors as long as they believe that a majority of their customers oppose nuclear energy. However, a societal consensus on the necessity for and benefits of the technology may be very difficult or impossible to attain. The previous analysis indicated that the general public and the staffs of some public interest groups are concerned about the possibility of a catastrophic reactor accident. They perceive that the technology offers few or no benefits compared to these risks. In addition, many Americans' personal values contribute to their skepticism of the technology and its managers. These value conflicts may prevent a total resolution of the current controversy. However, attitudes might change either as a result of external events (e.g., another oil embargo or new research findings on the environmental impacts of coal burning) or because of improvements made internally by government and the nuclear industry. External events cannot be controlled, but it is up to the nuclear establishment to demonstrate the safety and economic attractiveness of nuclear power.

Assuming that major improvements were made in management of nuclear power, it would still be difficult to communicate them to the public because of the present lack of trust in government and industry. There are some extremists on both sides of the nuclear controversy whose opinions will not change, regardless of the evidence placed before them. Even more moderate citizens, who are willing to change their opinion on the basis of new evidence, are influenced strongly by preexisting attitudes and values so that they may "filter out" or wrongly interpret new evidence. Finally, for the majority of the public, new information on improvements in utility management of nuclear power will be viewed skeptically unless presented in a manner that arouses trust and interest. However, while better communications are needed, the first and most important step is to make concrete improvements responding to public concerns.

Enhance Nuclear Advantages

Research conducted in the United States and the Netherlands suggests that people's judgment of a technology or activity is influenced as much by their assessment of its potential benefits as by their view of its risks. There are at least three potential benefits of nuclear power that could be perceived by the public: 1) its contribution to na-

Photo credit: William J. Lanouette

Protectors' tent at a demonstration against the Seabrook nuclear plant in May 1977

tional energy and electricity supply, 2) its potential cost advantage relative to other energy options, and 3) the fact that safely operated nuclear plants produce no fossil air pollution.

It is difficult for many Americans to see a need for nuclear powerplants at a time when electricity demand has slowed. While this slow growth is expected to continue over the next several years, new powerplants of some kind still will be needed in the years ahead. Regions experiencing rapid economic and population growth will need new capacity sooner than others. Plans could be developed at a regional level to evaluate the alternatives to meet demand growth. The planning process itself could become a vehicle for public participation, and any long-term cost advantages of nuclear power could be most clearly demonstrated to the public this way.

Under some conditions, nuclear electricity *can* be cheaper than its major competitor: electricity from coal combustion. Standardized plant designs, increased predictability in the licensing process, and improved management of operating reactors all could help to realize the technology's economic potential. New rate regulation systems also could be used to reduce the initial costs of new nuclear and coal powerplants to the consumer. Assuming all of these changes took place and nuclear electricity did indeed offer long-term cost advantages, public opposition to new plants in hearings before State PUCs very likely would be reduced.

However, coal is not the only alternative to nuclear power in meeting national energy needs. Conservation, oil shale, and renewable energy resources all can be used to match energy sup-

ply and demand but widespread application of these technologies could be expensive. In Maine, public rejection of a 1982 referendum to shut down Maine Yankee was based in part on recognition that conservation and renewable energy could not quickly make up for the inexpensive nuclear power lost by the shutdown (see Case Studies).

Paradoxically, accelerated R&D on these alternatives might enhance the image of nuclear power and could confirm that they may never be widely competitive. As part of accelerated R&D on alternative energy sources, the environmental costs and benefits of each source should be examined. Environmental groups currently are among the leading critics of nuclear power. These groups also are very concerned about the adverse impacts of coal combustion and other energy sources, and are monitoring research into those impacts. If this research indicated that acid rain was a more serious problem than presently perceived or that carbon dioxide buildup would result in near-term climatic changes, some environmentalists might become less negative about nuclear relative to coal. This shift, in turn, could change attitudes among the broader public.

Public relations or educational programs are unlikely to increase public awareness of nuclear power's potential benefits until those benefits are apparent. This might result either from events outside the industry's control which decrease availability of alternative energy sources (e.g., an oil disruption) or from improvements in management of the technology. Without such actions, public relations programs such as the current Committee for Energy Awareness campaign may have little impact, and possibly even a detrimental effect on public opinion. The response to this campaign from critics may increase public uncertainty and skepticism. Even programs viewed as unbiased by all sides, such as the League of Women Voters Education Fund's (LWVEF) "Nuclear Energy Education Program" carried out in 1980 and 1981, may do little to increase public acceptance until the costs of new nuclear powerplants are better controlled (34). Nevertheless, the low level of public understanding of nuclear technology does indicate a need for more information, and a number of organizations are involved in public awareness campaigns.

