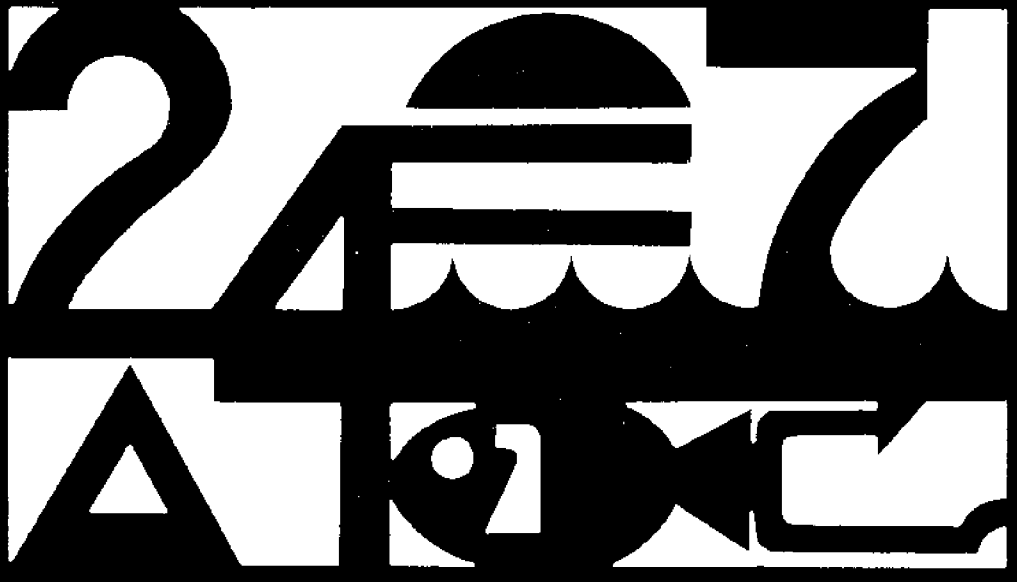
SEA GRANT COLLEGE TECHNICAL REPORT
WIS-SG-75-225

THE ROLE OF TECHNICAL INFORMATION IN DECISIONS ON NUCLEAR POWER PLANTS

Marjorie Beane

John Ross



THE UNIVERSITY OF WISCONSIN

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THE ROLE OF TECHNICAL INFORMATION IN DECISIONS ON NUCLEAR POWER PLANTS

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Center for Human Systems
Institute for Environmental Studies
University of Wisconsin-Madison

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UNIVERSITY OF WISCONSIN SEA GRANT COLLEGE PROGRAM
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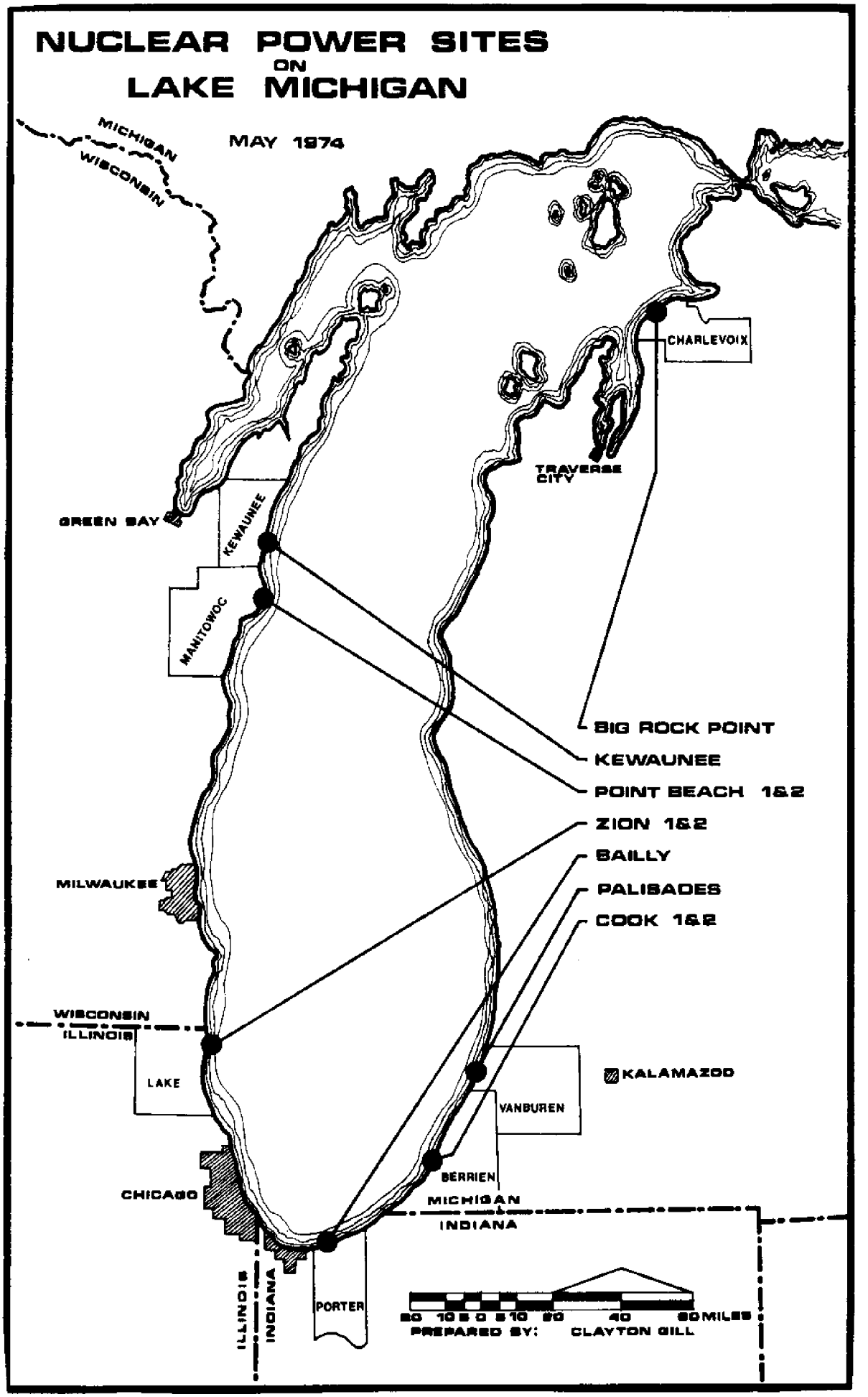
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INDIANA
PORTER
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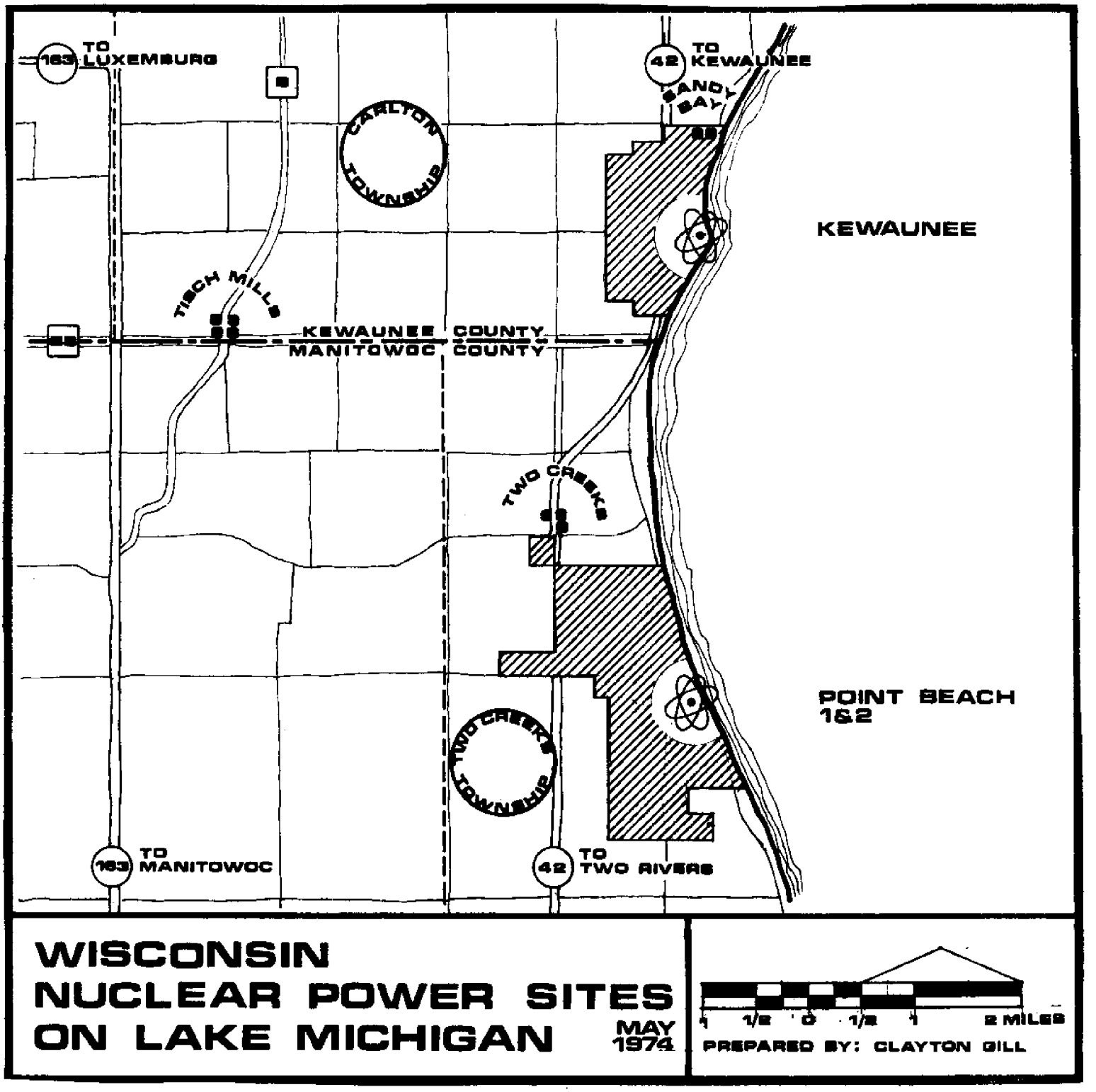
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NUCLEAR POWER SITES ON LAKE MICHIGAN

BIG ROCK POINT

Plant name: Big Rock Point Nuclear Plant
Location: Charlevoix, Charlevoix County, Michigan
On-line (first commercial power production): December 1962
Design capacity: 75 MWe
Current operating capacity: 65 MWe
Reactor type: Boiling water reactor (BWR)
Manufacturer: General Electric
Engineer: Bechtel Power Corporation
Lead utility: Consumer's Power Company
Owner: Consumer's Power Company

KEWAUNEE

Plant name: Kewaunee Nuclear Power Plant
Location: Carlton, Kewaunee County, Wisconsin
On-line: April 1974
Design capacity: 540 MWe
Current operating capacity: 400 MWe (to be 540 MWe in June 1974)
Reactor type: Pressurized water reactor (PWR)
Manufacturer: Westinghouse
Engineer: Pioneer Service and Engineering Company
Lead utility: Wisconsin Public Service Corporation
Owners: Wisconsin Public Service Corporation, Wisconsin Power and Light Company, Madison Gas and Electric Company

POINT BEACH 1 & 2

Plant name: Point Beach Nuclear Plant, Units 1 and 2
Location: Two Creeks, Manitowoc County, Wisconsin
On-line: Unit 1—December 1970
Unit 2—April 1973
Design capacity: 497 MWe each (identical units)
Current operating capacity: Unit 1—470 MWe (at present, down for refueling)
Unit 2—470 MWe
Reactor type: Pressurized water reactors (PWRs)
Manufacturer: Westinghouse
Engineer: Bechtel Power Corporation
Lead utility: Wisconsin Electric Power Company
Owners: Wisconsin Electric Power Company (WEP) and Wisconsin-Michigan Power Company (subsidiary of WEP)

COOK 1 & 2

Plant name: Donald C. Cook Nuclear Plant, Units 1 & 2
Location: Lake, Berrien County, Michigan
On-line: Unit 1—December 1974
Unit 2—December 1975
Design capacity: 1100 MWe each (identical units)
Anticipated operating capacity: 1050 MWe each
Reactor type: Pressurized water reactors (PWRs)
Manufacturer: Westinghouse
Engineer: American Electric Power Company's Service Corporation
Lead utility: Indiana-Michigan Power Company
Owners: Indiana-Michigan Electric Company (subsidiary of American Electric Power Company)

ZION 1 & 2

Plant name: Zion Nuclear Station, Units 1 and 2
Location: Zion, Lake County, Illinois
On-line: Unit 1—June 1973
Unit 2—December 1973
Design capacity: 1100 MWe (identical units)
Current operating capacity: Unit 1—770 MWe (to be 1050 MWe in October 1974, following shakedown of modified steam generator)
Unit 2—Currently shut down for steam generator modification (to be on-line at 770 MWe in September 1974)
Reactor type: Pressurized water reactors (PWRs)
Manufacturer: Westinghouse
Engineer: Sargent & Lundy Engineering Corporation
Lead utility: Commonwealth Edison Company
Owner: Commonwealth Edison Company

BAILLY

Plant name: Bailly Nuclear One
Location: Westchester, Porter County, Indiana
On-line: Summer 1979
Design capacity: 685 MWe
Anticipated operating capacity: 660 MWe
Reactor type: Boiling water reactor (BWR)
Manufacturer: General Electric
Engineer: Sargent & Lundy Engineering Corporation
Lead utility: Northern Indiana Public Service Company
Owner: Northern Indiana Public Service Company

PALISADES

Plant name: Palisades Nuclear Power Plant
Location: Covert, Van Buren County, Michigan
On-line: December 1971
Design capacity: 811 MWe
Current operating capacity: Presently shut down for reactor vessel and steam generator repairs (AEC provisional license for 700 MWe)
Reactor type: Pressurized water reactor (PWR)
Manufacturer: Combustion Engineers
Engineer: Bechtel Power Corporation
Lead utility: Consumer's Power Company
Owner: Consumer's Power Company

1. INTRODUCTION — THE RESEARCH PROBLEM

Decisions affecting environmental quality are constantly being made by officials in state and federal governments, by business and industrial managers, by elected officials at all levels of government, and by citizens faced with development in their communities.

A fundamental question in making these decisions is whether (1) a full array of technical information is available and, (2) is actually used in making the decision.

The process of environmental decisionmaking is complex and usually involves many different interest groups competing for the same limited resources.

For example, an electric utility may want to site a power plant on a stretch of Lake Michigan shoreline, while an environmental groups may want to preserve this same land against development. Other groups of citizens may want the land for residential use or for farming. The use or non-use of this land for any of these purposes will affect air and water quality and the local economy and, certainly, in the case of the power plant, will affect the region's power supply. Other local groups, plus state and federal groups, will likely become involved in the decision. There is growing discussion and debate over whether such decisions will be made at the local level or at some higher level of government. This very point is a key one being debated in the Wisconsin Legislature at this writing on Bill 814 on Power Plant Siting. (See Appendix A.)

This raises a series of information-related questions about environmental decisionmaking.

What sources of information do decisionmakers at all levels have about technical matters on issues such as nuclear power and generating plants? Are they aware of the range of technical issues? What is the degree of knowledge of technical matters? Are their attitudes on these issues related to the level of technical knowledge? How do other factors such as education, use of media and social activities relate to the level of knowledge and the attitudes? Are there viable channels of communication among federal, state, and local levels in the decision process?

These questions are important, because gaps in the information possessed by different people in a decision situation may contribute to selection of a less-than-adequate alternative and to controversy and conflict in the process. Thus, problems in decisionmaking may be due to communications gaps as well as to thoroughly documented differences of attitude on what is the right decision.

It is now generally accepted that the process of making decisions should consider costs and benefits of various alternatives, and that the decision will require some degree of arbitration and consensus among interest groups. For example, environmentalists may concur in the siting of the power plant if there are strict controls on thermal discharges and if the utility

converts part of the site into a nature center. However, if no consensus is reached, the utility may still acquire the land by eminent domain and encounter legal opposition that delays the plant's construction and operation for years.

Whether the technical information is transmitted effectively depends on several factors:

(1) Personal characteristics of the individuals are involved. These include age, education, social activity, communication behavior, socioeconomic position, self-interest, knowledge of alternatives and attitudes toward these alternatives.

(2) The media system is another factor. People may receive information on decision alternatives from research monographs and technical journals and reports; from the mass media, i.e., newspapers, television, radio and magazines; through personal contact with friends or acquaintances; and/or through hearings and meetings. Hearings can be a forum for presentation of a position by an agency, or they can be a forum for exchanging information and even for reaching some consensus between different interest groups. For example, a federal or state agency may hold a hearing on the proposed siting of a power plant in a community. At the hearings, the utility could describe its plans for siting the plants; federal and state officials could cross examine utility officials and discuss regulatory requirements; and citizens could ask questions and state their concerns about the project.

(3) On a technical environmental issue such as nuclear power, how individuals will respond to the information they receive through any channel will depend on their comprehension and understanding of the issues and their personal interest in the decision. Issues such as nuclear safety or radiation and thermal pollution are complex and there are <u>often no absolutely right or wrong answers</u>. However, without some comprehension of the issues, citizens or regulatory officials may later become dissatisfied with their decision and withdraw their support or approval of the project.

(4) The development of controversy may also affect decisionmaking. Conflict between interest groups can lengthen the decision process and influence the volume and form of communication involved. People could actually become more aware of the issues but not necessarily more informed about alternative solutions. For example, with the development of controversy, individuals may become polarized on the issues and the rational processing of information may slow down.

To acquire a better understanding of environmental decisionmaking and the factors that influence it, it is possible to study the flow of information among participants in this process and determine how and when knowledge and attitudes on the issues fluctuate with the amount of information available. It is also possible to study how the development of controversy or other situational variables affect the flow and processing of information. Such a study would require five to ten years of intensive field research.

This study is not that comprehensive. It looks at individual factors, such as knowledge level, that could influence environmental decisionmaking at a point in time. It was designed to determine if the people who were involved in the decision to site Point Beach Nuclear Power Plant in Wisconsin were informed on nuclear power and related issues and if their attitudes on these issues were related to their level of knowledge. The decisionmaking process and the channels available for communication between interest groups were documented. The research also determined if media exposure, age, social activity, personal interest and education were related to knowledge and attitudes on nuclear issues.

Although Point Beach Power Plant was sited in 1965, seven years prior to the study, the decision to fully operate the plant was not made until 1973. Controversy over safety features and thermal pollution delayed plant operation. In January, 1973, the local county board voted in favor of the power plant's operation and in May, federal officials approved full operation. Therefore, the issues surrounding the siting of Point Beach were still of concern to federal, state, and local groups during the time this study was being conducted (1972-73).

The study focused on nuclear power plant siting because it was an example of an environmental decision with highly technical ramifications in a range of categories. In order to arrive at a sound and rational decision, individuals who take part in the decision presumably need information on nuclear power and on other alternatives such as fossil fuel and the costs and benefits associated with each. Information on air and water quality standards and energy requirements (for generating electricity) is also pertinent.

The debate continues about whether "the public" can, in fact, accumulate the range and depth of technical information needed to consider the "go" or "no go" decisions in power plant siting. It is not the intent of this report to pass judgment on that point, but rather to assess the status of the information system.

2. METHOD

THE INSTRUMENTS

An earlier phase of this study measured the amount and type of information on nuclear power plant construction around Lake Michigan that appeared in local and regional newspapers in the years 1966-1969.

The coding categories developed for that content analysis were used in this phase to construct a knowledge and attitude questionnaire on nuclear power. The categories covered power plant siting issues such as the environmental impact of nuclear and fossil-fuel plants, energy alternatives, energy demand and power plant regulatory requirements.

The reader may want at this point to take the questionnaires that were administered to the participants in the study. Annotated answers to the questionnaires are presented in Appendix D. (The reader should remember that court decisions and administrative rulings may have changed since these annotations were written.)

KNOWLEDGE QUESTIONNAIRE

The questions in this survey cover a wide variety of subjects. Since each individual has different areas of expertise or interest, no one is expected to know the correct answers to all questions; however, please try to answer all questions to the best of your ability. Do not consult other individuals and materials.

---

1. There is an established threshold limit below which radiation will not cause biological injury.

   T or F or Don't know

2. Exposure to radiation may cause

   a) cancer
   b) genetic damage
   c) shortening of life span
   d) a & c
   e) all of the above
   f) don't know

3. If the accumulation of radionuclides is kept below limits safe for human health, plants and animals in the environment will automatically be protected.

   T or F or Don't know

4. The concentration of a radioactive product of nuclear fallout, cesium-137, along the lichen-reindeer-man food chain

   a) increases
   b) decreases
   c) remains the same
   d) don't know

5. Some of the radioactive wastes produced in large quantities in nuclear reactor fuel will remain hazardous for centuries.

   T or F or Don't know

Note: Not all questions were asked of all groups. State officials received the complete set of questions. Some of the more technical questions were dropped from the local sample. Several questions were dropped because of ambiguity. Statistical cross-comparisons were made only on "surviving" questions. All questions are reported, however, as they were asked.

6. A certain amount of radioactive gas from nuclear plants is routinely released into the atmosphere.

T or F or Don't know

7. To date, there has been no leakage of radioactive materials in transit from fuel enrichment and fuel fabrication centers to nuclear plants.

T or F or Don't know

9. Emergency core cooling systems have been tested under actual accident conditions in a power reactor and have proven to be effective.