Reduce Concerns Over Nuclear Accidents

While increased awareness of nuclear power's benefits might decrease concerns about risk, one of the most favorable things that could happen to the nuclear industry over the next 10 years would be an increasing output of nuclear electricity along with an absence of events causing bad publicity. Presently, both TMI-type accidents and incidents such as the failure of the safety control system at the Salem, N. J., plant are viewed by the public as precursors to a catastrophe. Given the slow rate at which public support for nuclear power has declined, an extended period of quiet, trouble-free operations could have very positive impacts on public attitudes. Chapter 5 identifies a number of approaches to improved utility management of nuclear power, which, if implemented, could help to assure that neither major accidents nor precursors take place.

While a period of uneventful operation of nuclear plants is necessary to restore public confidence, it probably is not sufficient. Maine Yankee has had very high reliability but State voters have twice come close to shutting it down (see Case Studies). In addition, critics probably would remain skeptical. It would be important to demonstrate to them that the period of quiet operation was a result of real improvements and the beginning of a new trend, rather than just luck. However, given the present level of distrust between interveners, the NRC, and the nuclear industry, it might be very difficult to do this.

Several steps could be taken to improve communications between the nuclear community and public interest groups critical of nuclear power. An effort might be made to identify the concerns of particular groups and respond to the substance of those concerns. For example, some groups currently are concerned about insurance. A compromise on this issue might not decrease the groups' fundamental criticism of nuclear safety, but it could improve the climate and allow further negotiations to take place. If the current heated debate could become a reasoned ongo-

ing dialog, the public might be less likely to view the technology as unsafe. As discussed previously, the prominence and stridency of the debate currently increases public uncertainty and encourages opposition.

As part of this effort, the Federal Government could actively encourage involvement of responsible interveners in both regulatory proceedings and long-range planning efforts through funding and other support. In Ontario, Canada, the independent Porter Commission funded knowledgeable nuclear critics to conduct studies and participate in extensive hearings as part of its long-term electricity planning. In the Commission's interim report, health problems caused by improper disposal of uranium mine tailings were identified, and environmental groups were acknowledged for bringing the issue to the public's attention. Similarly, based on testimony from leading critics, the commission found that the probability of a loss of coolant accident causing a meltdown at Ontario Hydro's heavy water reactors was much greater than the Canadian nuclear industry had claimed. Because the Commission not only sought critics' concerns but also acknowledged and responded to them, the process had the effect of moderating some groups' antinuclear positions (see vol. **II).**

Previous U.S. efforts to involve government, industry, and environmentalists in dialog or "environmental mediation" provide another model for improved communication. Nonprofit organizations such as the Conservation Foundation in Washington, D. C., as well as several private firms have brought all three parties together to discuss topics such as radioactive waste disposal and chemical waste management. By careful staff preparation and beginning the discussions with a common objective (e.g., safe disposal of toxic wastes), these forums have succeeded in developing preliminary agreements on Federal and industry policy.

Nuclear regulators and the industry can increase their credibility with both interveners and the public by emphasizing candor in their public information programs. Prior to the accident at Three Mile Island, the nuclear establishment created the impression that such an accident was so unlikely as to be "impossible." As a result, when the accident did happen, it greatly reduced the credibility of the regulators and the industry. The nuclear establishment should acknowledge that both operating events and more serious accidents can occur, attempt to educate the public about the difference between the two, and demonstrate its preparedness to deal with accidents. For example, TVA immediately reports to the media any event that could be considered newsworthy. This very open approach increases the utility's credibility with both the media and the public. Another positive example is offered by a Midwestern utility that encountered quality-assurance problems during construction. Once the company had greatly increased its construction management capabilities, it launched a public relations effort to educate the public about the problems and the steps it had taken to overcome them. These efforts appear to have increased local trust in the utility. (See Case Studies.)

Two approaches to siting policy might help alleviate the public's safety concerns. Both respond to the public's opposition to construction of new plants near where they live. First, as discussed earlier, some people living near nuclear plants tend to view them as less risky than people who are less familiar with the technology. While some polls show increasing opposition to nearby plants since the accident at Three Mile Island, support for other plants has remained high. This fact has led Alvin Weinberg and others to promote a "confined siting" policy, under which most new reactors would be added to existing sites, rather than creating new sites. This approach has been used successfully in Canada (see vol. Ii) and is supported by some U.S. environmental groups. It is most attractive in the East, where high population density makes remote siting infeasible.