T or F or Don't know

10. Beneficial uses of radiation include

a) medical uses such as X-rays for tuberculosis and cancer
b) industrial uses such as radioactive tracers for detecting the level of liquid in containers and locating leaks
c) commercial uses such as radioactive screening devices for burglar-proofing businesses and homes
d) a & b
e) all of the above
f) don't know

11. The Plowshare Program was established by AEC to develop

a) nuclear explosives for peaceful use
b) nuclear equipment for military use
c) uses of nuclear isotopes in agriculture
d) underground nuclear power plants
e) none of the above
f) don't know

12. Most nuclear power plants now approach 42% thermal efficiency in converting the energy stored in fuel to electricity while the best fossil-fueled plants are only 30% efficient.

T or F or Don't know

13. Nuclear power plants using water from a river or lake for cooling purposes discharge about 50% more heated water than fossil-fueled plants using the same cooling method for an equal output of power.

T or F or Don't know

14. Thermal pollution may

a) reduce the recreational value of water by heating it and increasing the growth of algae
b) raise the water level of a lake or river and cause flooding
c) reduce the waste assimilation capacity of the receiving body of water
d) a & c
e) all of the above
f) don't know

15. The total amount of water used for cooling by all power plants is now about 120 billion gallons per day or about 10% of the average daily runoff of water in the Continental United States.

T or F or Don't know

16. Sizeable increases in the water temperature of a lake or stream may

a) increase the occurrence of disease in fish populations
b) interfere with the spawning activities of fish
c) decrease the respiration rate of aquatic organisms
d) a & b
e) all of the above
f) don't know

17. The use of wet cooling towers or cooling ponds is known to cause fog or icing at certain times of the year.

T or F or Don't know

18. Coal-burning power plants are a major source of mercury pollution.

T or F or Don't know

19. Fossil-fuel burning power plants discharge approximately 50% of all air polluting

a) nitrogen oxides
b) sulfur oxides
c) hydrocarbons
d) particulate matter
e) all of the above
f) don't know

20. At present, there are no commercially proven processes for eliminating stack emission of sulfur oxides or nitrogen oxides.

T or F or Don't know

21. Sulfur dioxide alone or in combination with particulate matter may cause

a) damage to vegetation
b) corrosion of building materials, including stone, marble and steel
c) respiratory diseases such as emphysema, bronchitis and bronchial asthma
d) b & c
e) all of the above
f) don't know

22. Both coal and uranium are strip-mined.

T or F or Don't know

23. Uranium tailings, containing significant quantities of radium and other radioactive materials, have been piled near uranium mills where they are exposed to erosion by wind and rain.

T or F or Don't know

24. The land acreage requirements of a 3,000-megawatt nuclear power plant would be less than those of a coal-burning plant of comparable size.

T or F or Don't know

25. Solar energy has not been used to generate electricity because a method for harnessing this energy does not exist.

T or F or Don't know

26. The efficiency of electrical generation may be improved within conventional fossil-fuel and nuclear power plants by

a) thermonuclear fusion
b) magnetohydrodynamics
c) fuel cells
d) all of the above
e) none of the above
f) don't know

27. An atomic explosion is not possible in current light water nuclear reactors.

T or F or Don't know

28. A fast breeder reactor produces more nuclear fuel than it consumes.

T or F or Don't know

29. Utility corridors are corridors of land reserved for

a) use by electric transmission lines only
b) use by gas and oil pipelines only
c) use by gas and oil pipelines and electric and telephone wires
d) none of the above
e) don't know

30.* Melting scrap to obtain metal requires less electric power than refining ore.

T or F or Don't know

31. Direct home heating by natural gas and oil can result in less pollution and waste of valuable energy resources than electric space heating.

T or F or Don't know

32. Studies of evaporation show that roughly twice as much water would be lost from cooling tower operations as from systems using ponds or lakes.

T or F or Don't know

33. In a dry cooling tower, the heated water from a power plant condenser falls through an upward-moving stream of air and is cooled mainly by evaporation.

T or F or Don't know

34. Researchers have suggested using waste heat from power plants for

a) desalting sea water
b) irrigation
c) heating apartments and office buildings
d) aquaculture
e) all of the above
f) don't know

---

*Question not included in total score. See annotated answer for reason.

35. The approach used by most power plants for disposing of the bulk of waste heat is

a) cooling ponds
b) "once through" cooling
c) cooling towers
d) 150 ft. stacks
e) none of the above
f) don't know

36. The current method of storing high-level radioactive wastes is

a) solidification and storage is salt mines
b) in boiling, liquid form in metal containers
c) in gaseous form in an underground pipe system on nuclear plant sites
d) none of the above
e) don't know

37. Since 1940, the use of electricity has been roughly doubling every

a) 5 years
b) 10 years
c) 15 years
d) 20 years
e) don't know

38. At present, the demand for electricity is growing at a faster rate than the population and the national economy.

T or F or Don't know

39. The Federal Power Commission projects that nuclear-fueled power plants will account for ____% of the electric power generation by 1990.

a) 5%
b) 21%
c) 33%
d) 53%
e) don't know

40. Utilities must reveal plans for new plants and transmission lines at least 10 years in advance of construction.

T or F or Don't know

41. The choosing of power plant sites and transmission line routes by utilities has to be integrated with regional land use planning in the area.

T or F or Don't know

42. In the State of Wisconsin, electric utilities, through application to the State, have the power of eminent domain and may condemn land for transmission lines or plant sites.

T or F or Don't know

43. At the present projected levels of fuel use, which of the following fuels will be depleted first?

a) coal
b) oil
c) natural gas
d) uranium-235
e) don't know

44. Federal research and development effort for civilian energy production centers on research and development for fossil fuel energy.

T or F or Don't know

45. Supplies of nuclear fuel for generating electricity are less subject to interruption from strikes or other labor disputes than the supplies of coal are.

T or F or Don't know

46. Delays in nuclear power plant construction and operation are the result of

a) equipment failures
b) supply delays
c) environmental concerns
d) b & c
e) all of the above
f) don't know

47. There is a shortage of trained men to build and operate nuclear power plants.

T or F or Don't know

48. The costs of electricity will increase in the future because of

a) environmental protection and enhancement features
b) increasing competition for fossil fuels
c) rising costs of "capital"
d) all of the above
e) don't know

49.* The AEC has ruled that the requirements of the National Environmental Policy Act would not be applied to already licensed nuclear facilities.

T or F or Don't know

50. To construct a nuclear power plant in Wisconsin, the utility must first obtain a permit or approval from the

a) State Public Service Commission
b) Division of Economic Development of the State Department of Local Affairs and Development
c) State Administration Office
e) none of the above
f) don't know

51. Any person whose interest may be affected by an AEC licensing proceeding of a nuclear plant may file a petition for leave to intervene.

T or F or Don't know

52. A provisional permit for nuclear plant construction may be issued even if technical details related to plant safety are still in the developmental stage.

T or F or Don't know

53.* Public hearings are required before the AEC grants an operating permit for a nuclear plant.

T or F or Don't know

54. When a cooling water intake or discharge structure of a nuclear plant in Wisconsin extends into navigable water, the utility must obtain a permit from the

a) Department of Interior
b) State Department of Natural Resources
c) Army Corps of Engineers
d) b & C
e) all of the above
f) don't know

55. The utility may construct facilities such as a turbine building and water intake and discharge structures before the issuance of a construction permit by AEC.

T or F or Don't know

---

*Question not included in total score. See annotated answer for reason.

56. In order to receive a construction permit from the AEC, the utility compiles a preliminary safety analysis report which is reviewed by the

a) Advisory Committee on Reactor Safeguards
b) AEC Division of Reactor Licensing
c) Atomic Safety and Licensing Board
d) b & c
e) all of the above
f) don't know

57.* The power to set Federal standards for permissible doses, exposures and concentrations of radiation is held by the

a) Atomic Energy Commission
b) Environmental Protection Agency
c) Federal Radiation Council
d) International Council on Radiation Protection
e) none of the above
f) don't know

58. Present radiation standards take into account the total accumulation of radiation individuals receive from all emitting sources.

T or F or Don't know

59. Cost, not technology, is the primary constraint on reducing and perhaps eliminating radioactive discharges from nuclear power plants.

60. States may set radioactive emission limits more strict than those of the federal government.

T or F or Don't know

61. The thermal standards for lakes and rivers in Wisconsin are set by the

a) Environmental Protection Agency
b) State Department of Natural Resources with the approval of EPA
c) Department of Interior
d) National Oceanic and Atmospheric Administration
e) Council on Environmental Quality
f) don't know

---

*Question not included in total score. See annotated answer for reason.

62.* If a major nuclear power plant accident occurred, the damages would be paid in large part by the

a) U.S. government
b) insurance companies
c) utility company
d) affected persons
e) don't know

63. The current**rate structure of utilities

a) increases the unit cost of electricity as consumption increases
b) decreases the unit cost of electricity as consumption increases
c) retains the same unit cost of electricity regardless of consumption
d) don't know

64. Advertising costs are included in the operating expenses which are recoverable in the rates that utilities charge customers.

T or F or Don't know

65. In order to obtain a change in rates, a utility must ordinarily file a formal application with the

a) Federal Power Commission
b) Department of Health, Education and Welfare
c) State Public Service Commission
d) State Administrative Office
e) don't know

---

*Question not included in total score. See annotated answer for reason.

**Question was asked before March 8, 1974 order by Wisconsin Public Service Commission. See note at end of annotated answer.

MATCHING—Write the letter found by each word in Group II on the line with that word's proper definition. (Answer as many as you can.)

Group I	Group II
_____ a substance that slows down the neutrons produced by fission in a nuclear reactor	A) cladding
_____ used to slow down or speed up fission chain reaction in a nuclear reactor	B) fission
_____ refers to the time required for the processes of decay to reduce the concentration of radioactive substance by 2	C) curie
_____ consists of the fuel, the moderator, and the control rods in a nuclear reactor	D) moderator
_____ contains nuclear fuel in the form of uranium dioxide pellets	E) reactor core
_____ describes a quantity of radioactive material	F) fuel rod
_____ a reaction in which nuclei come together to form more complex nuclei with the release of energy	G) fusion
_____ the metal or carbon jacket around the fuel in nuclear reactors	H) halflife
_____ expresses the effect of radiation energy upon biological materials	I) rem
_____ a reaction in which the most complex nuclei such as uranium or thorium split up into lighter components with the release of energy	J) control rods

ATTITUDE QUESTIONNAIRE

1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

2. Nuclear power plants should not be allowed to make any discharges of radioactive wastes into the air and water.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

3. The aesthetic impact of overhead transmission lines is not great enough to warrant the extra cost of putting them underground.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

4. There is a direct relationship between growth of the national economy and the demand for power and energy.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

5. The use of electric power has helped people to achieve an easier and better life.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

6. The national government should encourage research leading to technological changes that would reduce the demand for electricity.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

7. The continued prosperity and welfare of our nation depend on our ability to meet the increasing demand for electricity.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

8. Compared to fossil-fueled plants, nuclear plants are a clean source of energy.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

9. Thermal effluent from power plants should not be discharged into lakes, rivers and other natural bodies of water.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

10. To date, the public has not been involved in a meaningful way in the utility planning process.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

11. The fundamental question of whether specific power plants are in fact needed has not been subject to meaningful review by regulatory authorities or the public.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

12. There should be more channels for public participation in power plant site selection.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

13. Environmental costs of producing and supplying power should be included in the sale price of electricity.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

14. The current promotional rate structure of electric utilities should be modified to remove incentives for increased consumption.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

15. Full regulatory authority regarding licensing, safety, public health and environmental impact of nuclear facilities at the federal level should be transferred from AEC to EPA.

Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
____	____	____	____	____	____

16. The Atomic Energy Commission is responsible for both promoting and regulating peaceful uses of nuclear technology. Are these two roles compatible?

Yes	No	Don't know
____	____	____

THE SAMPLES

The study set out to determine the groups and individuals that actually were involved in the decision to site a nuclear power plant, either through formal responsibility, or informally, and then to persuade these people to participate in the survey.

TABLE 1

DECISIONMAKERS

State Level

*Public Service Commission
*Department of Natural Resources
*Department of Health and Social Services
(Radiation Protection Section)
*Department of Industry, Labor and Human Relations
(Industrial Safety and Buildings Division)
Department of Justice
(Attorney General's Office)
Department of Transportation
*Department of Administration
(Wisconsin Aeronautics Division)
Department of Local Affairs and Development
(Division of Economic Development; Division of Housing)

Federal Level

*Atomic Energy Commission
Department of the Interior
Federal Power Commission
*Environmental Protection Agency
*Army Corps of Engineers
*Federal Aviation Administration

Local Level

*Town Board
*County Zoning Administration
County Board of Supervisors
Local and Regional Planning Commissions
Local property owners
Conservation groups
Chamber of Commerce
Service organizations—Rotary, Kiwanis, etc.
Local businesses
School officials—PTA, School Boards
Local Media—newspapers

*Some type of approval is usually needed from this organization.

STATE LEVEL DECISIONMAKERS

The sample of state agency decisionmakers was fairly complete as compared to the number of individuals who are active in the process. The most important individuals missing were four Public Service Commission officials who declined to participate in the study. The Departments of Transportation, Administration, and Local Affairs and Development play rather minor roles so their omission from the state sample is less important.

TABLE 2

STATE SAMPLE

Agencies	Number of Respondents
Public Service Commission	5
Department of Natural Resources	10
Department of Health and Social Services (Radiation Protection Section)	3
Department of Industry, Labor and Human Relations (Industrial Safety and Buildings Division)	6
Attorney General's Office	1

The review process, especially at the state level, is changing because of increasing public interest in nuclear power decisions as well as advances in demand forecasting technology. There seems to be greater willingness on the part of some agencies to make new rules regarding the impacts of electric power growth. In the spring of 1974 the Wisconsin Public Service Commission sponsored a series of public hearings looking into electrical demand, alternative energy technologies and public opinion. Also, the Department of Local Affairs and Development is starting to deal with the previously obscure problems of persons displaced by a nuclear power plant. This agency is now requiring utilities to file "Relocation Plans" for large electric power projects.

Some of the difficulties met in building up the government samples for this study are discussed briefly, agency by agency, because they illustrate the complexity of the communication process in a controversial issue such as this. The official functions of the regulatory agencies are presented in detail in Appendix B (state) and Appendix C (federal).

PUBLIC SERVICE COMMISSION (PSC)

The Public Service Commission has the most important role of all Wisconsin state agencies in power plant siting. The Commission must approve a utility's plans to build a power plant before major construction activities can begin. The two basic considerations in granting a Certificate of Authority (CA) are (1) whether the power plant is needed, and (2) whether it is economically feasible. The Commission must also consider the environmental impact of the power plant in its decision to grant a CA.

Contacts for this study in the PSC centered in the Engineering Division. These individuals were very knowledgeable about a range of power plant siting and nuclear issues. They also were familiar with the functions and responsibilities of the different divisions in their agency, and had contacts in the state Department of Natural Resources and the state Department of Industry, Labor and Human Relations. Their division also corresponded with the Atomic Energy Commission and the Federal Power Commission on power plant siting issues. Thus, there seemed to be some coordination of activities within the PSC and channels of communication between this agency and other agencies involved in the siting process.

DEPARTMENT OF NATURAL RESOURCES (DNR)

The state Department of Natural Resources—like the federal Environmental Protection Agency (EPA)—is a fairly new organization that is constantly undergoing changes in structure and acquiring new responsibilities with the passage of more environmental quality laws. Several individuals in DNR's Division of Environmental Protection had held their present positions for less than one year and were not familiar with many of the activities in their division and other divisions. In fact, each official interviewed gave a different version of exactly how the DNR would be involved in the siting of a nuclear power plant— for example, the permits or approvals needed for discharging thermal effluent and building discharge structures. One reason for the confusion was the fact that thermal standards were being revised and the type of permit or approval needed for discharging thermal effluent was still unsettled at both the federal and state level.

The state Environmental Protection Division of DNR also reflected lack of information on activities at the regional EPA office. One DNR official described several frustrating encounters with EPA and commented that "if you find out who in the EPA regional office makes the decisions about thermal standards, please let me know." At that time, EPA had suggested that Wisconsin adopt stricter thermal standards for Lake Michigan, yet many DNR officials felt that EPA had not provided the scientific data to justify these new standards. DNR officials also said that the policies of EPA Region V often conflicted with policies set at national level.

DEPARTMENT OF HEALTH AND SOCIAL SERVICES

The state Radiation Protection Section in the Bureau of Environmental Health had, at the time of this survey, three people in the Madison office and a few part-time employees scattered throughout the state. On first contact (August 1972) this section was only responsible for off-site monitoring of nuclear power plants. However, in 1973, EPA and AEC contracted the state radiation service to do on-site monitoring for radiation at nuclear power plants in Wisconsin. These new responsibilities make this section an even more important part of the state sample.

The director of this office agreed to have each of the employees in his office fill out the questionnaire. He had worked closely with utility representatives and AEC officials in the siting and construction of several nuclear plants and thus was very knowledgeable on nuclear power issues. In carrying out his responsibilities, he often consults with officials in EPA, AEC and the state Department of Natural Resources. This director was the first of several state officials to point out the enormous volume of literature that he received on nuclear plants or related issues and to comment on the problems of dealing with so much material.

DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS

The Industrial Safety and Buildings Division enforces state codes for building safety in Wisconsin. However, the officials contacted in the division agreed that these state codes do not cover the special safety features of nuclear power plants. They rely on the Atomic Energy Commission to evaluate plant safety and will usually approve exceptions from state codes for nuclear plants. These officials had great respect for the AEC and were confident that the plants constructed in Wisconsin were safe.

Although the division's review and inspection of nuclear facilities does not require knowledge of nuclear power, the director of this division does encourage his employees to go to AEC hearings and to become familiar with nuclear issues. Several engineers in the division also felt that the state should probably investigate possible code additions that would cover safety features of nuclear plants. The Chief Engineer agreed to the survey and supplied the names of six employees who had reviewed or inspected nuclear plants in the state.

DEPARTMENT OF JUSTICE

Members of the Environmental Section of the Attorney General's office represent the state of Wisconsin at licensing hearings for nuclear power plants. The office also comments on environmental impact statements. The assistant attorney general responsible for reviewing nuclear power plants in the state agreed to fill out the questionnaire.

FEDERAL LEVEL DECISIONMAKERS

We do not know the total number of federal officials that would comprise an adequate sample but our sample is clearly incomplete and is not included in the survey results.

TABLE 3

FEDERAL SAMPLE

Agencies	Number of Representatives
Atomic Energy Commission	0
Army Corps of Engineers	25
Environmental Protection Agency	0
Federal Power Commission	1
Department of Interior	1
Department of Commerce	5
Federal Aviation Administration	0

The federal sample was incomplete for several reasons:

(1) The knowledge questionnaire was far reaching and many federal officials felt that staff members in their agencies would not do well in the survey. Low scores on the questionnaire might give people the impression that they were not qualified to carry out their regulatory responsibilities. Even after it was emphasized that "no one was expected to know the answers to all questions" and that "we were interested in the range of information available across agencies," federal officials still viewed the survey as a test of their agency's expertise in a subject area.

(2) Federal officials also feared that their employees' opinions could be construed as official government policy.

(3) The layers of bureaucracy—at the regional and national level—made it difficult to identify exactly who was responsible for certain decisions. And once these people were identified, it was almost impossible to get approval for their participation in the survey from the different officies and bureaucrats.

(4) Even with the cooperation of all federal agencies, it still would have been difficult to obtain a complete sample of federal decisionmakers

because the decision process at this level is so fragmented. For example, there was confusion within agencies over who was responsible for various aspects of power plant siting. Many federal agencies were also unaware of each other's involvement in power siting, and there was little contact between agencies. Some of our tribulations in trying to get a federal sample are presented in the discussion which follows.

ATOMIC ENERGY COMMISSION (AEC)

The Atomic Energy Commission is the most important regulatory agency involved in the decision to build a nuclear power plant. Before the passage of the National Environmental Policy Act of 1970, the AEC was concerned only with reactor safety in licensing nuclear plants. Now, the Commission must also consider the environmental impact of these plants and estimate their costs and benefits compared to alternative sources of energy. This has prompted the AEC to work more closely with other federal and state agencies that have some regulatory authority and expertise in environmental areas. Unfortunately, many of the federal and state officials interviewed commented that they seldom conferred with the AEC.

While the other federal agencies included in the survey have regional offices that perform regulatory duties, the AEC carries out most of its regulatory responsibilities in Washington, D.C. Although the Commission relies on national laboratories in different regions of the country to do safety and environmental research, the applications to construct and operate nuclear plants are processed in the Washington office. Also, there are three different groups in the AEC that review these applications: the Regulatory staff, the Advisory Committee on Reactor Safety and the Licensing and Safety Panel. The large number of people involved in the decision process and the fact that they were scattered throughout the country made it virtually impossible to request that everyone in the AEC participate in the survey. Thus AEC officials were asked for a representative sample from each one of these groups to fill out the knowledge and opinion questionnaire.

The Chicago AEC information office gave appropriate references for outlining the AEC regulatory process and then offered to send the request for AEC participation in the survey to Washington officials. It took from September 2, 1972 to February 17, 1973 to receive a reply.

The AEC officials who reviewed the questionnaire decided that they could not participate in the survey for several reasons. First, they felt that some of the questions and options available for answers were not straight-forward factual matters with clear correct or incorrect answers. "...when one fills out the questionnaire, he is subjecting himself to someone else's judgment on whether or not an answer is correct and thus whether or not the participant is knowledgeable about nuclear matters." Second, comparing knowledge of the general public with knowledge of the people in the nuclear field would be a "no win" situation for the AEC because people would expect everyone in the AEC and its advisory bodies to know all the answers. Anything short of perfect would make them appear unqualified to regulate the nuclear industry.

Third, answering the opinion questions might put many AEC officials in a position of appearing to have predispositions or biases which would affect future judgments. Fourth, the regulatory staff had a heavy workload.

ARMY CORPS OF ENGINEERS

When this study started in January 1972, the Army Corps of Engineers granted two different types of permits to utilities building power plants—a construction permit for discharge structures extending into navigable waters and a refuse permit for discharging thermal effluent. In 1973, EPA took over the refuse permit program and the Corps is now only responsible for granting construction permits.

Individuals within the Operations, Planning, and Engineering Divisions of the Corps review and comment on the applications for construction permits. Corps officials also request comments from the Bureau of Sport Fisheries and Wildlife in the Department of Interior (Minneapolis office) and the Environmental Protection Agency (Chicago office). Yet they usually do not contact the Atomic Energy Commission. In fact, one official commented that "the AEC resents any interference with their activities and getting approval for a discharge structure may delay other nuclear construction activities."

The Corps may also hold public meetings on these construction projects to provide interested citizens with information and to listen to any citizen objections. Of all the federal agencies contacted, the Army Corps of Engineers seemed to be the most concerned about communicating and cooperating with other state and federal agencies and the general public. It may be because this agency has been extensively criticized over the past five years for not consulting the public about major projects.

In general, the Chief Engineer felt that the study would be valuable and was cooperative. The process of contacting the Chicago office, getting approval for the survey and receiving the completed questionnaires took six months—from May 1972 to November 1972.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The Environmental Protection Agency is probably the newest participant in power plant siting and its role in this process has been constantly changing. When the study was first initiated in 1972, EPA was reviewing thermal standards set by states and radiation standards set by the former Federal Radiation Council. In 1973, the agency had taken over the refuse permit program from the Corps of Engineers, was requiring stricter thermal standards from many states, and was in the process of establishing new environmental radiation standards.

Upon first contact at the Chicago EPA office, there was confusion over how involved various divisions at the regional level were in power plant siting around Lake Michigan. One official thought that three divisions might be involved: the Federal Activities Branch, which reviews environmental impact

statements, the Refuse Act Permit Program, and the Categorical Programs-Radiation Division. In July 1972, directors of each program were asked if their employees could participate in the survey. In August, an employee from the Radiation office in Chicago called and requested two copies of the questionnaire for individuals within his office to fill out. After receiving the questionnaires, he called back and explained that most of the people who review radiation aspects of nuclear plants were located in the Washington, D.C. office. He apologized for not being familiar with most of the issues covered in the questionnaire and suggested contact with people in Washington about the study.

Later in August, the director of the environmental review board of the Federal Activities Branch called and requested a copy of the questionnaire to review before agreeing to participate in the study. However, he commented that he anticipated no problems and that final approval for the survey would come in a few weeks. After three months and several letters to EPA, the Federal Activities Branch was contacted again about the status of the survey. Finally, in a letter dated November 17, 1972, the regional director of EPA informed us that individuals in the Chicago office could not participate in the survey. He felt that their responses would not be meaningful because they represented just a "few of the individuals" actually involved in the review process. A reply letter explained that we were trying to include as many individuals involved in the review process as possible—for example the people in the Washington, D.C. Office of Radiation.

After two months and no response, the EPA office was called and asked if they had reconsidered participating in the study. The official in charge of the environmental review section said that the regional director had decided that they needed a mandate from Mr. Ruckelshaus, the top administrator of the Environmental Protection Agency, to give the questionnaire to all EPA staff reviewers. He explained that "since many reviewers of Lake Michigan nuclear plants are in other regions, the region V office felt that it did not have the authority to order these people to take the questionnaire. An order from Washington would insure full cooperation of all individuals."

A letter describing the study and the exchanges with the Chicago EPA office was sent to EPA Administrator Ruckelshaus. An EPA official responded for Ruckelshaus in April and said he felt the survey would not "serve a useful purpose" and, therefore, could not recommend that EPA reviewers fill out the questionnaire. His reasons were (1) EPA reviewers have "considerable expertise" in their subject areas and could answer the questions in those areas easily; (2) the reviewers' knowledge in other areas and their opinions on the issues are irrelevant to their performance.

Unfortunately, he believed that the questionnaire had been designed to measure the professional expertise of EPA reviewers in the area of environmental impact of power plants. Instead, the questionnaire had been designed to measure the general knowledge that individuals had on nuclear power issues. It wasn't intended to determine if a physicist or chemist was qualified to review nuclear power plants.

FEDERAL POWER COMMISSION (FPC)

Although the FPC has no regulatory authority over nuclear power plants, this agency does work with electric utilities to facilitate the planning, building and operation of needed power facilities. FPC officials may also testify at licensing hearings for power plants. For example, at hearings for an operating permit for Point Beach Unit II, an FPC official testified that the operation of the plant was needed to insure an adequate supply of power in the Midwest. The Chicago office of the FPC decided that completion of the questionnaire by staff members would not add to cross-sectional knowledge at the federal level. Also, certain questions dealt with matters of FPC policy.

DEPARTMENT OF INTERIOR

The Bureau of Sports Fisheries and Wildlife is the agency in the Department of Interior most concerned with power plant siting. In September 1972, one person in the Division of River Basin Studies was responsible for reviewing plans for nuclear plants in the Great Lakes region. The Director of the Bureau of Sports Fisheries and Wildlife reviewed the questionnaire and decided that the employee could not participate in the study. He commented that several questions requested opinions on power facilities and that an employee's opinions could be construed as being official Bureau views.

After additional inquiry and discussion the employee did complete the questionnaire but stressed that the knowledge and judgment were his own and did not reflect the views of the Bureau of Sports Fisheries and Wildlife. The director also commented that the employee had chosen not to answer certain opinion questions because he felt the fact that he was a federal employee would bias his opinions.

The other agency contacted in the Department of Interior was the U.S. Geological Survey. Officials in the Wisconsin state office of the U.S. Geological Survey indicated that one individual in the office was responsible for reviewing environmental impact statements on nuclear power plants.

DEPARTMENT OF COMMERCE

Many federal agencies commented on the environmental impact statement for Point Beach nuclear power plant, but one of the most thorough and detailed comments was submitted by the Office of Environmental Affairs in the Department of Commerce. The National Oceanic and Atmospheric Administration (NOAA) was the primary agency responsible for preparing the comment. The Director of NOAA agreed to allow five individuals in their Environmental Research and Air Resources Laboratories to participate in the survey. Gaining the cooperation of this agency was easy compared to the other federal agencies.

FEDERAL AVIATION ADMINISTRATION (FAA)

The Federal Aviation Administration must determine if any structure of a nuclear plant will interfere with the safe and efficient use of airspace or with future airport development. However, the director of the Great Lakes

office felt that his agency was in no way involved in the decision to build a nuclear plant. "We have neither authority nor expertise in the atomic energy field." He also indicated that their agency treated a nuclear plant like any other building. For example, FAA officials do not conduct individual studies of the potential consequences of airplanes coming into contact with a particular building—even nuclear power plants. Therefore, since these officials felt that they had little reason to be familiar with nuclear power or related issues, they were not included in the survey.

LOCAL LEVEL DECISIONMAKERS

The local sample consisted of people who were directly or indirectly involved with the siting of Point Beach nuclear power plant in Two Creeks. For example, elected officials on the Two Creeks Town Board and the Manitowoc County Board passed resolutions in favor of the nuclear plant. Other groups such as labor, business and local service clubs indirectly supported the plant by supplying services and publically endorsing its construction. A few groups such as POWER and the Sierra Club organized opposition against the plant.

TABLE 4

LOCAL SAMPLE

(Total in Sample = 200; Number of Respondents = 190)

(1) Resident-Property Owners

This group included people who sold property to the utility for Point Beach power plant and moved to adjacent farms or into the town of Two Rivers. It also includes residents who live within a five mile radius of the plant.

(2) Business Groups

Chamber of Commerce officers or members of the Board of Directors
Owners of local businesses in Two Rivers
Presidents or Managers of major industries in Manitowoc area

(3) Labor Organizations

Officers of these organizations:

Teamsters Union
Machinists Union
Boiler Makers Union
Steamfitters and Plumbers Union
Central Labor Council
Council of City and Municipal Employees
United Steel Workers
Building and Construction Union

Table 4 (continued)

(4) Service Organizations

Officers of these organizations:
Rotary
Optimists
Kiwanis
Lions
Jaycees
Jaycettes

(5) Local Media

Editor and reporters of Manitowoc Herald Times

(6) School Officials

Members of these organizations:
Two Rivers Board of Education
Mishicot School Board (near Two Creeks)
Area Board of Vocational Technical & Adult Education

(7) Conservation Groups

Members of these organizations:
Sierra Club
POWER (Protect Our Wisconsin Environmental Resources)
Conservation Education Inc. of Manitowoc
Two Rivers Environmental Advisory Board

(8) Two Creeks Officials

Town Board
Town Assessor
Town Attorney

(9) Manitowoc County Board of Supervisors

County Board Members

(10) Other Officials or Members of Appointed Boards in Manitowoc County

County Agent
County Planner
Conservation Education Specialist
Members of the County Planning and Park Commission and Board of Adjustment

Table 4 (continued)

(11) Two Rivers Officials

Councilmen of Two Rivers
City Manager
Buildings Supervisor
Director of Public Works
Director of Utilities
Director of Recreation
Fire Chief
Members of these boards:
City Planning Commission
Zoning Board of Appeals
Recreation Advisory Board

(12) Manitowoc City Officials

City Aldermen
Director of Public Works and Engineering
Planner
Buildings and Housing Administration
Recreation Directors

(13) State Representatives

State Senator
State Assemblymen

(14) 1966 Officials of County, Two Creeks, Two Rivers and Manitowoc

These people were active in the siting of Point Beach power plant in 1966.

The local sample was divided into two groups: community leaders in the Two Rivers-Manitowoc area (170) and Two Creeks residents living within a five mile radius of Point Beach nuclear plant (20). Personal interviews were conducted by the University of Wisconsin Survey Research Laboratory.

The names of the individuals included in each group were derived from several different sources. First, the records of the Public Service Commission hearings on Point Beach were examined for people or organizations that testified. Next, articles related to Point Beach published in the Manitowoc-Herald Times between 1966 and 1969 were surveyed. Many of those articles described meetings between utility officials and local service organizations and endorsements given by local businesses and clubs. The Chamber of Commerce and the City Clerks of Two Rivers and Manitowoc supplied directories of the elected and appointed officials in the county and the names of officers in local labor groups, service clubs, and the Chamber of Commerce. Finally, selected Two Creeks and Two Rivers residents were interviewed to describe what happened in the community during the siting and construction of the plant.

ADDITIONAL SAMPLES

The knowledge and attitude questionnaires were also given to (1) field managers of Wisconsin Power and Light Company, Madison, Wisconsin and (2) executive board members of two environmental organizations—Sierra Club (Wisconsin State Chapter) and Capital Community Citizens (a Madison, Wisconsin environmental group). In addition these questions were administered at the start and at the end of a Nuclear Energy and the Environment course at the University of Wisconsin—Madison

UTILITY AND ENVIRONMENTAL GROUPS

At a conference sponsored by Wisconsin Power and Light on May 4, 1973, thirty-four utility managers filled out a short version of the questionnaire. One manager suggested that we give the same questionnaire to members of environmental organizations to determine if they were well informed on energy matters. The leaders of two environmental groups, the Sierra Club and Capital Community Citizens, were asked if the executive board members of each organization would fill out the questionnaire. Both organizations agreed to participate in the study. These environmental groups were chosen because they had been active in court cases involving the safety and environmental aspects of nuclear plants (Sierra Club) and had also taken part in Wisconsin Public Service Commission hearings on utility rate structures (Sierra Club and Capital Community Citizens). The questionnaires were given to the environmental groups at executive board meetings in May 1973. Seven members of the Sierra Club executive board and eight members of the Capital Community Citizens filled out the questionnaire.

ENERGY CLASS

The 'Nuclear Energy and the Environment"course was given at the University of Wisconsin-Madison in the fall of 1972. Dr. Wesley K. Foell of Nuclear Engineering and the Institute for Environmental Studies was the major professor. Since the course was for non-nuclear engineering majors, the class consisted of people with a wide variety of backgrounds—philosophy, journalism, zoology, civil engineering and environmental studies. On the second day of the class, August 18, 1972, each of the twenty-four students filled out the long version of the knowledge and attitude questionnaire given to federal and state officials. The results were tabulated and given to the class in September but individual questions were not discussed. At the end of the course, on December 8, 1972, 14 of the 24 students filled out the same questionnaire again. (See page 50 for discussion of the results of the student pre- and post-test.)

3. SURVEY RESULTS

KNOWLEDGE ON NUCLEAR POWER ISSUES

Selected knowledge scores for five major samples are presented in Tables 5 - 8. Complete data on responses to questions are presented with the annotated answers in Appendix D. Knowledge scores are expressed as percentages of correct answers. The reader will note in Appendix D that the average score for state officials is based on a larger number of questions that for other samples. The percentages for federal officials were not included because the federal sample was inadequate. The five samples compared here are:

20 Two Creek residents living within a five-mile radius of Point Beach Power Plant

170 community leaders in the Two Rivers-Manitowoc area

25 Wisconsin state officials

34 utility field managers in the Wisconsin Power and Light Company

15 environmental leaders in the John Muir Chapter (the Wisconsin state chapter) of the Sierra Club and in Capital Community Citizens (a Madison, Wisconsin environmental action group)

The selected knowledge scores are grouped into four categories. Table 5 presents questions in which respondents scores high. Table 6 presents questions which produced low score answers. Table 7 includes the questions for which there were large differences in the knowledge scores. Table 8 shows one "surprising" response in which not as many people answered correctly as might have been expected.

TABLE 5

High Knowledge Scores

N =	20	170	25	34	15
	Local Residents	Local Leaders	State Officials	Utility Managers	Environmentalists
Average total knowledge score	24%	30%	62%	67%	67%
Question No. 17 The use of wet cooling towers or cooling ponds is known to cause fog or icing at certain times of the year. TRUE	70%	60%	75%	97%	80%
Question No. 38: At present, the demand for electricity is growing at a faster rate than the population and the national economy. TRUE	75%	83%	96%	97%	100%
Question No. 51: Any person whose interest may be affected by an Atomic Energy Commission (AEC) licensing proceeding of a nuclear plant may file a petition for leave to intervene. TRUE	50%	63%	67%	97%	60%

TABLE 6

Low Knowledge Scores

N =	20	170	25	34	15
	Local Residents	Local Leaders	State Officials	Utility Managers	Environmentalists
Average total knowledge score	24%	30%	62%	67%	67%
Question No. 1: There is an established threshold limit below which radiation will not cause biological injury. FALSE	0%	9%	38%	15%	73%
Question No. 18: Coal-burning power plants are a major source of mercury pollution. TRUE	10%	5%	38%	6%	33%
Question No. 36: The current method of storing high-level radioactive wastes is: b) in boiling, liquid form in metal containers.	5%	2%	21%	6%	13%
Question No. 46: Delays in nuclear power plant construction and operation are the result of: e) all of the above. [i.e., a) equipment failures b) supply delays c) environmental concerns]	5%	14%	33%	37%	47%
Question No. 58: Present radiation standards take into account the total accumulation of radiation individuals receive from all emitting sources. FALSE	10%	9%	17%	43%	67%

TABLE 7

Large Differences in Knowledge Scores Between Samples

N =	20 Local Residents	170 Local Leaders	25 State Officials	34 Utility Managers	15 Environmentalists
Average total knowledge score	24%	30%	62%	67%	67%
Question No. 2: Exposure to radiation may cause: e) all of the above. [i.e. a) cancer b) genetic damage c) shortening of life span.]	10%	32%	75%	48%	80%
Question No. 9: Emergency core cooling systems have been tested under actual accident conditions in a power reactor and have proven to be effective. FALSE	5%	12%	58%	43%	66%
Question No. 13: Nuclear power plants using water from a river or lake for cooling purposes discharge about 50% more heated water than fossil-fueled plants using the same cooling method for an equal output of power. TRUE	20%	20%	67%	82%	60%
Question No. 21: Sulfur dioxide alone or in combination with particulate matter may cause: e) all of the above. [i.e., a) damage to vegetation b) corrosion of building materials, including stone, marble and steel c) respiratory diseases such as emphysema, bronchitis and bronchial asthma.]	5%	24%	92%	64%	80%
Question No. 31: Direct home heating by natural gas and oil can result in less pollution and waste of valuable energy resources than electric space heating. TRUE	15%	13%	67%	39%	87%

TABLE 7 (continued)

N =	20 Local Residents	170 Local Leaders	25 State Officials	34 Utility Managers	15 Environmentalists
Question No. 66 (matching): Moderator—a substance that slows down the neutrons produced by fission in a nuclear reactor	15%	15%	79%	81%	58%
Control rods—used to slow down or speed up fission chain reaction in a nuclear reactor	25%	25%	83%	90%	80%
Halflife—refers to the time required for the processes of decay to reduce the concentration of radioactive substance by 2	25%	32%	83%	90%	100%
Reactor core—consists of the fuel, the moderator, and the control rods in a nuclear reactor	40%	37%	87%	93%	87%
Fuel rod—contains nuclear fuel in the form of uranium dioxide pellets	30%	35%	88%	87%	73%
Curie—describes a quantity of radioactive material	15%	14%	79%	51%	66%
Fusion—a reaction in which nuclei come together to form more complex nuclei with the release of energy	15%	31%	88%	81%	87%
Cladding—the metal or carbon jacket around the fuel in nuclear reactors	15%	21%	83%	78%	87%
Rem—expresses the effect of radiation energy upon biological materials	15%	12%	83%	54%	66%
Fission—a reaction in which the most complex nuclei such as uranium or thorium split up into lighter components with the release of energy	20%	27%	96%	75%	93%

Tables 5, 6, and 7 show that community leaders in Manitowoc-Two Rivers did not score significantly higher on the knowledge questions than local residents near Point Beach power plant. The percentages indicate, however, that state officials, utility managers, and environmental leaders scored significantly higher on the knowledge questionnaire than local citizens.

Table 8 shows the percentages for one question on which the local residents were as knowledgeable as the state officials but these percentages are surprisingly low. When Point Beach power plant was being built, utility representatives held public information meetings in the area and stressed at those meetings that the nuclear plant would not explode like an atomic bomb. Because of the information campaigns of the utilities and AEC, it is surprising that no more local residents and leaders and state officials answered this question correctly. A large percentage of utility managers knew that such an explosion was not possible.

TABLE 8

Surprising Results

N =	20	170	25	34	15
	Local Residents	Local Leaders	State Officials	Utility Managers	Environmentalists
Average total knowledge score	24%	30%	62%	67%	67%
Question No.27 : An atomic explosion is not possible in current light water nuclear reactors. TRUE	45%	38%	46%	88%	53%

ATTITUDES ON NUCLEAR POWER ISSUES

The responses of the same five samples to the attitude questionnaire are summarized in Table 9 and are analyzed in the pages following Table 9.