The second approach to dealing with local opposition to new construction is to site new reactors at remote locations. This approach could incorporate "confined siting, " with new reactors clustered at existing remote sites. Alternatively, new sites in remote areas could be identified. In either case, public opposition to such plants could be expected to be much less than opposi-

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tion to new plants in densely populated areas. Opinion polls show that the majority of the public favors remote siting of reactors, and the potential impacts of a major accident would be reduced greatly by this approach. However, the costs of transferring the power to load centers would be much greater, and construction in remote areas might lead to adverse "boomtown" effects on nearby communities.

Public fears of a nuclear accident also might be reduced by controlling the rate of new plant construction. Nuclear critics, fearing the impacts of potential accidents and the possibility of a centralized, undemocratic "nuclear state," base their opposition in part on the rapid scaling up in size and number of reactors in the 1960's and 1970's and on the industry's early projections of a "plutonium economy." These concerns might diminish if the nuclear program were bounded. Some within the nuclear industry also favor a definition of the size of the plant construction program as a guarantee of Federal support for nuclear energy. However, if this definition of size were viewed as an absolute limit on the program, rather than a target to be reached, the public might view it as an indication of Government skepticism of nuclear power. A less drastic alternative would be to limit the **rate** of growth in total nuclear capacity by limiting the number of new construction permits granted in any one year. Current demand projections indicate that rapid growth of nuclear power is unlikely for many years, but a limit might provide reassurance to those who feel the only choices are to eliminate the option now or forever risk an uncontrolled resurgence.

After years of debate, Sweden passed a referendum in 1980 calling for completion of the 12 nuclear-generating units then under construction or planned, with a phaseout after 25 years (the expected lifetime of the plants). While this com-

promise might seem to offer little future for nuclear power, it did allow construction of six new nuclear plants, with the result that over half the country's electricity is now nuclear. In the United States, a compromise under which regulators and nuclear critics agreed to encourage completion and operation of units currently under construction or planned might be preferable to the current impasse, especially in terms of financial return to investors. It has been suggested that Americans might reach consensus on a 150-gigawatt nuclear program (29). Similarly, the advocacy arm of the League of Women Voters has adopted a national policy calling for a continuation of nuclear power in its current percentage of national energy supply. As energy and electricity demand grow in the future, this policy would allow some growth in the nuclear program. Any such compromise or cap would have to allow for adjustments as nuclear and competing technologies are improved and economics change. In addition, regional differences in the United States might make a State-by-State approach more feasible than a national referendum as in Sweden.

While all of the approaches discussed above might decrease public concerns about current reactors, it is possible that public skepticism about the technology is so great that these changes would have little impact. In this case, other reactor concepts with inherent safety features might be considered. Several alternatives, such as the high temperature gas-cooled reactor (HTGR), the heavy water reactor (HWR), and an improved light water reactor (the PIUS reactor) are discussed in chapter 4. A substantial federally funded R&D effort on one or more of these alternatives might meet with public acceptance, particularly if demand for power picks up over the next two decades. The inherent safety features of the chosen design might appeal to the general public and the choice of design could be used as a vehicle for much greater involvement of nuclear critics. By bringing critics into the R&D program and addressing their specific concerns, consensus might be reached on an acceptable design for future reactors.

Minimize Linkage Between Nuclear Power and Weapons

Another issue that should be addressed in policy decisions about nuclear power is the connection between weapons development and civilian nuclear energy. Given the level of national concern over the arms race, public acceptance of nuclear power cannot be expected to increase substantially until the two nuclear technologies are separated in people's minds. This report has not analyzed the impact of policies that might minimize the linkages between nuclear weapons and power, but the effect on public opinion could be positive. For example, one action that might increase public acceptance by reducing the perceived linkages would be to remove nuclear weapons development from the jurisdiction of the Department of Energy. Another step would be to legislate a ban on commercial fuel reprocessing. Many critics are more concerned about reprocessing than about reactors because plutonium separated from the spent fuel might be stolen and used to construct a bomb or to threaten the public. A legislated moratorium on reprocessing might have greater impact on these concerns than the executive orders imposed by Presidents Ford and Carter that were later revoked by President Reagan. Such a ban might be especially effective if imposed in conjunction with limits on the total growth of the program, as discussed above. In addition, it might be best to keep industry and military waste disposal strictly separate, although some public interest groups support joint disposal, because it encourages action on military waste that has been allowed to accumulate for 40 years (53).

Policy makers also could take action to reduce the possibility of weapons proliferation through careful management of international nuclear power development. A previous OTA analysis identified weaknesses in the existing international nonproliferation regime (52). Recognizing the impact these weaknesses have on public perceptions of nuclear power, Alvin Weinberg has argued, "We must strengthen the Nonproliferation Treaty (NPT) regime and take the next steps,

which involve both a reduction in nuclear armaments and a strengthening of the sanctions that can be imposed on those who would violate the NPT" (75).