TABLE 9

Summary of Attitude Responses

	(1) Strongly agree	(2) Agree	(3) Agree-disagree	(4) Disagree	(5) Strongly disagree	(6) Don't know
1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.						
Residents	10.0%	35.0%	5.0%	45.0%	-	5.0%
Leaders	6.9%	30.5%	14.4%	37.9%	9.2%	1.1%
State	4.2%	37.5%	16.7%	20.8%	8.3%	8.3%
Utility	3.0%	18.2%	15.2%	42.4%	21.2%	-
Environmentalists	53.3%	33.3%	6.7%	6.7%	-	-
2. Nuclear power plants should not be allowed to make any discharges of radioactive wastes into the air and water.						
Residents	15.0%	55.0%	-	25.0%	5.0%	-
Leaders	22.4%	47.1%	8.0%	17.2%	2.9%	1.7%
State	4.2%	25.0%	12.5%	29.2%	16.7%	8.3%
Utility	3.0%	9.1%	12.1%	48.5%	27.3%	-
Environmentalists	73.3%	20.0%	6.7%	-	-	-
3. The aesthetic impact of overhead transmission lines is not great enough to warrant the extra cost of putting them underground.						
Residents	-	65.0%	5.0%	10.0%	5.0%	-
Leaders	9.2%	52.3%	10.3%	20.1%	5.7%	2.3%
State	8.3%	41.7%	12.5%	25.0%	-	8.3%
Utility	33.3%	57.6%	9.1%	-	-	-
Environmentalists	-	-	33.3%	33.3%	33.3%	-
4. There is a direct relationship between growth of the national economy and the demand for power and energy.						
Residents	30.0%	65.0%	-	-	-	5.0%
Leaders	33.9%	60.3%	4.0%	1.1%	0.6%	-
State	20.8%	62.5%	4.2%	4.2%	4.2%	-
Utility	60.6%	36.4%	-	3.0%	-	-
Environmentalists	26.7%	40.0%	6.7%	20.0%	-	6.6%

(continued next page)

TABLE 9 (continued)

	(1) Strongly agree	(2) Agree	(3) Agree-disagree	(4) Disagree	(5) Strongly disagree	(6) Don't know
5. The use of electric power has helped people achieve an easier and better life.						
Residents	35.0%	65.0%	-	-	-	-
Leaders	42.0%	52.9%	3.4%	1.1%	0.6%	-
State	37.5%	54.2%	4.2%	-	-	-
Utility	66.6%	33.3%	-	-	-	-
Environmentalists	13.3%	53.3%	20.0%	6.7%	-	6.7%
6. The national government should encourage research leading to technological changes that would reduce the demand for electricity.						
Residents	10.0%	20.0%	-	50.0%	10.0%	10.0%
Leaders	11.5%	38.5%	16.1%	27.6%	3.4%	2.9%
State	16.7%	41.7%	8.3%	16.7%	4.2%	8.3%
Utility	3.0%	48.5%	21.2%	18.2%	9.1%	-
Environmentalists	73.3%	26.7%	-	-	-	-
7. The continued propserity and welfare of our nation depend on our ability to meet the increasing demand for electricity.						
Residents	25.0%	65.0%	-	10.0%	-	-
Leaders	29.9%	58.6%	5.7%	4.6%	1.1%	-
State	12.5%	50.0%	25.0%	8.3%	-	-
Utility	33.3%	63.6%	-	3.0%	-	-
Environmentalists	13.3%	-	20.0%	46.7%	13.3%	6.7%
8. Compared to fossil-fueled plants, nuclear plants are a clean source of energy.						
Residents	25.0%	65.0%	5.0%	-	-	5.0%
Leaders	30.5%	59.8%	5.2%	1.1%	0.6%	2.8%
State	29.2%	41.7%	12.5%	4.2%	4.2%	8.2%
Utility	36.4%	54.5%	9.1%	-	-	-
Environmentalists	-	13.3%	20.0%	60.0%	-	6.7%
9. Thermal effluent from power plants should not be discharged into lakes, rivers and other natural bodies of water.						
Residents	5.0%	35.0%	20.0%	25.0%	5.0%	10.0%
Leaders	11.5%	28.7%	21.8%	32.2%	3.4%	2.3%
State	-	4.2%	37.5%	45.8%	4.2%	8.3%
Utility	-	13.0%	30.3%	36.4%	21.2%	-
Environmentalists	46.7%	26.7%	26.7%	-	-	-

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TABLE 9 (continued)

	(1) Strongly agree	(2) Agree	(3) Agree-disagree	(4) Disagree	(5) Strongly disagree	(6) Don't know
10. To date, the public has not been involved in a meaningful way in the utility planning process.						
Residents	5.0%	55.0%	15.0%	20.0%	-	5.0%
Leaders	6.3%	48.3%	12.1%	27.6%	3.4%	2.3%
State	16.7%	45.8%	16.7%	20.8%	-	-
Utility	-	25.0%	21.8%	43.8%	9.4%	-
Environmentalists	60.0%	33.3%	-	6.7%	-	-
11. The fundamental question of whether specific power plants are in fact needed has not been subject to meaningful review by regulatory authorities or the public.						
Residents	5.0%	40.0%	5.0%	25.0%	-	25.0%
Leaders	3.4%	21.8%	10.3%	54.0%	7.5%	2.9%
State	-	41.7%	13.2%	25.0%	16.7%	4.2%
Utility	-	3.1%	6.2%	40.6%	50.0%	-
Environmentalists	40.0%	40.0%	-	6.7%	-	13.3%
12. There should be more channels for public participation in power plant site selection.						
Residents	10.0%	50.0%	5.0%	35.0%	-	-
Leaders	6.9%	29.3%	12.6%	46.6%	4.6%	-
State	8.3%	37.5%	17.5%	33.3%	-	4.2%
Utility	-	9.4%	34.4%	37.5%	18.8%	-
Environmentalists	53.3%	26.7%	13.3%	-	-	6.7%
13. Environmental costs of producing and supplying power should be included in the sale price of electricity.						
Residents	5.0%	70.0%	-	20.0%	-	5.0%
Leaders	5.7%	67.2%	5.7%	17.2%	2.3%	1.7%
State	16.7%	70.8%	8.3%	4.2%	-	-
Utility	50.0%	43.8%	3.1%	3.1%	-	-
Environmentalists	60.0%	26.7%	-	6.7%	-	6.7%
14. The current promotional rate structure of electric utilities should be modified to remove incentives for increased consumption.						
Residents	5.0%	55.0%	5.0%	20.0%	-	15.0%
Leaders	5.7%	37.9%	9.8%	37.4%	6.9%	2.3%
State	20.8%	29.2%	4.2%	29.2%	4.1%	12.5%
Utility	-	6.2%	21.9%	37.5%	34.4%	-
Environmentalists	80.0%	20.0%	-	-	-	-

(continued next page)

TABLE 9 (continued)

	(1) Strongly agree	(2) Agree	(3) Agree-disagree	(4) Disagree	(5) Strongly disagree	(6) Don't know
15. Full regulatory authority regarding licensing, safety, public health, and environmental impact of nuclear facilities at the federal level should be transferred from the Atomic Energy Commission to the Environmental Protection Agency.						
Residents	15.0%	5.0%	50.0%	10.0%	-	20.0%
Leaders	2.3%	12.1%	14.9%	52.9%	16.1%	1.7%
State	-	8.0%	12.5%	37.5%	25.0%	16.7%
Utility	3.1%	3.1%	12.5%	37.6%	37.5%	6.2%
Environmentalists	33.3%	33.3%	13.3%	-	-	20.0%

16. The Atomic Energy Commission is responsible for both promoting and regulating peaceful uses of nuclear technology. Are these two roles compatible?

	Yes	NO	Don't know
Residents	75.0%	10.0%	15.0%
Leaders	74.1%	21.3%	4.6%
State	54.2%	29.2%	16.6%
Utility	75.8%	12.1%	12.1%
Environmentalists	6.7%	80.0%	13.3%

There were no significant differences in attitudes between the five groups on three question. Residents, community leaders, state officials, utility managers and environmental leaders had a tendency to agree with these statements.

4. "There is a direct relationship between growth of the national economy and the demand for power and energy."

5. "The use of electric power has helped people to achieve an easier and better life."

13. "Environmental costs of producing and supplying power should be included in the sale price of electricity."

Correlations between attitude responses indicated that the questions clustered into two groups. For example, if a person had a tendency to agree with one group of attitude questions, he had a tendency to disagree with the other set of attitude questions.

In general, people who had a tendency to disagree with the six statements in Group 1 had a tendency to agree with the 10 statements in Group 2. Environmental leaders followed this pattern of agreement and disagreement.

Group 1

3. The aesthetic impact of overhead transmission lines is not great enough to warrant the extra cost of putting them underground.

4. There is a direct relationship between growth of the national economy and the demand for power and energy.

5. The use of electric power has helped people to achieve an easier and better life.

7. The continued prosperity and welfare of our nation depend on our ability to meet the increasing demand for electricity.

8. Compared to fossil-fueled plants, nuclear plants are a clean source of energy.

16. The Atomic Energy Commission is responsible for both promoting and regulating peaceful uses of nuclear technology. These two roles are not compatible.

Group 2

1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.

2. Nuclear power plants should not be allowed to make any discharges of radioactive wastes into the air and water.

6. The national government should encourage research leading to technological changes that would reduce the demand for electricity.

9. Thermal effluent from power plants should not be discharged into lakes, rivers and other natural bodies of water.

10. To date, the public has not been involved in a meaningful way in the utility planning process.

11. The fundamental question of whether specific power plants are in fact needed has not been subject to meaningful review by regulatory authorities or the public.

12. There should be more channels for public participation in power plant site selection.

13. Environmental costs of producing and supplying power should be included in the sale price of electricity.

14. The current promotional rate structure of electric utilities should be modified to remove incentives for increased consumption.

15. Full regulatory authority regarding licensing, safety, public health, and environmental impact of nuclear facilities at the federal level should be transferred from AEC to EPA.

In general, environmentalists and utility officials had a tendency to have stronger attitudes on nuclear power issues than local citizens or state officials, i.e. they were more likely to strongly agree or disagree with attitude statements. Two Rivers-Manitowoc citizens and state officials tended to agree with utility managers on attitude questions rather than with environmentalists. For example, in responding to three questions, residents, leaders and state officials had a greater tendency to agree with the attitudes of utility officials than with the attitudes of environmentalists.

	"Strongly agree" and "agree"	% Difference from Utility officials	% Difference from Environmentalists
1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.			
Residents	45%	24%	42%
Leaders	35%	17%	49%
State	42%	21%	45%
Utility	21%	-	-
Environmentalists	87%	-	-
6. The national government should encourage research leading to technological changes that would reduce the demand for electricity.			
Residents	30%	22%	70%
Leaders	50%	2%	50%
State	58%	4%	42%
Utility	52%	-	-
Environmentalists	100%	-	-
15. Full regulatory authority regarding licensing, safety, public health, and environmental impact of nuclear facilities at the federal level should be transferred from the Atomic Energy Commission to the Environmental Protection Agency.			
Residents	20%	14%	47%
Leaders	14%	8%	53%
State	4%	21%	63%
Utility	6%	-	-
Environmentalists	67%	-	-

4. DISCUSSION — SUMMARY — CONCLUSIONS

STUDY PRETEST AND RETEST IN A COURSE ON NUCLEAR ENERGY AND THE ENVIRONMENT

The knowledge and attitude tests were originally pretested in a class of undergraduate and graduate students in a course on Nuclear Energy at the University of Wisconsin-Madison. After that initial pretest and after the field survey was underway the course instructor and the authors decided to give the same test again at the completion of the course. The change in data and some comparisons of the students to the field samples turn out to be of enough interest to report here. Before and after data on students is based on a sample of 14.

The average knowledge score of the students was 52% correct before the course and 77% correct after the course. Thus, even before the course, most of the individuals in the class were as knowledgeable on the nuclear power issues covered in the questionnaire as state officials. (The average score for state officials was 62% correct.)

Individual knowledge scores ranged from 28% to 78% correct before the course and from 52% to 92% correct after the course.

After students completed the course, their attitudes had changed significantly on three of the questions. (T tests = .05 level of significance)

	Strongly agree	Agree	Agree-disagree	Disagree	Strongly disagree	Don't know
2. Nuclear power plants should not be allowed to make any discharges of radioactive wastes into the air or water.						
Before	33.3%	33.3%	16.7%	4.2%	-	12.5%
After	7.1%	35.7%	35.7%	7.1%	14.3%	-

Students had a tendency to disagree with this statement after the course. These students also had significantly more knowledge on radiation and nuclear power issues than they had before the course. State and local officials with more knowledge also had a tendency to disagree with this statement. Thus, knowledge on radiation and nuclear power issues may be an important factor influencing attitude on the elimination of radioactive discharges.

	Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
4. There is a direct relationship between growth of the national economy and the demand for power and energy.						
Before	45.8%	41.7%	8.3%	4.2%	-	-
After	7.1%	64.3%	7.1%	14.3%	7.1%	-

Students had a greater tendency to disagree with this statement after they completed the course.

	Strongly agree	Agree	Agree-Disagree	Disagree	Strongly disagree	Don't know
7. The continued prosperity and welfare of our nation depend on our ability to meet the increasing demand for electricity.						
Before	8.3%	20.8%	29.2%	20.8%	20.8%	-
After	-	-	28.6%	50%	21.4%	-

Students also had a greater tendency to disagree with this statement after they completed the course.

These changes in knowledge and attitudes are not necessarily the result of the students' participation in the "Nuclear Energy and Environment" course. Other factors such as the mass media exposure and attendance of public hearings could have influenced the attitudes and knowledge level of the students. However, the course did provide information on most of the issues covered in the questionnaire and a forum for discussing many of the attitude questions.

The students had significantly more knowledge on nuclear power issues before they completed the course than local residents and leaders in the Two Rivers-Manitowoc area of Wisconsin.

The attitudes of these students before the course also were significantly different from the attitudes of local respondents. For example, students had a greater tendence to agree with the following statements than local leaders and residents.

1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.

6. The national government should encourage research leading to technological changes that would reduce the demand for electricity.

9. Thermal effluent from power plants should not be discharged into lakes, rivers and other natural bodies of water.

10. To date, the public has not been involved in a meaningful way in the utility planning process.

11. The fundamental question of whether specific power plants are in fact needed has not been subject to meaningful review by regulatory authorities of the public.

12. There should be more channels for public participation in power plant site selection.

14. The current promotional rate structure of electric utilities should be modified to remove incentives for increased consumption.

15. Full regulatory authority regarding licensing, safety, public health, and environmental impact ofnuclear facilities at the federal level should be transferred from AEC to EPA.

16. The Atomic Energy Commission is responsible for both promoting and regulating peaceful uses of nuclear technology. These two roles are not compatible.

...And students had a greater tendency to <u>disagree</u> with these statements than local leaders and residents.

3. The aesthetic impact of overhead transmission lines is not great enough to warrant the extra cost of putting them underground.

5. The use of electric power has helped people to achieve an easier and better life.

7. The continued prosperity and welfare of our nation depend on our ability to meet the increasing demand for electricity.

At the start of the course, the average knowledge score of these students (52% correct) did not differ significantly from the average knowledge score of state officials (62% correct). However, many of the students' attitudes were significantly different from the attitudes of state respondents. For example, students had a greater tendency to <u>agree</u> with the following statements than state officials.

1. The public has not been kept fully informed of the risks and consequences of nuclear power reactor accidents.

2. Nuclear power plants should not be allowed to make any discharges of radioactive wastes into the air and water.

9. Thermal effluent from power plants should not be discharged into lakes, rivers and other natural bodies of water.

11. The fundamental question of whether specific power plants are in fact needed has not been subject to meaningful review by regulatory authorities.

12. There should be more channels for public participation in power plant site selection.

14. The current promotional rate structure of electric utilities should be modified to remove incentives for increased consumption.

15. Full regulatory authority regarding licensing, safety, public health and environmental impact of nuclear facilities at the federal level should be transferred from AEC to EPA.

...And students had a greater tendency to <u>disagree</u> with these statements than state officials.

3. The aesthetic impact of overhead transmission lines is not great enough to warrant the extra cost of putting them underground.

5. The use of electric power has helped people to achieve an easier and better life.

7. The continued prosperity and welfare of our nation depend on our ability to meet the increasing demand for electricity.

After the students had completed the course and had acquired more knowledge on nuclear power issues, the average knowledge score for the class was significantly greater than the average knowledge score of local and state respondents.

Although the students who participated in the "Nuclear Energy and the Environment" course, were more knowledgeable on nuclear power issues than local or state respondents, knowledge may not have been the only factor contributing to the differences in attitude between these groups. For example, before the students completed the course, their average knowledge level was not significantly different from that of state officials. However, at this time, the students had significantly different attitudes from those of state officials on ten of the sixteen attitude questions. Therefore, age, educational background, personal values, and other factors probably influenced the attitudes of these students and state officials.

Two major factors that may have contributed to the difference in attitude between students and local and state respondents were age and the environmental orientation of most students. The average age of students was 21 compared to 50 for local respondents and 42 for state officials. Many of these students were also majors in environmental studies and active in environmental groups. The attitudes of the students did not differ significantly from the opinions of environmentalists who filled out the questionnaire.

SUMMARY

The major hypothesis of this study is "that federal and state officials will have significantly more information on a technical issue such as nuclear power than local citizens, and that the attitudes of these officials will differ significantly from those of the citizens."

Since data at the federal level were incomplete, the study does not conclusively show that federal officials are better informed on nuclear power issues than local officials or, for that matter, than state officials. It is likely that experts in the Atomic Energy Commission and the Environmental Protection Agency, the two agencies most concerned with nuclear plant siting, could have answered reasonably well the knowledge questions. However, on the basis of a number of interviews conducted by the authors it appears that experts within these agencies are often knowledgeable on only one aspect of nuclear plants—radiation, thermal pollution, etc., and most of these experts are not expected to or required to relate their investigation of one subject to other issues. Thus, state officials who are not as specialized in their review often appeared to have a broader knowledge of nuclear issues than federal officials.

Most state officials scored fairly well on the knowledge questions—an average of 62% correct. Interviews with these officials also indicated that they were knowledgeable on many power plant siting issues.

At the local level, citizens in Two Rivers-Manitowoc did not score as well on the questionnaire—an average of 30% correct. These citizens scored especially low on the environmental impact section of the questionnaire. For example, while most citizens were aware of the increasing demand for energy, few citizens were knowledgeable on air pollution and radioactive waste disposal.

There were certain issues in which respondents at all levels lacked knowledge. Most respondents did not know that there is no established threshold limit below which radiation will not cause biological injury; that the current method for storing high-level radioactive wastes is in liquid form in metal containers and not solidification and storage in salt mines; that emergency core cooling systems have not been tested under actual accident conditions in a power reactor; that coal-burning power plants are a major source of mercury pollution; that present radiation standards do not take into account the total accumulation of radiation individuals receive from all emitting sources; and that delays in nuclear power plant construction and operation are the result of equipment failures, supply delays and environmental concerns and not just environmental concerns.

On reviewing the knowledge results, one could ask "but what does the questionnaire really measure? Can you assume that a high score on the questionnaire indicates that a person is knowledgeable on all nuclear power issues?" In the strictest sense, the questionnaire only measures a person's knowledge of certain facts on nuclear power, the environmental consequences of power production, energy alternatives, energy demand and power plant regulatory requirements. And some of the questions on these issues may be ambivalent. However, it is not unreasonable to assume that a person who answers most of the questions on radiation hazards correctly is familiar with this issue and probably has some knowledge on radiation.

A more important question is whether a person who knows these facts can assimilate the material on radiation, air pollution, waste disposal and other issues, understand the interrelationships between these issues, and come to an intelligent decision as to whether a nuclear plant, a fossil-fuel plant or no plant should be built in a certain location. Some scientists would argue that even if a layman has some knowledge of nuclear safety, thermal discharges or radiation, he is not equipped to deal with the facts or understand their significance without a professional background in the field of nuclear energy, water chemistry or radiology. In other words, a citizen could not form an intelligent opinion on whether a nuclear or fossil-fuel plant should be built. While no individual is likely to have expertise in all the fields related to power plant siting, someone has to make the decisions about what type of power plant should be built and at what location.

The complexity and technical nature of nuclear power and other environmental problems make them extremely difficult issues for the general public to cope with. In a paper entitled "The Nuclear Power Information Communication Predicament," Costagliola, a former AEC commissioner, concluded that even college doesn't equip a person with the ability to assimilate and rationally deal with information on nuclear power. He felt that the educational process is fragmented, so people can't see the interrelationships among various subjects. This fragmented way of learning is carried over to the real world through the mass media which presents information in bits and pieces.*

Perhaps a more important factor than the fragmented presentation or discussion of a technical subject such as nuclear power is the controversial and ambivalent nature of nuclear issues. There are no really clear cut answers to many of the questions on nuclear safety, thermal pollution or energy supplies. One group of experts may present scientific evidence to show that nuclear plants are safe and another group may present evidence proving that they are unsafe. Thus, much of the information presented to the public may look like "modern propaganda" or "half-truths" because there is no one complete and total "truth" about an issue. People interpret the facts about nuclear safety or thermal pollution differently and their conclusions are packed with value judgments.

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*Costagliola, F., "The Nuclear Power Information Communication Predicament," *The Environmental and Ecological Forum 1970-71*, Oak Ridge, Tennessee: AEC, pp. 131-143.

Our study shows that involvement with environmental groups and reading environmental literature was related to the knowledge and attitudes of respondents. In fact, our sample could be allocated to environmentally oriented and non-environmentally oriented individuals and on this basis, one could predict their attitudes on many issues. However, the fact that some people belonged to environmental groups and read environmental magazines does not fully explain why their attitudes differ so radically from the attitudes of others.

At the local level, a series of demographic questions were added to the survey. With these data we made four hypotheses:

1. *"Education and personal interest will be highly associated with the quality of information acquired by an individual on the issue of nuclear power."*

Formal education was not highly associated with the knowledge level of local respondents. Although local leaders had significantly more education than local residents, they did not have significantly more knowledge on nuclear issues.

In other studies, prior knowledge, i.e., information acquired through previous education or reading, has been strongly correlated with acquisition of highly technical or scientific information. However, the fact that someone has a college education or a professional degree does not mean that he or she necessarily has prior knowledge of nuclear power. A well educated citizen may have the ability to comprehend nuclear issues but is not knowledgeable on these issues either because he has never had access to information on nuclear power or he is not tuned in to the issues. Citizens—especially community leaders—must also deal with many social and environmental problems and it is difficult for them to be knowledgeable on all issues.

Thus, in this study, the knowledge gap is not between high and low socio-economic levels or high and low educational levels but between citizens and governmental specialists. Although it may be unrealistic to hope to bridge this knowledge gap, citizens need to be able to convey their interests and concerns about nuclear power to the federal and state experts in nuclear energy or environmental sciences. It may be possible to bring local governmental leaders and specialists together for workshops or meetings, so local citizens can become more familiar with fundamental energy issues. With sufficient knowledge on nuclear issues, community leaders and citizens can ask more meaningful questions and work more closely with specialists on siting decisions in their community.

A more important factor than education was personal interest. Citizens who felt some personal danger from the power plant's presence were more knowledgeable on nuclear issues than those who perceived no personal danger. In other words, people concerned about the possible effects of the nuclear plant were more knowledgeable about the environmental consequences of power production, energy needs and alternatives, and power plant regulatory proceedings. Their attitudes on these issues were also significantly different from other citizens.

2. *"Persons who prefer newspapers or magazines as sources of public affairs information will have more and better information on nuclear power than persons who prefer television or radio. Multi-media usage will produce the highest acquisition of information."*

The total media exposure of local leaders was related to their overall knowledge of nuclear issues. However, knowledge of these issues was correlated with only one particular medium—magazines—and not with newspapers, radio or television. Furthermore, local respondents who read conservation and environmental magazines such as Audubon, Sierra Club Bulletin or National Wildlife were more knowledgeable on the questionnaire than other respondents. Thus, persons who preferred magazines as sources of public information—especially environmental or scientific magazines—had more and better information on nuclear issues than persons who preferred newspapers, television or radio.

3. *"The amount of information that a person has about nuclear power will vary with the amount of influence that a person sees himself to have in the decisionmaking situation."*

The local respondents who thought that they had a lot or some influence in the siting of a nuclear power plant in their community did not have significantly more knowledge on nuclear issues than respondents who thought that they had little or no influence in the decisionmaking process. Most local citizens were just not well informed on nuclear issues, regardless of whether they considered themselves influential or not.

4. *"People with more social contact or belonging to a number of organizations will have greater knowledge than those who have less social contact."*

Local leaders belonging to a number of organizations had more knowledge on nuclear issues than those who had less social contact. Members of activist environmental organizations such as the Sierra Club were among the most knowledgeable respondents.

CONCLUSIONS

The majority of citizens in Two Rivers-Manitowoc were overwhelmingly in favor of the Point Beach nuclear power plant both before and after it was built. Several factors contributed to the positive feelings that most respondents had toward Point Beach. First, many businessmen and governmental officials were attracted to the economic benefits associated with the plant's construction—such as increased tax base, employment, and increased business. Second, the public relations work of the electric utility was very effective in creating a good image of Point Beach. For example, when the plant was first announced, utility officials held public meetings and spoke to citizen organizations about nuclear power. Permanent employees of the nuclear plant became involved in civic affairs. In fact, several respondents commented that "the manager of Point Beach was the best public relations man that the utility had." Finally, most citizens felt that the utility officials were knowledgeable on nuclear issues, respected these officials and trusted them to do a good job.

In contrast, many of the citizens interviewed had a very negative impression of the environmentalists who had intervened in the licensing of the nuclear plant. These intervenors were considered "outsiders" who did not represent the interests of the Two Rivers-Manitowoc community and, thus, were not credible sources of information for local citizens. Furthermore, the information that environmentalists were trying to convey to citizens was fear-arousing. The environmentalists' claim that the nuclear plant might not be safe suggested that there was a chance of an explosion which could destroy the community. For example, when local respondents were asked "What do you think the damages to a surrounding community might be if a major accident occurred at a nuclear power plant?" many respondents found the question offensive or unfair and refused to answer it. The interviewers commented that most respondents appeared upset or disturbed by the question.

Although there were several public hearings on safety and environmental aspects of Point Beach and some news coverage of these events, the majority of citizens were not well informed on the environmental consequences of power production. However, the controversy over environmental impact and nuclear safety occurred after the Two Rivers-Manitowoc community had supported the construction of the nuclear plant. As a result, the citizens may not have been very receptive to information that was dissonant with their prior decision.

Furthermore, since issues such as thermal pollution and nuclear safety were controversial, i.e. experts disagreed on these issues, citizens could have selectively read material that reinforced their belief that the plant was safe and a clean source of energy. There is also the possibility that citizens may not have had access to information on many environmental issues. For example, the local newspaper did not give extensive coverage to environmental issues or other controversial aspects of Point Beach. And no citizens interviewed read magazines such as *Science* or *Environment* that covered these issues in depth.

However, even if there had been more local coverage of safety and environmental issues, we doubt that the citizens would have changed their attitude toward the nuclear plant. For example, in Humbolt County in California, the Pacific Gas and Electric Company built a nuclear plant at Eureka. After the plant was built, a reporter for the Eureka Times Standard did a long series of stories detailing charges made against the plant by a discharged employee. His series detailed radiation readings more than twice as high as those recommended by the AEC in its new guidelines. The reporter, John A. Read, said that the series involved an enormous amount of research but was unrewarding because "the citizens just weren't interested."

As with Point Beach, there was no local opposition to the Eureka nuclear plant, and the citizens resented visitors and outsiders coming into their community and telling them that the plant was dangerous. Most people in Eureka and Point Beach recognized the nuclear plant as an economic asset—a clean piece of tax base—and only wished to be good neighbors.

Citizens in Two Rivers-Manitowoc and Eureka might have been more receptive to information on safety and environmental issues if they had received this information before they had made the decision to permit construction of the nuclear plant in their community. Environmental hearings and meetings held after the plant was built only served to put local citizens in the position of defending the plant and created hostility between the community and the environmentalists intervening in the plant's operation.

The survey results also revealed that there was little communication between federal, state and local levels. The Department of Interior had developed formal contacts with the AEC for the purpose of reviewing certain aspects of nuclear plants; however, in general, there was little contact between federal agencies except to send the AEC comments on environmental impact statements. The state Department of Natural Resources did consult with the Department of Interior and the Environmental Protection Agency but DNR officials indicated that communication with EPA had not been very satisfactory. Interviews with Two Rivers-Manitowoc officials indicated that there was practically no contact between these local leaders and citizens and state and federal officials.

As a result, there was little coordination between federal, state and local officials in the siting of the nuclear plant. The only party that consulted with all these officials and that tried to make the licensing process flow smoothly was the electric utility company building Point Beach. But what a bureaucratic jungle the company had to crawl through!

The licensing process might flow more smoothly if one agency at the federal level coordinated the review process. At present, the AEC is responsible for reviewing all comments from federal and state agencies on the environmental, economic and social impact of a nuclear plant and for deciding whether the construction of a nuclear plant is desirable.

While most people would agree that there should be more coordination between state and federal agencies in the licensing process, not everyone would favor more local involvement in this process.

If citizens are to become more involved in nuclear power plant siting or other issues, they will need objective sources of information on the issues and forums for discussing them. A state or independent agency within the state could serve as an information-education center where citizens could request information on energy issues and other environmental problems. This agency could also refer citizens to other sources of information. Responsible local or regional mass media—such as newspapers, and television stations—could cover some of the siting issues in depth. Public meetings and informal hearings could be held in the community. Such public participation in the early planning stages of power plant siting could teach citizens how to deal with intricate problems such as nuclear power and train future community leaders who can bridge the gap between citizens and technocrats (technical experts in governmental agencies). Citizens could also plan for the social and economic impact of the power plant on their community.

APPENDIX A

POWER PLANT SITING LEGISLATION IN WISCONSIN AS OF 1 JUNE 1974*

In February 1974 the Wisconsin General Assembly passed Assembly Bill 814. This bill required Wisconsin's electric utilities to prepare bienniel "advance plans" for development of major generating and transmission facilities. It required electric utilities to obtain a "certificate of public convenience and necessity" from the Public Service Commission before building new facilities. Also, AB814 put conditions on utilities' powers of condemnation—they had to get 60% of the necessary land through voluntary arrangements. However, when the Legislature adjourned in March, it had reached no final agreement on the power plant siting bill.

When Governor Lucey called the Wisconsin Legislature into special session at the end of April, he included power plant siting among their major charges. At the Governor's request, Special Session Senate Bill 1 was introduced. This bill retained most of the features of AB814, the regular session bill.

At the same time, members of the State Senate introduced Senate Substitute Amendment 1 to Senate Bill 1. The amendment, favored by Wisconsin's investor-owned utilities, strongly contrasted with SB 1. The amendment strengthened the condemnation powers of utilities by cutting some of the prerequisites to using those powers. Also, the amendment did not permit local governments to stop construction or operation of certain proposed electrical facilities. Further, the Senate amendment deleted requirements for environmental impact statements and judicial review at the planning stage. These requirements held, however, at the construction certification stage.

In the special session, the General Assembly's version of the power plant siting bill became Assembly Substitute Amendment 1 to SB 1. The houses deadlocked over provisions dealing with utility power to override local ordinances and the extent or condemnation powers. Senate and Assembly versions went to a conference committee early in May.

Wisconsin's power plant siting bill has not yet come out as a report of the conference committee.* Besides trouble in compromise on the home rule and condemnation issues, dispute over the type of public hearings for review of utility advance plans has caused problems in the committee. Committee members have argued about two major types—the legislative hearing and the quasi-judicial hearing. Both are supposed to offer interested persons a chance to input into the planning process. Yet, some committee members argue that the second type would build a more suitable record, adequate for full judicial review. Some members have proposed a "fair play hearing" to follow any legislative hearing. These men intended to reduce the importance of Public Service Commission discretion at hearings early in the advance plan approval process.

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*The special session of the legislature ended on June 13, 1974, with no action on the power siting bill.

The following is a summary of Governor Lucey's power plant siting bill in the 1974 Special Session of the Wisconsin Legislature. If one of the current proposals becomes law during this session, it is not likely to be as strict as this version. Areas of most probable compromise are degree of home rule, extent of utility condemnation power,and quality and timing of public input into the planning process.

1974 Special Session Senate Bill 1

29 April 1974—Introduced by the Committee on Senate Organization, by request of Governor Patrick J. Lucey.

Special Session Senate Bill 1 establishes a process allowing closer public and government scrutiny in the development of major electric generating and transmission facilities in Wisconsin. It grants greater authority over electric power planning and construction to the Public Service Commission (PSC) and the Department of Natural Resources (DNR).

The bill requires every electric utility, including electric cooperative associations, to file "advance plans" with the PSC every two years, beginning in 1975. Generally, the plans indicate anticipated electrical demand and how the utility intends to respond to this demand. If the utility expects to construct major generating plants—bulk and intermediate load—or transmission facilities, it must:

1) Describe the location, size and type of proposed facilities;

2) Indicate what demand these facilities would satisfy;

3) Propose practical alternatives to their own plans;

4) Specify environmental impacts and possible responses to adverse impacts at particular project sites which the utility intends to use in the next three years.

The utility must develop these advance plans in coordination with the Federal Power Commission's electric power planning activities.

When the utility files advance plans with the PSC, it must also send copies to the DNR, the Department of Administration, the Department of Health and Social Services, the Department of Local Affairs and Development, the Department of Transportation, the Department of Justice, the Department of Business Development and appropriate regional planning commissions. Also, the utility must send relevant parts of advance plans to appropriate county planners and city, town and village governments with jurisdiction over the area of any project site.

Soon after receiving an advance plan, the PSC sends a copy of the plan—or relevant parts—to the main public library in each county, city, town and village affected by that plan.

Within 180 days after receipt of an advance plan, agencies must review the plan and submit comments to the PSC. Agency comments must include:

1) A description of any statutory permits or approvals required by the agency.

2) A description of the types and forms of information required for adequate review of an application for each permit or approval.

3) A discussion as to the areas in which the plans coordinate with the agency's plans, policies, functions and programs and the areas in which the plans conflict and the significance of such conflicts.

Following the same time limit, local governments and any interested persons may send comments to the PSC.

Within 150 days after the PSC receives an advance plan, it must prepare a general environmental impact statement on that plan. This statement is made public for at least 30 days, after which the PSC must hold a hearing. Not an adversary proceeding, this public hearing is only for information and clarification at the discretion of the PSC. The PSC may hold hearings in any region where there is significant public interest or concern. Residents of a county which has a proposed site may petition the PSC to hold hearings at a more convenient location.

The PSC approves an advance plan when, on the basis of submitted comments, its environmental impact statement and the record of the public hearings, that plan:

1) Will result in an adequate supply of electrical energy;

2) Is technologically, economically and environmentally satisfactory;

3) Is reasonably coordinated with the plans and policies of other agencies.

Also, the PSC may wholly or partly approve an advance plan. In the latter case, the PSC specifies which parts are incomplete or need modification. Every approved plan must include the PSC's list of those permits and approvals the utility must obtain prior to first construction and those the utility can get after building starts.

Before an electric utility may actually construct a major electric generating or transmission facility, it must obtain a "certificate of public convenience and necessity" from the PSC. Furthermore, the utility must obtain all permits and approvals required by the DNR.

Once an application for a certificate is filed, the PSC, aided by the DNR, must prepare a detailed environmental impact statement or determine that no statement is required. Except for the environmental duties of the DNR, the PSC is responsible for every aspect of the certificate application review.

At least 30 days after the PSC has made the environmental impact statement public, it must notify and hold hearings that include the applicant, specified governmental agencies, affected land owners, other interested persons and the public. At the same time, the DNR must hold hearings on permits and approvals it requires and on whether the proposed facility will comply with environmental statutes and rules it administers.

The PSC issues a certificate of public convenience and necessity when:

1) The DNR grants all necessary permits and approvals or exercises an option which conditionally approves engineering plans following public hearings, which shows that the proposal complies with the DNR's environmental statutes and does not unduly affect public rights and interests in natural resources including navigable waterways, the effective flood flow capacity of a stream, the rights of other riparian owners, and water quality;

2) The proposed facility is consistent with the most recently approved advance plan;

3) The proposed facility is necessary to supply adequate electric energy.

4) Its design and location is satisfactory and will not have an undue adverse impact on the environment or unreasonably interfere with orderly land use and development.

Included in the certificate is the condition that the facility must comply with federal, state and local requirements regarding pollution and land use. No local ordinance may work to preclude or inhibit the building or operation of an approved facility. And for environmental impact statements or PSC decisions regarding an advance plan or certificate of public convenience and necessity, judicial review is the exclusive judicial remedy.

Finally, Special Session Senate Bill 1 establishes several conditions for the use of condemnation powers by public utilities:

1) An electric utility must obtain a certificate of public convenience and necessity from the PSC prior to condemning property for construction purposes. Issuance of a certificate determines that a taking is necessary. An electric utility may condemn limited interests for test and study purposes without a certificate, but such activity must be consistent with approved advance plans and cause minimum disturbance to the property and its owner. A limited property interest cannot exceed three years duration.

2) No public energy utility, including electrical utilities, may condemn without prior approval from the most immediate local government. This does not apply to rural electric cooperative associations.

3) An electric utility must acquire at least 60% of a proposed generating facility's land area through voluntary negotiations.

APPENDIX B

OFFICIAL FUNCTIONS OF STATE REGULATORY AGENCIES

PUBLIC SERVICE COMMISSION (PSC)

The Public Service Commission authorizes a utility to spend money on a new power plant by granting a Certificate of Authority. The two basic considerations in granting the CA are: 1) "If the public convenience and necessity require such work," i.e., if it is needed and 2) if it is economically feasible and does not involve unreasonable expenditures. Under the recently passed Wisconsin Environmental Policy Act, the Commission must also consider the environmental impact of a major utility construction.

In applying for a CA, the utility describes its plans for the proposed power plant, the details related to the need for the plant and the cost and feasibility of the project.

A public hearing may or may not be held; except that in the case of a major project like a nuclear power plant, a public hearing is almost a certainty. The state environmental impact law may also require a hearing on this type of project. Notices of hearings are usually sent to the local governmental units (county, town, municipality) in the area of the site and also to news media in the area. The hearing may be held in the Commission's offices in Madison or in the locality of the site (usually the county seat or the nearest suitable location).

At the hearing, the utility presents its justification of the necessity and feasibility of the plant. The Commission and its staff question or cross-examine the utility to solicit further information. Members of the general public may also present their views on the proposed project and may question utility witnesses.

For the construction of a nuclear power plant, all three utility divisions of the Commission staff may be involved. The Engineering Division is involved in researching the need and economic feasibility, the Accounts and Finance Division and the Rates and Research Division are involved with the feasibility, financing, and effect on the rates. However, the final decision to grant a CA is the responsibility of the Commission itself (the 3 Commissioners), based on the record of the case as contained in the application and the hearing transcript and exhibits.

In determining if a power plant is needed, the PSC staff relies primarily on electric load forecasts supplied by the utilities and the Federal Power Commission. The PSC may cross-check some of the utility projections by referring to state and federal population growth estimates for regions, or by conducting its own study. In assessing environmental impact, the PSC works closely with the Department of Natural Resources and allows discussion of environmental matters at public hearings. However, where a project requires an environmental review at the federal level, the PSC is not required to duplicate this review. In the case of a nuclear power plant, the Atomic Energy Commission prepares an environmental impact statement on the proposed project.

The timetable from receipt of application to PSC authorization varies with the completeness of the utility's application, the scope of the project, the length of the hearing, whether there is opposition, and the Commission's work load. This may involve several weeks to several months. Since Commission authorization is required prior to any construction, the application must be filed far enough in advance to fit the utility's proposed construction time schedule. Large generating plants, especially nuclear, usually require from 8 to 10 years to construct.

The Public Service Commission is also the appointed liaison agency between the Atomic Energy Commission and the state. The Commission receives copies of most AEC filings and correspondence with respect to its regulatory functions in nuclear plant licensing. A file is kept for the information and use of all other state agencies and is also open to the public.

DEPARTMENT OF NATURAL RESOURCES

In the Department of Natural Resources (DNR), several bureaus in the Division of Environmental Protection are concerned with nuclear power plant siting and construction.

The Industrial Wastewater Section in the Bureau of Water Supply and Pollution Control reviews plans for intake and water treatment facilities of nuclear plants and, if the plans meet state standards, issues a letter of approval. This section is concerned with chemical wastes, including radioactive materials and the treatment of these wastes before they are discharged into a river or lake.

Domestic sewage is handled separately by the Municipal Wastes Section. The utility submits its plans and specifications for sewage treatment to this section for review at least 30 days before approval is desired. No construction can be started until the approval is obtained. The Municipal Wastes Section also investigates functioning systems and if excessive pollution is found, an abatement order is issued requiring the submission of plans by a certain date for correcting the pollution.

The Bureau of Water and Shoreline Management must review and approve cooling water intake or discharge structures that extend into navigable water. The utility applies for a permit to build such a structure and a hearing may be held on the application. The bureau will grant the utility a permit if the intake structure doesn't obstruct navigation or reduce the effective flood flow capacity of a stream and is not detrimental to the public interest.

If a nuclear plant discharges warm water directly into a lake or river, the utility must also comply with state thermal standards set by the DNR. The Bureau of Standards and Surveys—Water Quality Evaluation Section—recommends water quality standards to the Board of Natural Resources. The Board considers these staff recommendations, testimony given at public hearings on proposed standards and then adopts final state water quality standards. These standards must meet the approval of the federal Environmental Protection Agency.

In the future, permits for thermal discharges will be issued by the DNR. The necessary enabling legislation was passed by the Wisconsin legislature in February 1974 so that the DNR has the authority to operate the permit program as soon as EPA issues the effluent guidelines. These guidelines are expected by the end of September 1974. After January 1, 1975, it will be illegal for any power plant to operate without a permit for thermal discharge.

DNR's Environmental Impact Section reviews environmental impact statements for state and federal projects. It, therefore, reviews and comments upon Atomic Energy Commission statements for proposed nuclear power plants. It does not hold a Public Hearing as part of the review. Its comments on the environmental impact statement are forwarded to the AEC.

Other bureaus or sections in the DNR may be involved in the environmental review of nuclear plants. For example, the Bureau of Fish Management comments on nuclear power plant siting and construction.

RADIATION PROTECTION SECTION (DEPARTMENT OF HEALTH AND SOCIAL SERVICES)

The Radiation Protection Section of the Department of Health and Social Services conducts both onsite and offsite monitoring for radiation from nuclear power plants located in Wisconsin. In 1973, this division entered into contract with the AEC to collect samples of particulate matter from plant stacks and gaseous and liquid wastes from holding tanks within the nuclear plant and to analyze these samples for levels of radioactivity. The samples collected are divided equally between three groups: the AEC Idaho Falls laboratory, the utility and the state Radiation Section. In the past, the utility conducted most of the onsite monitoring but now the AEC requires its laboratory and the state laboratory to provide separate evaluations of the same onsite samples.

The Radiation Protection Section also tests fish, vegetables, soils, water and air for levels of radioactivity within at least a ten-mile radius of the plant. It collects rainwater samples and looks for radioactive isotope buildup in the food chains. Copies of its reports are sent to the Atomic Energy Commission, the Environmental Protection Agency, the Public Service Commission and other interested groups.

The radiation standards adopted by the state of Wisconsin are the same as those used by the AEC. The Radiation Protection Section uses these standards in its offsite investigations and has the power to issue abatement orders where excess radiation levels are found. So far this has not been necessary.

INDUSTRIAL SAFETY AND BUILDING DIVISION (DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS)

The Industrial Safety and Building Division of the Department of Industry, Labor and Human Relations is concerned with all buildings built in Wisconsin, public or private, which are larger than single and two family homes or small farm buildings. Plans and specifications must be submitted to the Division to be reviewed for compliance with the state safety code. Unless a major change in the plans is necessary, the Division will give a conditional approval listing any small violations to be corrected, or if everything is in order, a letter of approval. The approval letter qualifies the company for a local building permit from the municipality. Code requirements are the same for all buildings.

However, in the case of nuclear power plants, state codes really do not cover the special safety features of these buildings. Nuclear reactor safety and radiation controls are strictly under the regulation of the Atomic Energy Commission. In fact, the Division usually approves exceptions from state codes for nuclear power plants. For example, a nuclear plant would not require the same type of fire exits or windows as another industrial building in the state. The plant must be constructed to contain any accident or any leakage of radioactive materials; so windows or exits required by state codes may not be appropriate.

When the Division grants a letter of approval, it charges a fee to cover the cost of inspecting the building. From one to six inspections are conducted during the construction of the building, including a final one. After completion of the building, the Division continues to conduct periodic routine inspections. If a violation is found, an order is issued to correct the problem.

Several sections of the Division oversee particular aspects of plant construction and equipment safety. Individual sections are concerned with boilers and pressure vessels, electricity, elevators and escalators, and construction site safety. In each case procedures are the same. Plans are reviewed for compliance with the appropriate standards and approval is granted. This is not a formal permit or license, however. The Department's regulatory powers are exercised when a violation is found and an order issued. Each section oversees its particular concern during construction or installation and by routine inspections after the plant is completed.

DEPARTMENT OF JUSTICE

Members of the Environmental Section of the Attorney General's Office represent the state of Wisconsin at licensing hearings for nuclear power plants. The office also comments on environmental impact statements.

DEPARTMENT OF TRANSPORTATION

This department may be involved with power plant siting when access roads are constructed, existing roads are close, or oversized load permits are needed.

DEPARTMENT OF ADMINISTRATION

The Wisconsin Aeronautics Division checks the right-of-way for proposed transmission routes from the proposed power plant to be sure they won't interfere with existing or proposed airports.

DEPARTMENT OF LOCAL AFFAIRS AND DEVELOPMENT

The Division of Economic Development is favorable to the building of nuclear power plants in Wisconsin. It does not have any regulatory or licensing powers but encourages their acceptance because of the vital necessity of adequate supplies of electricity to economic and industrial development within the state.