The link between nuclear weapons and nuclear power also might be reduced in people's minds if more proponents of nuclear power who oppose the continued buildup of nuclear weapons stated their beliefs publicly. For example, Hans Bethe, a prominent nuclear physicist who has been active in the arms control movement and supportive of civilian nuclear power, reaches an audience who might otherwise reject nuclear power along with weapons (48).

In conclusion, current public attitudes toward nuclear power pose complex problems for the nuclear industry and policy makers. However, technical and institutional steps could be taken that might lead the public to view nuclear power as an important and attractive energy source in the years ahead. Constructive leadership and imagination will be required to start this process.

CASE STUDY 1

Maine Yankee: Economics as the Key to Public Support

Despite an excellent operating record, Maine Yankee has become the focus of statewide opposition to nuclear power.[1] However, based on the plant's economic benefits, the voters of Maine twice have rejected proposals to bring its operations to a complete halt. Maine Yankee is owned and operated by the Maine Yankee Atomic Power Co., a consortium of utilities including Central Maine Power (the largest owner). Completed in 1972, the 840-MW plant is located on Montsweag Bay on the south-central Maine coast.

Initial local reaction to Maine Yankee was overwhelmingly positive, based on the construction jobs and tax revenues the plant would bring. Residents of Wiscassett (then around 1,200 people), within whose borders the plant was to be located, generally supported the plant. A few local environmental groups raised questions about emergency evacuation planning, the impacts of thermal discharge, and waste disposal during operating license hearings in 1972, but most Maine residents remained relatively unconcerned about the plant.

In 1974, Central Maine Power (CMP) announced plans to build another nuclear plant at Sears Island, further up the Maine coast. Although the plant was never built, this proposal led Pat Garrett, a retired engineer living near the planned site, to organize Safe Power for Maine (SPM). Garrett's work on radiation protection during World War II made him concerned about the impacts of a reactor accident. Three years later, at an SPM rally, Garrett's description of the impacts of a full-scale reactor accident made a vivid impression on Ray Shadis, who lived about 2 miles from Maine Yankee at Edgecomb.

In March of 1979, the NRC ordered Maine Yankee to shut down while the implications of a faulty computer code used to design for earthquake resistance at the plant were examined. Later that month, the accident at Three Mile Island coincided with a minor earthquake at Maine Yankee, causing increasing local controversy. Shadis, who increasingly had become angered at what he considered to be arrogance on the part of Maine Yankee representatives in dealing with seismic risk, discovered that there had been a spill of radioactive water at the plant during the shutdown process. His belief that the utility should have made the spill public was the impetus for a town meeting in the Edgecomb Town Hall in April which drew nearly 1,000 people.

This overwhelming response inspired Shadis and his wife to initiate a referendum vote on closing down the plant. By March of 1980 they had organized the Maine Nuclear Referendum Committee and presented the Maine Secretary of State with over 50,000 signatures; a special election was called for that September. To coun-

[1]This case study is primarily based on phone interviews conducted during March 1983. The following persons were interviewed: Ray Shadis (organizer of the 1980 referendum campaign); Pat Garrett (Safe Power for Maine); Don Vigue (Maine Yankee Atomic Power Co.); Gordon Weil (formerly with Maine Governor's Energy Office); Tom Kinder (Fund for Secure Energy); John Menario (Committee to Save Maine Yankee); and Denise Goodman (free-lance journalist).

ter the Referendum Committee, a business consultant and CMP setup the Committee to Saw ." Maine Yankee (CSMY), raising over $800,000.[2] The funds were used for advertisements, speakers, and a direct mail campaign emphasizing the economic advantages of the nuclear plant. CSMY projected that replacing Maine Yankee with oil-fired electricity would add 30 percent to the average residential customer's bill.

The Referendum Committee emphasized three issues in its campaign: the magnitude of a potential accident and its devastating effect on the coast of Maine; the impact of radioactive waste on future generations; and the concept of franchisement, in which people have the responsibility to make their own value judgments a nuclear power and other issues that affect their lives. With less than $150,000, the committee relied heavily on the fairness doctrine to obtain media coverage of their views,

Following a large voter turnout, the referendum committee lost, by 41 to 59 percent. Observers on all sides agreed that economics had been the deciding factor in the vote. Near the end campaiof the:hard Hill,professor at the University of Maine at Orono who was well known for his expertise renewab in energy publ argued in a that these resources could not make up for the lost Maine Yankee power. From then on, the referendum committee had trouble refocusing the campaign on health and safety issues and ultimately los .