A nuclear power project includes the purchase of several thousand acres of land and causes major relocation. Prior to any purchase of land, a utility must receive approval from the Division of Housing of a "Relocation Plan." The plan is supposed to assure "reasonably adequate rehousing" of all persons displaced by a utility project. In order to educate utility representatives to the requirements of the law and the agency rules, the Department sets up informal meetings and training sessions before it accepts relocation proposals. In a Relocation Plan a utility must:

1) delineate precisely the boundaries of the project,

2) disclose exactly which parcels of land, residences, farm units, and businesses would be displaced,

3) conduct personal interviews with all affected persons, assessing their relocation needs,

4) determine the amounts and types of necessary rehousing,

5) assure reasonably adequate rehousing by: a) showing that equivalent units are available in reasonable locations at reasonable prices, or, b) providing an alternative housing plan. This could be promises to build comparable replacement housing or to move existing buildings.

The law does not require a utility to show that other farm land is available or to provide relocated farm land. Only farm residences are involved. And under the law, there can be no cash substitute for relocated housing, since the utility is dealing with a state agency, not property owners. The information in a Relocation Plan need only be valid at the time a utility submits its proposals. After the Department grants approval, changing conditions do not warrant a new or revised Relocation Plan.

At one point, the Department relocation guidelines seem to go beyond the enabling legislation in the Wisconsin Stats. Chapter 32.19-26 (Ch. 103, Laws of 1971). That is, the guidelines call for "comparable replacement housing not subject to adverse environmental location." In the future, the Department may have to treat broader environmental problems in relocating persons near nuclear power plants. And regarding future large-scale nuclear generating complexes, the Department is not certain to what extent it will be involved in more comprehensive relocations. For instance, if the Wisconsin-Upper Michigan Systems consortium were to choose Haven in northern Sheboygan County as the site for two or more nuclear units, it is likely the utilities would have to relocate the entire village.

APPENDIX C

OFFICIAL FUNCTIONS OF FEDERAL REGULATORY AGENCIES

ATOMIC ENERGY COMMISSION

The Atomic Energy Commission is responsible for the promotion and regulation of peaceful uses of nuclear technology. These responsibilities are carried out by the General Manager and the Director of Regulation who report directly to the Commission. (The Commission is composed of five members appointed by the President with the advice and consent of the Senate.)

Under the direction of the General Manager, programs are developed for the promotion of industrial, institutional and public participation in the development and use of atomic energy for civilian purposes. This office disseminates technical and scientific information through publications, exhibits and other means and also sponsors special purpose training in the interest of the development of atomic energy uses.

The policy development and program coordination functions are performed primarily by the Washington Headquarters divisions. However, the operations are carried out largely by industrial concerns and private and public institutions under contracts administered by the 12 AEC field offices.

The Director of Regulation is responsible for the licensing and regulation of the civilian use of nuclear materials and the construction and operation of nuclear reactors and other nuclear facilities. Under the Director, there are programs for the safeguarding of special nuclear materials in the possession of AEC licenses. Agreements are negotiated with the states for their assumption of certain licensing and regulatory authority for atomic energy activities. Finally, this office develops and enforces rules and regulations governing the construction of nuclear reactors and facilities for the protection of the public health and safety.

The inspections of licensees for compliance with applicable regulations are carried out by five regional compliance offices and three district safeguards offices.

AEC Process of Licensing Nuclear Power Reactors

The AEC publishes criteria to guide utility companies in selecting sites that will be safe in terms of site hydrology, geology, meteorology, seismology, use and population density of the immediately adjacent land, and the distance to the nearest population center. Other factors that must be considered are the characteristics of the proposed reactor, including maximum power level, and the particular safety features to be engineered into the plant either to prevent accidents or to limit their consequences. A prospective applicant is encouraged to discuss informally the possible sites for the reactor with the Commission's regulatory staff. Once the site is chosen, detailed studies of the site characteristics are begun.

Until March 1972, the utility could construct facilities such as a turbine building and water intake and discharge structures before the issuance of a construction permit. Under a new amendment, "commencement of construction" is defined, for facilities subject to environmental review, to include any clearing of land, excavation or other substantial action that would adversely affect the natural environment of a site, and construction of non-nuclear facilities.

In February 1974, the AEC proposed amendments to the licensing procedure that would allow such construction activities before a "construction permit" is actually granted but only after hearings are held on environmental issues. Under the new amendments, the AEC would have separate hearings and decisions on National Environmental Policy Act issues. If the findings and decisions on NEPA issues are favorable to the issuance of a construction permit, the applicant would be authorized to begin certain onsite preparation activities. However, any activities undertaken would be entirely at the risk of the applicant and the issuance of the authorization would not prejudice resolution of any outstanding issues in the proceeding with respect to the requirements of the Atomic Energy Act of 1954. A full hearing on all such issues would still be required before issuance of any construction permit.

In order to receive a construction permit (class 103 license), the utility files an application with the Director, Division of Reactor Licensing. Copies of the application are also sent to each atomic safety and licensing board member and the Chairman, Office of Secretary, Commission's Advisory Committee on Reactor Safeguards, and state and local officials. The application includes general information about the utility and its financial qualifications, a list of regulatory agencies that have jurisdiction over the rates and services incident to the proposed activity, and a list of trade and news publications which circulate in the area where the plant will be built. As an important part of this application, the company includes comprehensive data on the site and preliminary designs and safety information for the proposed reactor.

Under AEC's revised regulations implementing NEPA, applicants for nuclear power permits are also required to submit an environmental report. This report includes a cost-benefit analysis which considers and balances environmental impact of the facility and alternatives available for reducing or avoiding adverse environmental effects, as well as environmental, economic, technical and other benefits of the facility.

A public announcement of the receipt of the application is issued by the AEC and a notice is published in the Federal Register. Copies of all correspondence and filings relating to the application are placed in the Commission, which are available to any member of the public at the Commission's Washington office.

The application is reviewed by technical experts of the Commission's regulatory staff. The review includes consideration of all the radiation safety and environmental aspects of the proposed reactor, as well as the applicant's technical and financial qualifications.

The Division of Reactor Licensing supplements the study of the safety analysis report with conferences with the technical staff of the applicant and may ask the applicant for further information. This division also prepares an evaluation of the safety aspects of the proposed power reactor for the Advisory Committee on Reactor Safeguards (ACRS).

The ACRS is an independent committee established by law to advise the Commission on safety aspects of reactors and is composed of scientists and engineers qualified in various fields related to reactor technology. The Advisory Committee considers the applicant's preliminary safety analysis report, together with the evaluation prepared by the Division of Reactor Licensing. Representatives of the applicant and members of the technical staff of the Division of Reactor Licensing meet with the ACRS to deal with questions that arise during the Committee's review of the reactor. Usually a subcommittee meeting is held, often at the proposed site, before their reports are made public.

The ACRS report is typically in the form of a letter to the chairman of AEC. This report does not discuss the proposed facility in detail, but discusses only those features that the ACRS regards as of interest or significance. It frequently suggests the need for additional research and development, changes in design, and careful review of particular matters by the AEC regulatory staff and calls upon the applicant to provide further information from time to time. The final paragraph usually expresses the Committee's judgment and that outstanding issues can be resolved during construction and that there is reasonable assurance that the reactor can ultimately be operated without undue risk to the health and safety of the public. Individual members of the ACRS have occasionally appended their separate views to the ACRS report.

Besides analyzing the safety report, the AEC's regulatory staff must also review the environmental report of the applicant and make the report available to the public for comments. The Director of Regulation or his designee is responsible for analyzing the report and preparing a draft detailed statement of environmental considerations. A team composed of members from the regulatory staff and an assigned laboratory review the report. Three laboratories—Argonne, Oak Ridge and Pacific Northwest (Battelle)—furnish assistance to the regulatory staff for the preparation of environmental statements.

The team members include specialists in the major scientific and engineering disciplines involved in evaluating environmental statements. Such disciplines normally include ecology, hydrology, biology, radiation health physics, chemistry, thermal diffusion, and chemical, mechanical, civil and nuclear engineering.

The environmental statement includes an independent assessment by the AEC of the environmental impact of the construction and operation of a nuclear facility on air, land, water and human resources and values. It involves assessments of non-radiological as well as radiological effects and includes evaluations of alternatives, particularly those directed toward reducing environmental impacts.

The review involves the evaluation of a multitude of data provided by the applicant and obtained by AEC from other sources. Based on such evaluation, projections of impacts are made and quantified to the extent possible. Finally, by means of a cost-benefit analysis, the staff balances the environmental costs including potential risks to health and safety against the benefits from the proposed facility and related alternatives.

The Commission then transmits a copy of the report and of the draft detailed statement to Federal agencies designated by the Council on Environmental Quality as having "jurisdiction by law or special expertise with respect to any environmental impact involved" or as "authorized to develop and enforce environmental standards." The Governor or appropriate state and local officials who are authorized to develop and enforce environmental standards also receive copies. The transmittal will request comment on the report and draft statement within 45 days in the case of federal agencies and 75 days in the case of state and local officials. The commission also publishes a summary notice of the availability of the applicant's environmental report and the draft statement in the Federal Register.

After the issuance of the draft environmental statement, the staff reviews and acts upon each comment received from the other federal agencies, state and local agencies, intervenors and the general public. Final assessments and conclusions are incorporated in a final environmental impact statement, which is made available to the President, the Council on Environmental Quality and to the public.

A notice of hearing to consider a construction permit may be issued before these technical reviews are complete, in some cases several months in advance. The notice, in addition to specifying a time for filing petitions to intervene, may designate an Atomic Safety and Licensing Board to conduct the hearing and will set forth the issues to be considered and the pertinent documents currently available. Generally, it will not establish a definite date for either a pre-hearing conference or the public hearing. These will be scheduled by the Atomic Safety and Licensing Board at an appropriate time after the period for filing petitions has passed.

Any person whose interest may be affected by a licensing proceeding may file a petition for leave to intervene (which gives him full powers of cross examination) or make a limited appearance to present his viewpoint. The petition should state the person's interest in the proceedings, how it may be affected by the proposed licensing action, and the person's contentions in reasonably specific detail. Petitions stating contentions relating only to matters outside the Commission's jurisdiction will be denied.

Recently, the Director of Regulation announced that the AEC regulatory staff will meet informally with intervenors and potential intervenors at an earlier stage in the review process. At these meetings, intervenors can present directly to the licensing project manager and the environmental project manager their concerns about a particular application to build or operate a nuclear power plant.

The Commission also provides for public inspection of pertinent documents in a location in the vicinity of the nuclear facility. These include the application; the report of the Advisory Committee on Reactor Safeguards; the AEC Staff Safety Evaluation; and the AEC detailed statement of the environmental aspects of the facility.

The public hearing is usually conducted by a three-man atomic safety and licensing board which is composed of two technical experts and one lawyer drawn from a pool of people within the AEC, the industry, and various teaching positions. The board is appointed by the Commission and the lawyer serves as chairman.

The application, any amendments to the application which may have been filed, and other pertinent documents are submitted for the record. If the application is uncontested, the hearing usually involves only the presentation of testimony by representatives of the applicant and the AEC regulatory staff. The Board does not conduct a new evaluation of the evidence. Rather, its role is merely to determine whether the application and the record contain "sufficient information" and whether the regulatory staff's review has been adequate to support findings that must be made for issuance of the construction permit. In contested cases, evidence is presented by representatives of the applicant, the AEC regulatory staff, and by witnesses called by the intervenors. In these proceedings, the Board is required to evaluate from scratch the evidence with respect to the matters that are in controversy.

In performing its role, the Board does more than merely weigh the evidence incorporated in the record of the proceeding. The evidence is weighed and assessed in terms of the knowledge, experience, and biases of the expert members of the Board. Moreover, the hearing procedures have been significantly less formal because a "trial type" of hearing is not considered appropriate for the development of scientific and technical information concerning safety and also to accommodate the temperament and experience of the scientists and engineers who testify and sit on the boards.

The Board renders an initial decision which becomes effective and constitutes final action of the Commission in 45 days unless a party files exceptions or the Commission on its own initiative requests that the record be certified to it for final decision. In such cases the final decision is made by the five-man commission. For example, the Board's initial decision will include findings and conclusions which may affirm or modify the contents of the detailed environmental statement. If the Commission or the Atomic Safety and Licensing Appeal Board, in a review of the initial decision, reaches conclusions different from the Atomic Safety and Licensing Board with respect to environmental aspects, the detailed statement will be modified again.

A construction permit is usually issued even though technical details related to plant safety are in the developmental stage and will be incorporated into the plant as they develop during construction. The utility takes a risk that the AEC will not approve the final plans. In the future, the AEC will probably require safety details to be more complete before issuance of a construction permit.

During construction, representatives of the Commission's Division of Compliance periodically inspect the reactor to assure that the requirements of the construction permit are met. Amendments to the application and reports may be submitted from time to time by the Division of Reactor Licensing.

When the final design is completed, and plans for operation are ready, the applicant submits the final safety analysis report in support of an application for an operating license. The information includes plans for operation, procedures for coping with emergency situations, and pertinent details on the final design of the reactor itself—such as containment design, design of the nuclear core, and waste handling systems. Once again the Division of Reactor Licensing makes a detailed review of the information on the reactor and presents an evaluation of it to the Advisory Committee on Reactor Safeguards. The ACRS makes an independent evaluation and reports its opinion to the Commission. An environmental report submitted by the utility is also reviewed by the AEC regulatory staff and a detailed environmental statement is prepared. The reports are made public.

A public hearing for an operating license is not required by law; the AEC announces that a given plant will receive an operating license unless members of the public petition for a hearing prior to a given date. A 30-day notice to the public that the Commission is considering issuance of an operating license will be given while the technical reviews are in the later stages. If, as a result of the 30-day notice, timely and valid petitions are received, the Commission will issue a notice of hearing similar to that described earlier for the construction permit hearing.

If no petitions are received before the specified time, the Commission will issue the license after receipt of a report by the Advisory Committee on Reactor Safeguards, submission of a favorable safety evaluation of the application by the AEC Division of Reactor Licensing and upon making the required findings with respect to the health and safety of the public and common defense and security. Before issuance of the license, the facility will be inspected by AEC to determine that construction of the facility had been satisfactorily completed.

If a hearing is held, the decision of the hearing board is subject to review by the Atomic Licensing and Appeal Board and by the five AEC Commissioners. Also, during the hearing, the Atomic Safety and Licensing Board may authorize the loading of nuclear fuel in the reactor core and limited operation if environmental and safety aspects are not violated. This authorization may be opposed by a party to the proceeding.

If the operating license is granted, it will specify various technical details to be met during plant operation. Each reactor operator is licensed by the AEC after passing a knowledge test. During operation, reactors are inspected by the Division of Compliance (Regional office).

In May 1972, Congress amended the Atomic Energy Act to permit the issuance of interim licenses for plants whose power was needed to meet the summer peak of that year, the winter peak of 1972-73 and the summer peak of 1973. Thus it modified the National Environmental Protection Law which normally requires a complete environmental review before federal approval of such a project. Under the new legislation, only a limited environmental review is required as well as favorable findings on safety issues. In addition, in cases where a public hearing is held on the full-term operating license, the AEC could make a decision on the interim license on the basis of affidavits and pleadings instead of a trial-type proceeding.

Material Licensing

Material licensing may also affect the environment; thus, the AEC requires an environmental report for such licenses authoirizing commercial radioactive waste disposal by land burial or licenses for possession of source material for uranium milling and production of uranium hexafluroide.

Unlike licensing of production and utilization facilities, the licensing of materials does not require separate authorizations for construction and operation. Ordinarily, therefore, there will be only one Applicants' Environmental Report required and only one detailed statement prepared in connection with an application for materials license.

According to the AEC's revised regulations, application for such licenses must be filed at least nine months before commencement of construction of the plant or facility to assure full consideration of environmental effects. Applications are filed with the Director, Division of Material Licensing.

ARMY CORPS OF ENGINEERS (DEPARTMENT OF ARMY)

Under the provisions of the Rivers and Harbor Act, the Army Corps of Engineers must issue permits for dredging, filling, and excavation in the navigable waters of the U.S. Thus, where a cooling water intake or discharge structure extends into such waters, a construction permit is required.

The Chicago District Operations Office receives the application for construction permits in Region V (which includes Wisconsin), and determines if they are complete. (The utility or a construction company acting for the utility may apply for these permits.) The applications are then reviewed by the Engineering and Planning divisions within the Corps. The Engineering Division reviews the plans for the discharge structure and the Planning Division considers the siting of the project—for example, water currents in relation to the discharge structure. Comments are also requested from the Department of the Interior, the Environmental Protection Agency (EPA), state agencies such as the Department of Natural Resources (Bureau of Shoreland Management, Bureau of Industrial Waste Waters and the Division of Environmental Protection) and the public.

In the past, the Fish and Wildlife Service of the Department of the Interior has usually sent comments on the application for construction permits. EPA has also offered comments. However, state agencies have seldom sent comments to the Corps. Finally, the public has often expressed dissatisfaction with certain features of applications.

On receiving these comments, the operations office makes them available to the applicant who either agrees to any changes requested by various agencies and the public or suggests alternative changes. In such cases, the Corps acts as a mediator between the applicant and other parties. Public meetings may be held where citizens, members of various governmental agencies and the applicant discuss features of the application. If a compromise cannot be reached, the district office will send the application to the division office. If this office feels unqualified to make a decision, it will forward the application to Washington. Members of the national office will again confer with representatives of EPA and other governmental agencies and then render a final decision.

Sometimes, the applicant and other parties will pressure the Washington office for action while the district office is still reviewing the application. On such occasions, the Washington headquarters may urge the division and district offices to act on a permit.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) has two major regulatory responsibilities that influence the siting, design and construction of nuclear power plants. This agency sets environmental radiation standards and approves water quality standards established by each state.

In 1970 the functions of the former Federal Radiation Council (FRC) were transferred to EPA. These functions include setting radiation protection standards for application to the environment; guiding all federal agencies in the formulation of radiation standards; and establishing radiation programs in cooperation with the states.

The Atomic Energy Commission (AEC) enforces these radiation standards through their own regulations. For example, the actual license conditions for radioactive emissions are specified by the AEC, but must conform to EPA general guidance and any specific EPA standards that exist.

The Office of Radiation Programs—Standards Division—may also issue standards for individual classes of radiation sources. In the case of nuclear power reactors, EPA has accepted the new AEC proposed regulations for radiation releases from nuclear plants and has not yet found it necessary to issue more restrictive standards in this case.

Under the Federal Water Pollution Control Act Amendments of 1972, the Environmental Protection Agency became responsible for a pollution control program covering all U.S. waters (previously only interstate waters were covered by federal legislation). While states retain primary responsibility for setting water quality standards and reducing pollution, they must do so within the framework of a new national program. And if the states do not or cannot fulfill their obligations under the law, EPA is empowered and directed to take action.

This new law affects the regulation of thermal discharges from power plants. Under the 1899 Refuse Act, industries applied to the U.S. Corps of Engineers for permits to discharge wastes (including heated water) into waterways. Without revoking the 1899 Refuse Act, the Federal Water Pollution Act of 1972 establishes a new permit system to be controlled by EPA and the states. EPA must issue effluent guidelines which will be applied by the states in granting permits to individual dischargers. In addition, EPA must rule on the adequacy of any state permit program before allowing that state to issue a permit.

Until the state has the authority to grant permits, EPA issues them to dischargers within the state. Once a state has this authority, EPA has the right to veto the issuance of any individual permit that doesn't conform to federal guidelines.

EPA must also approve thermal standards established by states. For example, in Wisconsin, the Department of Natural Resources adapted thermal standards recommended by EPA for Lake Michigan. Under these new standards, heated water discharges cannot raise lake temperatures more than three degrees at the edge of the mixing zone which would be equivalent to a circle of a 1000 feet in radius. This new boundary of 1000 feet may force several nuclear power plants on Lake Michigan to install closed cycle cooling facilities. However, in September 1974, EPA will issue guidelines for daily emissions of pollutants, including heated discharges, and these effluent guidelines may influence state thermal standards.

FEDERAL POWER COMMISSION

The Federal Power Commission has no regulatory authority over nuclear power plants. However, this independent agency does work with the electric utility industry to facilitate the planning, building and operation of needed facilities on time. Under the provisions of the Federal Power Act, the FPC is responsible for assuring "an abundant supply of electric energy" throughout the nation, and for encouraging the voluntary interconnection and coordination of facilities for the generation, transmission and sale of power.

The FPC collects information on the entire electric power industry and forecasts the electric energy requirements of the nation. In 1972 the FPC issued its second National Power Survey report which lays out a long range guide for efficient development of the nation's electric power industry through the year 1990. The report points out that the nation's electric power program of the next two decades is critically dependent on the successful introduction on schedule of new nuclear power. Although nuclear fuel accounted for only 2% of the power generation in 1970, the FPC projects that it will produce over 53% of the nation's electricity in 1990.

DEPARTMENT OF THE INTERIOR

Although the Department of the Interior has no regulatory authority over nuclear power plants, many of the bureaus within the department work closely with the Atomic Energy Commission (AEC) in siting and constructing these plants.

Various bureaus or agencies within the department may be contacted at a federal, state and local level to supply environmental data needed for power plant siting. Agencies such as the Fish and Wildlife Service, Bureau of Mines, National Park Service, Geological Survey and the Bureau of Outdoor Recreation also comment on environmental impact statements for nuclear power plants.

In 1961 the Licensing Division of the AEC agreed to have the Fish and Wildlife Service review all applications for permits to install nuclear power plants. This review was formalized in 1964 with a Memorandum of Understanding between the AEC and the Department of the Interior.

The Division of River Basin Studies in the Bureau of Sport Fisheries and Wildlife has been given the responsibility for coordinating and cooperating with the Atomic Energy Commission and the Power Company in all steps of a power plant facility from its design and development through construction and operation, to monitoring the effects of thermal and radioactive discharges.

The Division is initially notified through two channels: (1) By the Power and Light Company requesting assistance in the preparation of portions of their Preliminary Safety Analysis Report (PSAR) concerned with the environment and associated terrestrial and aquatic animal resources and (2) by a request from the Atomic Energy Commission to review and comment on a PSAR which the company has written and forwarded to AEC in Washington, D.C. The Division also reviews amendments and supplements leading to the final safety analysis report and the environmental impact statement. Recommendations made by the Division are often accepted and included in the design plan and operation of the power plant.

The main concern of the Division is to protect the environment by requesting controls on thermal waste-heat discharge, entrainment of aquatic organisms, and on radioactive emissions.

Other agencies of the Department of the Interior have also arranged for review and comment on nuclear power plants. The Geological Survey reviews and reports on the hydrologic and geologic aspects of plant sites and comments on design criteria proposed to protect plants from physical hazards.

FEDERAL AVIATION ADMINISTRATION (DEPARTMENT OF TRANSPORTATION)

The Federal Aviation Agency's review of a proposed nuclear power plant is limited to making determinations as to the possible effect it might have on existing or planned airport development, or the safe and efficient utilization or airspace.

When a utility proposes any type of construction described in part 77.13 of the Federal Aviation Regulations, it must file a notice of construction with the Chief of the Airspace and Procedures Branch of the FAA. For example, any structure of a nuclear plant that will exceed 200 feet in height above ground level requires the approval of the FAA. If the plant is located near an airport, this height limit may be lower. The FAA also inspects and approves the utility's plans for lighting buildings, stacks and standpipes which are 150 feet or more above ground level.

The Notice of Construction must be filed by the utility at least 30 days before construction begins and should describe the location and dimensions of the construction. The utility must also submit a supplemental notice 48 hours before the start of construction and 5 days after the construction reaches its greatest height.

The Airspace and Procedures Branch of the regional FAA office reviews the notice and conducts an aeronautical study of the effect upon the operation of air navigation facilities and the safe and efficient utilization of the navigable airspace. Such a study may be requested by the utility or determined appropriate by the FAA. The regional FAA office also solicits comments from those qualified to make a review of the project and may hold a meeting with all interested persons for the purpose of gathering relevant data. If there are objections to the proposal, FAA officials will attempt to develop recommendations for adjustment of aviation requirements that would accommodate the proposed construction or to develop possible revisions of the proposal that would eliminate the exceeding of standards.

After completing this review, the agency issues a determination as to whether the proposed construction would be a hazard to air navigation and sends copies to all known interested persons. This determination is final unless, within 30 days after the decision, a petition for review is filed and the agency grants the review. The regional office may conduct a review on the basis of written materials or hold public hearings.

OTHER FEDERAL AGENCIES

Many federal agencies may comment on the environmental impact statement prepared for a nuclear power plant. For example, the AEC regulatory staff considered comments from these federal agencies in preparing the environmental impact statement for Point Beach nuclear power plant.

Council on Environmental Quality
Department of Commerce--National Oceanic Atmospheric Administration (NOAA)
Department of Transportation--U.S. Coast Guard
Department of Health, Education and Welfare
Department of Defense--Army Corps of Engineers
Federal Power Commission—Bureau of Power
Department of the Interior--Fish and Wildlife Survey; U.S. Geological Survey; National Park Service and other bureaus
Department of Agriculture--Soil Conservation Service; Economic Research Service; Forest Service
Department of Housing and Urban Development
Environmental Protection Agency
Advisory Council on Historic Preservation

APPENDIX D

ANNOTATED ANSWERS

1. There is an established threshold limit below which radiation will not cause biological injury.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	0	45	55
Local Leaders	9.2	58.6	32.2
State Officials	37.5	50	12.5
Utility Managers	16	78	6
Environmental Leaders	73	27	0

No one has ever produced evidence that any specific amount of radiation will be without harm. According to the Federal Radiation Council, which was responsible for setting the present U.S. radiation standards (the Environmental Protection Agency now has this responsibility), "...every use of radiation involves the possibility of some biological risk, either to the individual or his descendants."[1] The International Commission on Radiological Protection and the National Council on Radiological Protection and Measurements have taken similar positions.[2]

For example, when the Federal Radiation Council (FRC) set 0.17 rad* as a legally permissible, average, annual radiation exposure for an individual in the U.S. population, the Council was not establishing a threshold limit below which radiation will not cause biological injury. In setting the standard, the FRC hoped that the benefits to be received from peaceful uses of atomic energy would outweigh the risks associated with them.

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*rad is the unit of absorbed dose, corresponding to the absorption of 100 ergs (rad, rem and rotegen are units used to express the effect of radiation energy upon biological materials).

[1]Federal Radiation Council Staff Report, May 1, 1960, p. 1.

[2]Lauriston S. Taylor, "Standards for Protection Against Radiation," *Proceedings of a Student Conference on Nuclear Power and the Environment*, Madison, Wisconsin, April 3-4, 1970, pp. IV 1-15.

2. Exposure to radiation may cause

(a) CANCER
(b) GENETIC DAMAGE
(c) SHORTENING OF LIFE SPAN
(d) a & c
The answer is—(e) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	10	30	60
Local Leaders	32.2	38.5	29.3
State Officials	75	25	0
Utility Managers	48	32	20
Environmental Leaders	80	13	7

Exposure to large doses of radiation, i.e. 200-600 rads, can cause acute injury or death within hours. However, smaller doses of radiation may cause delayed effects in the individual exposed, with symptoms sometimes not appearing for 20 or more years. Their main effect is in the form of cancer, especially leukemia, cancer of the bone, lung, and the thyroid gland. There may be other effects, such as cataracts or impaired fertility, as well as a generalized effect which manifests itself in the shortening of the lifespan.[1]

For example, medical researchers have found an increased incidence of cancer in populations that survived Hiroshima and Nagasaki and in early radiologists who did not know enough about radiation to take the precautions now followed.[2]

Radiation exposure may also damage genetic materials, mainly by causing gene mutations or chromosome changes. The genetic effect may manifest itself in a variety of ways, some occurring in the first generation born to exposed individuals, others being latent for several generations. Among the effects in first-generation offspring are abortions, stillbirths, congenital defects, infant mortality, reduction in birth weight and a change in sex ratio.[1]

It should be stressed that radiation will have the same biological effects whether it comes from a dental x-ray machine, from natural background radiation or from a nuclear power plant. The effect of a given dose will depend on factors such as age (children being more sensitive), diet, oxygenation of the organ exposed, and so forth.

However, although the effects mentioned above have been observed in man or in experimental animals, so far it has not been possible to draw a definite relationship between the incidence of cancer or genetic damage and a specific dose of radiation. Researchers have found the biological effects of low level radiation, technically difficult, if not impossible to measure.[3]

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[1]P. J. Lindop and J. Rotblat, "Radiation Pollution of the Environment," *The Energy Crisis*, Chicago, Illinois: Bulletin of Atomic Scientists, 1972, pp. 41-49.

[2]Robert W. Miller, "Delayed Radiation Effects in Atomic Bomb Survivors," *Science*, 166, October 31, 1969, pp. 569-574.

[3]Karl A. Morgan, "Never Do Harm," *Environment*, January-February, 1971, p. 28.

3. If the accumulation of radionuclides is kept below limits safe for human health, plants and animals in the environment will automatically be protected.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	5	40	55
Local Leaders	21.8	46.6	31.6
State Officials	58.3	20.8	20.9
Utility Managers	—	--	--
Environmental Leaders	--	--	--

Many plants and animals concentrate specific radionuclides in certain organs and tissues. For example, iodine is concentrated in the thyroids of higher animals, including humans, and strontium in bones, scales and shells. The extent to which different radionuclides are concentrated by different organisms varies widely.[1]

Radionuclides may also be concentrated along a food chain. For example, dilute radioactive minerals can be taken up by algae, thus separating the mineral from the water and concentrating the radioactivity in the process. Algae are then consumed by zooplankton and zooplankton by fish, being further concentrated at each step. The chain may continue through larger fish to man. Though radionuclide levels in human diets may not be significantly increased or exceed "permissible," levels, no one can accurately predict the effects such accumulations might have on plants and animals.[2]

The addition of radionuclides to the environment may be particularly damaging to aquatic organisms because they are normally subjected to relatively small amounts of ionizing radiation. For example, a study by a marine biologist, G. G. Polikarpov, showed that very small concentrations of Strontium-90 (less than that of naturally occurring potassium in sea water) significantly increased the frequency of abnormal fish larvae.[3] Unfortunately, there is little known about the effects of small amounts of radiation upon the inherited characteristics of living things.

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[1]Eugene P. Odum, "Radiation Ecology," in *Fundamentals of Ecology*, Chapter 17, Philadelphia: W.B. Saunders Company, 1971, pp. 451-467.

[2]C. A. Carlson et al., *Radioactivity and a Proposed Power Plant on Cayuga Lake*, Ithaca, N. Y., Cornell University, 1968.

[3]G. G. Polikarpov, *Radioecology of Aquatic Organisms*, New York, Reinhold Book Division, 1966.

4. The concentration of a radioactive product of nuclear fallout, cesium-137 along the lichen-reindeer-man food chain

The answer is—a) INCREASES
b) decreases
c) remains the same

	% Correct	% Incorrect	% Don't know
Local Residents	--	--	--
Local Leaders	--	--	--
State Officials	50	12.5	37.5
Utility Managers	--	--	--
Environmental Leaders	--	--	--

Studies of cesium-137 in arctic ecosystems indicate that cesium increases in concentration along the lichen-caribou (reindeer)-man food chain by a factor of about 2 at each successive level. This means that caribou will have twice the concentration of cesium-137 as the lichen and man twice as much as the caribou.[1] Biological concentration of radiation can also occur along other food chains.

[1]W. C. Hanson, "Cesium-137 in Alaska Lichens, Caribou and Eskimos," in *Readings in Conservation Ecology*, New York: Meredith Corporation, 1969, pp. 424-432.

5. Some of the radioactive wastes produced in large quantities in nuclear reactor fuel will remain hazardous for centuries.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	30	30	40
Local Leaders	43.7	25.3	31
State Officials	83.3	8.3	8.4
Utility Managers	94	6	0
Environmental Leaders	100	0	0

Plutonium-239, strontium-90 and cesium-137 are among the most toxic and long-lived radioactive substances produced in nuclear reactor fuel.[1] The strontium and cesium will be hazardous for over 200 years and the plutonium for over 200,000 years.[2]

The total amount of high level wastes from commercial power reactors will almost triple over the next thirty years. In 1970, commercial reactors produced about 700,000 gallons of high-level wastes. Between 1970-1980, the AEC expects 3,500,000 gallons of such wastes to accumulate. And by the year 2000, nuclear reactors may have produced over 60,000,000 gallons of high-level liquid wastes.[3]

Although the mass of these nuclear wastes is small compared to the tons of wastes (ashes) produced by fossil fuel plants, the quantity of radioactivity involved is large. For example, one gallon of high-level liquid wastes may contain as much as 50 to 100 curies of strontium. It would take about one billion gallons of water to dilute one curie of this strontium-90 to current guideline levels for drinking water.[4] Thus, the isolation of these radioactive wastes from the environment is a major problem of nuclear waste disposal.

[1]Charles Fox, "Radioactive Wastes," United States Atomic Energy Commission, Division of Technical Information, Washington, D.C., Government Printing Office, 1969.

[2]Alvin W. Weinberg, "Social Institutions and Nuclear Energy," *Science*, 177, July 7, 1972, pp. 27-34.

[3]Morton I. Goldman, "Management of Nuclear Fuel Reprocessing Wastes," *Proceedings of a Student Conference on Nuclear Power and the Environment*, Madison, Wisconsin, April 3-4, 1970, pp. VIII 1-7.

[4]Atomic Energy Commission, U.S. Code of Federal Regulations, Vol. X, Pt. 20, 1972.

6. A certain amount of radioactive gas from nuclear plants is routinely released into the atmosphere.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	35	20	45
Local Leaders	20.7	38.5	40.8
State Officials	58.3	33.3	8.4
Utility Managers	76	15	9
Environmental Leaders	66	7	27

Low level radioactive wastes from nuclear plants are routinely discharged into the air and water. Radioactive substances such as iodine-131, krypton-85, tritium and xenon-133 are discharged as gases via stacks or exhaust ducts of power plants in accordance with AEC regulation.[1] The AEC regulations for nuclear plants limit the amount of radioactive gases released to conform with environmental radiation standards.[2]

[1]B. Kahn, "Release of Radioactivity From Nuclear Installations During Routine Operation," *Proceedings of a Student Conference on Nuclear Power and the Environment,* Madison, Wisconsin, April 3-4, 1970, pp. V 1-20.

[2]Atomic Energy Commission, U.S. Code of Federal Regulations, Vol. X, Pt. 20, 1972.

7. To date, there has been no release of radioactive materials in transit from fuel enrichment and fuel fabrication centers to nuclear plants.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	--	--	--
Local Leaders	--	--	--
State Officials	33.3	12.5	54.2
Utility Managers	64	12	24
Environmental Leaders	17	33	50

There have been accidents involving trucks carrying fuel to nuclear plants but there has never been any release of radioactive material as a result. There has been release of radioactive material in transit but most of the cases involved sources other than radioactive fuel such as medical or industrial isotopes.[1]

The major concern over transportation of radioactive materials involves the large increase in such shipments as the nuclear industry grows. Although shipments of pure fuel are much less radioactive than shipments of used fuel (which has picked up fission products while in the reactor), there is some concern over the theft or hijacking of this fresh fuel for the construction of nuclear bombs.[2]

However, the shipment of high level liquid wastes from nuclear plants to reprocessing plants poses the greatest problem. The possibility of a major accident or release of radioactive wastes will increase with the number of shipments. And the number of casks of spent fuel shipped annually will rise from 30 in 1970 to 9,500 in the year 2000.[3]

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[1]*Operational Accidents and Radiation Exposure Experience*, Division of Operational Safety, USAEC 1943-1970, Wash 1192, Fall 1971.

[2]Victor Gilinsky, "Bombs and Electricity," *Environment*, XIV, No. 7, September 1972, pp. 10-18.

[3]Deborah Shapley, "Radioactive Cargoes: Record Good But the Problems Will Multiply," *Science*, June 25, 1971, pp. 1318-22.

8. The AEC exercises direct control over the quality of equipment purchased by utilities and the terms of the equipment supply contracts.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	--	--	--
Local Leaders	--	--	--
State Officials	37.5	33.3	29.2
Utility Managers	--	--	--
Environmental Leaders	--	--	--

The increasing failure of the electric utility industry to provide reliable electric power is partly the result of inadequate control over the quality and delivery of equipment. No regulatory body exercises direct control over the quality of equipment purchased by utilities or the terms of the equipment supply contracts.[1]

The AEC's regulatory program has provided a focal point for efforts in the development of regulatory guides, criteria, and standards for nuclear plants. For example, recent AEC hearings on the emergency cooling systems were held to review the adequacy of certain nuclear reactor safety standards. However, the following examples of reactor operating experiences illustrate the need for an augmented effort in the development and application of engineering codes and standards.[2]

In a nuclear plant under construction, serious deficiencies were encountered in a number of large pipe fittings, purchased to meet the requirements of the ASA Code for Pressure Piping. Subsequent investigation disclosed that the vendor had not met the requirements of the code and the manufacturer in which rework was needed to raise them to the required quality levels.[3]

In the summer of 1972, two workers in Virginia Power Company's Surry nuclear plant were killed in the act of inspecting a set of malfunctioning valves when still another valve exploded. An AEC investigation attributed the accident to improper design in the piping system. Vermont Yankee Nuclear Power Company and Commonwealth Edison have complained of receiving defective fuel supplies. The operating licenses of six plants have been restricted because of fuel problems.[4]

A 1973 AEC safety report presented at the emergency core cooling hearings stated that "the number of defects, equipment malfunctions, or failure events that have been encountered during construction, pre-operation testing and routine nuclear power operations to date has been large...."[5] L. Manning Muntzing, Director of Regulation has stated, "There is an urgent need to develop and implement comprehensive regulatory safety criteria and guides and industry codes and standards for the siting, design, construction and operation of nuclear power plants."[6] To increase the regulatory criteria and guides output, the AEC has established a full-time standards staff and initiated public rulemaking hearings on safety and environmental standards.[7] The AEC also encourages standard development by industry and supports efforts of the Nuclear Standards Board (NSB) and the USA Standards Institute.[8]

Although the AEC has developed standards and criteria for the design and construction of nuclear plants, it does not exercise direct control of the quality of equipment puchased by utilities and the terms of the equipment supply contracts. Many of the codes and standards have been set by industry and are often inadequate or not strictly enforced. However, since "direct control" was a difficult term to interpret, the question was not included in the total knowledge score.

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[1]Neil Fabricant and Robert M. Hallman, *Toward a Rational Power Policy: Energy, Politics and Pollution,* New York: George Braziller, 1971.

[2,3,8] *Considerations Affecting Steam Power Plant Site Selection,* A report sponsored by the Energy Policy Staff, Office of Science and Technology, Washington, D.C., U.S. Government Printing Office, 1968.

[4]Thomas Ehrich, "Atomic Lemons," *Wall Street Journal,* May 3, 1973.

[5]Robert Gillette, "Nuclear Safety: AEC Report Makes the Best of It," *Science,* 179, January 26, 1973, pp. 260-263.

[6,7]L. Manning-Muntzing, Director of Regulation, U.S. Atomic Energy Commission, statement before the 1973 Authorization Hearings Before the Joint Committee on Atomic Energy, March 9, 1972, pp. 17-18.

9. Emergency core cooling systems have been tested under actual accident conditions in a power reactor and have proven to be effective.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	5	50	45
Local Leaders	11.5	48.9	39.6
State Officials	58.3	0	41.7
Utility Managers	43	39	18
Environmental Leaders	66	0	34

Emergency core cooling systems (ECCS's) are safety devices designed to guard against what is thought to be the "maximum credible accident" that a nuclear reactor can possibly sustain, a major loss of cooling water through a broken pipe or valve.

During normal operation, heat generated by controlled fission reaction among the fuel elements is removed by circulating water around and between the elements. If a pipe breaks and the reactor core runs dry, the ECCS's are suppose to reflood it with water within seconds after the leak occurs. If the ECCS's hesitate, the cladding around the fuel and the fuel pins begin to melt. Emergency cooling water injected at this stage could amplify the disaster. The molten metals (melted fuel cladding and uranium oxide) would react violently with the water, releasing steam and hydrogen in amounts and at pressures that could burst the containment. The radioactive contents could then be scattered over a wide area.[1]

In recent AEC hearings on the ECCS's, specialists in nuclear safety have testified that existing designs of backup cooling systems might not adequately reflood a reactor after a major leak. AEC staff members also commented that a lack of experimental evidence made evaluation of the ECCS's very difficult.[2]

At present, no full scale tests of ECCS's have been done nor are they planned. Full scale tests appear to be impractical and would require destruction of a large part of an ECCS for each major test. This would be extremely expensive—several million dollars. However, trials have been made which are partial tests of the reactor core and ECCS. Additional tests will be conducted on larger models coming closer to ECCS's. One such test is scheduled for 1974 or 1975 and will involve loss of cooling water from a 50 megawatt reactor in an AEC test area in Idaho. In this experiment, the ECCS will be tested under accident conditions in a power reactor.[3]

The present controversy over the ECCS's began in the fall of 1970. AEC commissioned a safety contractor, Aerojet Nuclear Company, to do research on the cooling capability of emergency core cooling systems at the National Reactor Testing Station in Idaho Falls. Aerojet ran a series of tests, using a nine-inch-diameter model reactor core, to test the accuracy of mathematical models designed to evaluate the effects of loss of cooling water in a pressurized-water reactor. The model emergency system in these tests failed to deliver water to the core, and the computer models were unable to predict the test results.

As a result of the failure of these semi-scale tests and other developments concerning emergency cooling system adequacy, AEC appointed a task force under Dr. Stephen Hanauer to review the state of the art of ECCS's. Eventually, the task force recommended Interim Criteria which placed some restrictions on nuclear plant operation. When the AEC held hearings on these interim criteria, people within and outside the AEC criticized the criteria. For example, William Cottrell, director of Oak Ridge National Laboratory's Nuclear Safety Program, wrote to AEC's director of regulation L. M. Muntzing that "we are not certain that the Interim Criteria for ECCS adopted by the AEC will, as stated in the Federal Register, provide reasonable assurance that such systems will be effective in the unlikely event of a loss-of-coolant accident."[4] In October of the same year, the AEC regulatory staff filed written testimony at the hearings on the ECCS's suggesting increasing conservatism in some of the criteria. Most significant of these tentative staff opinions relate to increasing the conservatism in the acceptable temperature limit for the cladding of the single hottest fuel rod in the reactor—and in calculating the temperature of the rod cladding. The staff also indicated a need for development and use of improved analytical methods. If upon review of testimony, the staff concludes that these criteria are needed, the changes could result in increased in-service inspection of operating reactors, or limiting the operation of power plants after evaluation of individual reactor characteristics.[5]

[1]Ian A. Forbes, Daniel F. Ford, Henry W. Kendall, and James J. MacKenzie, "Nuclear Reactor Safety: An Evaluation of New Evidence," *Nuclear News*, September, 1971, pp. 32-40.

[2]Robert Gillette, "Nuclear Safety: AEC Report Makes the Best of It," *Science*, 179, January 26, 1973, pp. 260-263.

[3]"Nuclear Power and the Environment," by the San Diego Section of the American Nuclear Society, ANS San Diego Section, P.O. Box 608, San Diego, California.

[4]Hearing before a special set Atomic Safety and Licensing Board,, AEC Docket No. RM-50-1.

[5]Robert Gillette, "Nuclear Safety: At the AEC the Way of the Dissenter Is Hard," *Science*, 176, May 5, 1972, pp. 492-498; "Nuclear Safety (II): The Years of Delay," *Science*, 177, September 15, 1972, pp. 867-871; "Nuclear Safety (III): Critics Charge Conflicts of Interest," *Science*, 177, September 15, 1972, pp. 970-975.