The large turnout and vote split in the 1980 campaign encouraged a new Maine Nuclear Referendum committee* try again, and the issue was placed on the ballot as part of the regular 1982 election. This time, however, the referendum proposed to shut down Maine Yankee after 5 yews, in order to allow time for a smooth transition to conservation and renewable energy sources. CSMY again launched a counter-campaign.

In November 19$2, Maine voters again chose to keep Maine Yankee operating, though by a narrower margin (56 to 44 percent). Economics -r@ the key factor in the vote. An independent analysis by the Governor's Energy Office had found that electricity prices would increase by 10 to 25 percent if Maine Yankee were closed down. Despite a counter-study by the ref- een- lum- committee, most voters were convinced that expensive cdl-fired generation would be required. In addition, the referendum committee's credibility on health and safety issues was hurt by a U.S. Centers for Disease Control the claimlenging leukemia rates were higher than normal around Maine Yankee.

"' Public attitudes toward the Maine Yankee plant are similar in many respects to national attitudes. Residents @f Wiscassett, which benefits from thereveriues,x always have supported Maine Yankee. Environmentalism, too, has a strong influence on concerns about the plant. Many of the leaders of the referendum moved to Maine because of the * @ s remote, rural character. Concerns about nuclear war were instrumental in mobilizing opposition Yankee,eand the nuclear weapons freeze mhelpednt probab attract votes in favor of the referendum . Another issue that had a strong influence on the debate was the credibility of the utility. Exit polls taken after the first referendum indicated that some people, who supported Maine Yankee for economic reasons, voted to shut it down because they disliked CMP. Ultimately, however, this same Yankee independence led the voters to keep the plant, which they viewed as an economic necessity, running.

[2]Information on sources of funding in 1980 and 1982 for both the Referendum Committee and the Committee to Save Maine Yankee was provided by the Maine Secretary of State's office.

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cidence of a massive public protest based in part on concerns about earthquake-stance and an apparent industry failure to provide that resistance appeared to many people to vindicate the - protectors. In addition, PG&E's handling of the event may have contributed to doubts about the nuclear industry's credibility. When an independent study confirmed the quality-assurance problems with the seismic restraints, a PG&E spokesman dismissed the finding as being"a certain informality" in the utility's"seismic sentice contracts."

Public reaction to Diablo Canyon has reflected national trends in several respects. Early concerns about specific environmental impacts and support among some environmentalists gave way to broader concerns about seismic risk, need for power, and, ultimately, the competence and credibility of the utility. Conflicting scientific studies of seismic risk appear to have increased public skepticism about the plant, and the accident at Three Mile Island caused a sharp increase in local opposition.

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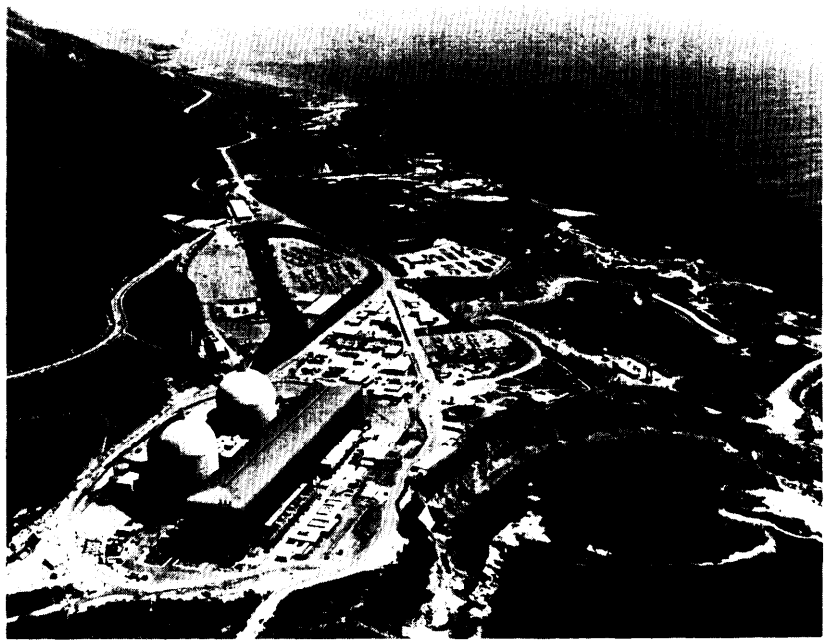

Photo credit: Pacific Gas & *Electric*

Demonstrations and court actions called attention to issues of seismic design at Diablo Canyon

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