10. Beneficial uses of radiation include

a) MEDICAL USES SUCH AS X-RAYS FOR TUBERCULOSIS AND CANCER
b) INDUSTRIAL USES SUCH AS RADIOACTIVE TRACKERS FOR DETECTING THE LEVEL OF LIQUID IN CONTAINERS AND LOCATING LEAKS
c) commercial uses such as radioactive screening devices for burglar-proofing businesses and homes

The answer is —d) a & b

e) all of the above

	% Correct	% Incorrect	% Don't know
Local Residents	15	45	40
Local Leaders	29.9	36.8	33.3
State Officials	54.2	45.8	0
Utility Managers	64	33	3
Environmental Leaders	80	20	0

Medical uses of radiation include diagnostic uses such as chest x-rays to detect tuberculosis and cancer. Cobalt-60 radiation is also used in cancer treatment.[1]

Radioactive tracers provide a convenient means for detecting leaks, especially in buried pipes carrying water or petroleum. A small quantity of a radioactive substance is dissolved in the liquid near the point of the suspected leakage. The actual location of the leak can then be found by means of a sensitive gamma-ray counter, although the escaping liquid is not visible.[2]

Several methods of detecting the thickness of a material or the level of a liquid in a tank utilize the absorption or scattering of radiation from a radioactive source. For checking the thickness of sheets of paper, cellophane, plastic, rubber, and even of metal plates or pipe, a source of radiation is placed on one side and a detector on the other side. The proportion of the radiation absorbed, and hence the amount reaching the detector, depends on the thickness of the material through which the radiation passes. A device of this kind gives a continuous record of the thickness while the machine is operating.[3]

[1]Ian A. Forbes, Daniel F. Ford, Henry W. Kendall, and James J. MacKenzie, "Nuclear Reactor Safety: An Evaluation of New Evidence," *Nuclear News*, September 1971, pp. 32-40.

11. The Plowshare Program was established by AEC to develop

The answer is—a) NUCLEAR EXPLOSIVES FOR PEACEFUL USE
b) nuclear equipment for military use
c) uses of nuclear isotopes in agriculture
d) underground nuclear power plants
e) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-		
State Officials	37.5	16.7	45.8
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Project Plowshare covers all aspects of peaceful application of nuclear explosives. Research on nuclear power production does not fall under Plowshare since it involves controlled fission as opposed to explosive fission and fusion reactions.

Nuclear explosives have been used to free tightly locked natural gas reserves from rock formations. With the explosion, gas can move up through cracks in the rock. The main problem is radioactive contamination. Natural gas freed by nuclear explosives has often been too contaminated to use safely in homes or industries. The AEC has also suggested using nuclear explosives for digging canals.[1]

[1]E. A. Martell, "Plowing a Nuclear Furrow," *Environment*, XI, No. 3, April 1969, pp. 3-10.

12. Most nuclear power plants now approach 42% thermal efficiency in converting the energy stored in fuel to electricity while the best fossil-fueled plants are only 30% efficient.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	62.5	29.2	8.3
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Nuclear reactors are thermally less efficient than fossil fuel plants. They do not produce steam at as high a temperature as fossil plants do and efficiency is dependent on the maximum temperature in a steam cycle. For example, maximum temperatures in the range of 650° F in nuclear units limit the overall efficiency to about 32%. In contrast, maximum temperatures in a modern fossil fuel plant are around 1200° F and these plants can sometimes achieve 42% efficiency.[1]

The maximum temperature in any plant is determined by the point at which metals and other materials making up the equipment start to lose their strength. Materials in a nuclear reactor must contend with damaging bombardment by radiation as well as high temperature so they weaken at a lower temperature than they would if temperature were the only factor. This problem can be remedied by technical innovation; thus, advanced nuclear plants of the future may have thermal efficiencies comparable to fossil fuel plants.[2]

[1,2] D. R. Harleman and R. M. Parsons, "Heat—the Ultimate Waste," *Energy Technology to the Year 2000*, Cambridge: Technology Review, 1972, pp.44-51.

13. Nuclear power plants using water from a river or lake for cooling purposes discharge about 50% more heated water than fossil-fueled plants using the same cooling method for an equal output of power.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	20	40	40
Local Leaders	19.5	32.8	47.7
State Officials	66.7	12.5	20.8
Utility Managers	82	18	0
Environmental Leaders	60	13	27

No thermoelectric generating plant is 100% efficient in converting the energy stored in fuel to electricity. At present, most nuclear plants are water-cooled and about 33% efficient, and thus reject about 67% of the heat generated. Modern coal, oil and gas fired plants are about 40% efficient, or reject 60% of the heat generated. Nuclear plants also reject all their heat to the cooling water, while in coal, oil or gas fueled plants, about 15-20% of the heat is rejected up the smoke stack as combustion products. Therefore, since nuclear plants are less efficient than fossil-fuel plants and reject all their heat to the cooling water, these plants discharge approximately 50% more heated water than fossil-fueled plants using the same cooling method.[1] For example, a nuclear plant producing 1000 megawatts will produce 7.2×10^9 B.t.u.* per hour of waste heat; a fossil plant 4.6×10^9 B.t.u. per hour.[2]

*B.t.u.—British thermal unit, the amount of energy needed to heat a pound of water by 1° F.

[1] "Electric Power & The Environment," Energy Policy Staff report sponsored by the Office of Science and Technology, 1970, p. 3.

[2] Summary Report: A Study of Social Costs for Alternative Means of Electrical Power Generation for 1980 and 1990, Argonne National Laboratory, February 1973, p. 138.

14. Thermal pollution may

a) REDUCE THE RECREATIONAL VALUE OF WATER BY HEATING IT AND INCREASING THE GROWTH OF ALGAE
b) raise the water level of a lake or river and cause flooding
c) REDUCE THE WASTE ASSIMILATION CAPACITY OF THE RECEIVING BODY OF WATER

The answer is—d) a & c
e) all of the above

	% Correct	% Incorrect	% Don't know
Local Residents	15	65	20
Local Leaders	17.8	31.7	50.5
State Officials	62.5	29.2	8.3
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Thermal pollution refers to the discharge of waste heat into bodies of water. The volume of these discharges has been rising rapidly with the increase in the number of power-stations and the use of water for industrial cooling. The principal contributor of thermal discharges is the electric power industry. By 1980 one-sixth of all fresh water in the U.S. will be needed for cooling these plants.[1]

Research on thermal pollution indicates that a stream or lake with a ready supply of nutrients may experience increased productivity with the addition of heat. For example, the production of small organisms (periphyton) was found to be greater in heated water near the Colbert Power Plant in Maryland.[2] (However, there is disagreement among scientists as to whether the waste heat or another factor such as higher water velocity was responsible for the increase in growth.[3]) Increased growth of algae and aquatic plants may deplete the oxygen supply of the water and threaten the existence of fish and other organisms.[4]

Increased temperature of water may also reduce its recreational value by stimulating the decomposition of sludge, formation of sludge gas and multiplication of bacteria and fungi.[5]

A rise in water temperature decreases the capacity of water to hold oxygen and thus reduces the waste assimilation capacity of a body of water. One situation which has been documented is Alabama's Coosa River. Raising the river's temperature 9° F above the existing summer temperature of 77° F resulted in a reduction of the stream's waste assimilative capacity by 11,000 pounds per day of oxygen demanding wastes.[6]

Although research has documented that thermal pollution does have an impact on the physical and chemical properties of water and thus on the habitat of aquatic organisms, the effects are not sufficiently known to assess the ecological implications for any particular situation.[7] For example, most states limit both the maximum water temperatures and allowable temperature rises, from 1 1/2° F, for various types of receiving waters. Yet there is no general agreement among aquatic biologists as to whether temperature increases in these magnitudes from waste heat are harmful.[8]

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[1]"Electric Power and the Environment," an Energy Policy Staff report sponsored by the Office of Science and Technology, 1970, p. 3.

[2]M. A. Churchill and K. Wojtalik, "Effects of Heated Discharges on the Aquatic Environment," *The TVA Experience, American Power Conference,* Chicago, Illinois, 1970.

[3]AEC Licensing hearings on Point Beach II before the Atomic Safety and Licensing Board, testimony of G. Fred Lee, Federal Courthouse, Milwaukee, August 1972.

[4]Alfred W. Eipper, "Nuclear Power on Cayuga Lake," *Patient Earth,* eds. John Harte and Robert H. Socolow, New York: Holt, Rinehart and Winston, Inc., 1971, pp. 112-134.

[5]J. E. McKee and H.W. Wolf, *Water Quality Criteria,* 2nd ed. California State Water Quality Control Board Publications 3-A, 1963.

[6]Dean E. Abrahamson, *Environmental Cost of Electric Power,* New York: Scientists Institute for Public Information, 1970, p. 9.

[7]U.S. Department of Interior, *Feasibility of Alternative Means of Cooling for Thermal Power Plants Near Lake Michigan.* Federal Water Quality Administration, Pacific Northwest Water Laboratory and Great Lakes Regional Office, 1970.

[8]R. F. Harleman and R. M. Parsons, "Heat—the Ultimate Waste," in *Energy Technology to the Year 2000,* Cambridge: Technology Review, 1972, pp. 44-52.

15. The total amount of water used for cooling by all power plants is now about 120 billion gallons per day or about 10% of the average daily runoff of water in the Continental United States.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	20.8	4.2	75.0
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Steam electric plants produce large amounts of waste heat as a result of the low level of efficiency achieved in the generation of electricity. About two-thirds of the heat energy cannot be turned into electricity; rather, it must be discharged into the air or water as waste heat. Most often the bulk of the waste heat is absorbed by cooling water withdrawn from a waterway, passed through the plant's condenser, and returned to the waterway.

Massive amounts of water are needed to cool the condensers: on a national basis, electric power generation accounts for over 80 percent of total cooling water use, and nearly 1/3 of the total water used for all purposes. The total amount of cooling water used for cooling power plants is about 120 billion gallons per day, or about 10 percent of the average daily runoff of water in the continental United States.[1] With the growth projections of fossil and nuclear power plants, cooling water requirements may increase to 200 billion gallons per day by 1980 and 600 billion gallons per day by 2000, the equivalent of 50 percent of the average daily natural runoff of water in the Continental United States (excluding Alaska).[2]

[1]Neil Fabricant and Robert M. Hallman, *Toward a Rational Power Policy: Energy, Politics and Pollution*, New York: George Braziller, 1971.

[2]Daniel Merriman, "The Calefaction of a River," *Science*, May, 1970.

16. Sizable increases in the water temperature of a lake or stream may

a) INCREASE THE OCCURRENCE OF DISEASE IN FISH POPULATIONS
b) INTERFERE WITH THE SPAWNING ACTIVITIES OF FISH
c) decrease the respiration rate of aquatic organisms
The answer is—d) a & b
e) all of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	54.2	33.3	12.5
Utility Managers	22	34	44
Environmental Leaders	66	21	13

With the addition of heat to a body of water, oxygen becomes less soluble while the metabolic rate and need for oxygen of aquatic organisms increases. Such temperature increases may thus reduce the ability of fish to move about, escape predation, compete with other species for food and successfully complete all of the vital life processes and stages of reproduction.[1] Aquatic research also indicates that higher water temperatures may increase the susceptibility of fish to certain disease organisms and to metabolic poisons.[2]

Temperature increases in inshore and beach zones may also pose a special threat to the normal spawning activity of many fish, since these shallow areas frequently serve as spawning grounds. Some fish pass through the inshore areas to spawn in tributary streams, and the addition of heat can cause the optimum temperature for spawning to be exceeded for certain species and may delay migration for others.[3] For example, female perch in Lake Michigan will abort their eggs near the end of the spawning season if the temperature of the lake increases beyond an optimum level.[4]

[1]E. B. Welch and T. A. Wojtalik, "Some Effects of Increased Water Temperature on Aquatic Life," Chattagooga: Tennessee Valley Authority Division of Health and Safety Water Quality Branch, 1968.

[2]Clarence A. Carlson, "Impact of Waste Heat on Aquatic Ecology," unpublished paper, Cornell Conservation Department, 1968, p. 3.

[3]U.S. Department of Interior, *Physical and Ecological Effects of Waste Heat on Lake Michigan,* Federal Water Quality Administration, Great Lakes Fishery Laboratory, Ann Arbor, Michigan, 1970.

[4]Thomas A. Edsall, "TheEffect of Temperature on the Rate of Development and Survival of Alewife Eggs and Larvae," *Transactions of the American Fisheries Society,* 99, 2, 1970, pp. 376-380.

17. The use of wet cooling towers or cooling ponds is known to cause fog or icing at certain times of the year.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	70	10	20
Local Leaders	59.8	12.1	28.1
State Officials	75	4.2	20.8
Utility Managers	97	3	0
Environmental Leaders	80	0	20

Wet cooling towers do produce visible plumes of moist air which usually rise and dissipate into the atmosphere. However, these plumes may come into contact with the ground and cause fog. This fog formation over inhabitated areas can be a problem if vision on highways or at nearby airports is obstructed. For example, the plume from an oil refinery caused such a problem on an adjacent highway during the winter.[1]

Although cooling towers are potential fog producers, they do not always produce fog. Climate and the type of cooling tower are important factors. Fog and icing will be a greater problem in cold, humid climates. And low profile mechanical draft towers are more likely to produce a fog condition than tall, natural draft towers.

Cooling ponds provide the greatest opportunity for fog formation at the surface. However, this cold weather "steam fog" usually stays over the surface of the pond and doesn't create local fog problems. Winter icing can occur near the edges of the pond. The fog conditions over cooling ponds probably differ little from those over a once-through cooling discharge area of a lake or river.[2]

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[1]Fred W. Decker, "Cooling Towers and Weather," Department of Physics, Oregon State University, February 1969.

[2]U.S. Department of Interior, *Feasibility of Alternative Means of Cooling for Thermal Power Plants Near Lake Michigan*, National Thermal Pollution Research Program, Pacific Northwest Water Laboratory, September 1970.

18. Coal-burning power plants are a major source of mercury pollution.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	10	15	75
Local Leaders	4.6	37.9	57.5
State Officials	37.5	54.2	8.3
Utility Managers	6	82	12
Environmental Leaders	33	40	27

Major sources of environmental mercury contamination include industrial and mining activities. Over 10,000 tons of industrial-produced mercury is released to the environment each year.[1]

However, a study by the National Bureau of Standards revealed that the burning of fossil fuels is another major source of mercury contamination. Research shows virtually none of the mercury in fossil fuel is trapped in fly ash but is released in gaseous form as a product of combustion. This gaseous mercury is washed from the air by rain, being deposited in rivers, lakes and oceans where it may be methylated to its most toxic form—methylmercury.[2]

Although the concentration of mercury in coal or oil is small, these fuels are consumed at enormous rates. For example, power plants burned over 300 million tons of coal in 1972.[3] The combustion of fossil fuels may contribute 3,000 to 5,000 tons of mercury to the environment each year.[4]

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[1]Liva I. Joensuu, "Fossil Fuel as a Source of Mercury Pollution," *Science*, 172, June 4, 1971, pp. 1027-1028.

[2]Harry L. Rook, Phillip D. LaFluer and Thomas E. Gills, "Mercury in Coal: A New Standard Reference Material," *Environmental Letters*, 2(4), 1972, pp. 195-204.

[3]*The Economy, Energy and the Environment*, a study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970, pp. 25-26.

[4]Liva I. Joensuu, "Fossil Fuel as a Source of Mercury Pollution," *Science*, 172, June 4, 1971, pp. 1027-1028.

19. Fossil-fuel burning power plants discharge approximately 50% of all air polluting

The answer is—
a) nitrogen oxides
b) SULFUR OXIDES
c) hydrocarbons
d) particulate matter
e) all of the above

	% Correct	% Incorrect	% Don't know
Local Residents	10	15	75
Local Leaders	19.5	20.8	59.7
State Officials	50	33.4	16.6
Utility Managers	70	18	12
Environmental Leaders	46	27	27

Fossil-fuels include coal, oil and natural gas. Nitrogen oxides are produced by the high temperature combustion of all fossil fuels. Sulfur oxides are produced by the combustion of sulfur-containing coal and oil; particulate matter is also produced by burning coal and oil.[1]

In 1970, fossil-fueled power plants in the United States discharged approximately 50% of the sulfur oxides, 25% of the particulates, 25% of the nitrogen oxide emissions and about 5% of the hydrocarbons. By 1980, power plants may discharge 36 million tons of sulfur dioxide or close to 75% of sulfur dioxide emissions. This figure may be lower if utilities install equipment at power plants to remove sulfur dioxide.[2]

[1]Neil Fabricant and Robert M. Hallman, *Toward a Rational Power Policy: Energy, Politics, and Pollution*, New York: George Braziller, 1971.

[2]*The Economy, Energy and the Environment*, a study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970.

20. At present, there are no commercially proven processes for eliminating stack emission of sulfur oxides or nitrogen oxides.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	45.8	20.8	33.4
Utility Managers	-	-	-
Environmental Leaders	-	-	-

A distinguished panel of engineers, organized under the auspices of the National Academy of Engineering has concluded that "commercially proven technology for control of sulfur oxides from combustion processes does not exist." The search for an economic method of removing sulfur compounds from gases has been going on for 30 years with little success.[1]

The three post-combustion removal processes which show the most promise for commercial use are the alkalized alumine process, the catalytic oxidation process and the limestone/dolomite process. Each process is relatively expensive. The alkalized alumine process requires large and complex equipment so that its application is limited to new, large power plants. The limestone/dolomite process is less expensive, requires less equipment and can be adapted to existing power plants. All three processes are in various stages of development.[2]

Regardless of the system chosen for the removal of stack gases, additional space is needed to erect equipment and to provide storages for the extracted wastes. For instance, the waste produced by limestone/dolomite process for a 1,250 megawatt power plant is about 2,000 tons per day.[3]

Because of the expense and the technical problems associated with these removal processes, many engineers and scientists have become more interested in dealing with sulfur at an earlier stage in the combustion process. For example, sulfur can be removed from fuels before they are burned. However, at present, it is not technically or economically feasible to remove all sulfur from oil or coal.[4]

Techniques for altering the combustion process within the boiler may also be available for substantially reducing nitrogen oxide emissions. However, there are no commercially proven methods for removing nitrogen oxides from stack gases emitted by power plants. In comparison to the effort now underway to control oxides of sulfur, research on nitrogen oxide control is virtually nonexistent.[5]

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[1] *Abatement of Sulfur Oxide Emissions from Stationary Combustion Sources,* National Academy of Engineering, National Research Council, 1970.

[2, 3, 5] *The Economy, Energy and the Environment,* a study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970.

[4] Arthur M. Squires, "Capturing Sulfur During Combustion," in *Energy Technology to the Year 2000,* Cambridge, Mass., Technology Review, 1972, pp. 52-59.

21. Sulfur dioxide alone or in combination with particulate matter may cause

a) DAMAGE TO VEGETATION
b) CORROSION OF BUILDING MATERIALS, INCLUDING STONE, MARBLE AND STEEL
c) RESPIRATORY DISEASES SUCH AS EMPHYSEMA, BRONCHITIS AND BRONCHIAL ASTHMA
d) b & c

The answer is—e) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	5	30	65
Local Leaders	24.1	32.8	43.1
State Officials	91.7	4.2	4.1
Utility Managers	64	27	9
Environmental Leaders	80	7	13

When sulfur oxides are taken into the lungs, a variety of chronic respiratory diseases such as emphysema, bronchitis and bronchial asthma can occur.[1] In New York City, levels exceeding 0.15 parts per million of sulfur dioxide were shown to produce aggravation of asthma and chronic bronchitis.[2]

The adverse health effects of sulfur oxides are greatest when accompanied by particulates. Small pieces of particulate matter often reach lower respiratory passages and lodge in tiny air sacs. Sulfur oxides are absorbed on these particles and brought into contact with lungs in concentrated amounts.[3]

Sulfur dioxide is also rapidly oxidized to sulfur trioxide which combines with water vapor to form sulfuric acid mists. These acid mists are not only harmful to humans—eye irritations—but are highly corrosive to building materials, including stone, marble and steel. For example, in England one third of the annual replacement costs for steel rails is due to air pollution. These sulfuric acid mists may also injure vegetation.[4]

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[1]Lester B. Lave and Eugene P. Seskin, "Air Pollution and Human Health," *Science*, 169, August 21, 1970, pp. 723-733.

[2]Hodgson, "Short Term Effects of Air Pollution on Mortality in New York City," *Environmental Science and Technology*, July 1970.

[3]*Air Quality Criteria for Particulate Matter*, U.S. Department of Health, Education and Welfare, NAPCA Pub. AP-50, Washington, D.C. Government Printing Office, January 1969.

[4]*Air Quality Criteria for Sulfur Oxides*, U.S. Department of Health, Education and Welfare, NAPCA Pub. AP-50, Washington, D.C., Government Printing Office, January 1969.

22. Both coal and uranium are strip-mined.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	70.8	0	29.2
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Stripping is a form of mining which consists of removing the overburden (surface layer of earth) to expose the horizon or vein of a mineral for removal by easy mechanical techniques. Although strip-mining is generally associated with the mining of coal, stripping and other surface mining methods have been used to remove uranium. For example, many of the mines for uranium in the Western United States are open-cut or open-pit operations.[1]

One of the undesirable effects of strip or surface mining is the drainage of acid mine wastes into streams. Solid mine wastes may also clutter stream channels and pose health hazards.[2]

Recent U.S. Bureau of Mines information indicates that approximately 6100 megatons of coal per acre are produced by strip-mining. Taking into account the 35 to 40 times greater specific energy content of uranium ore, 30-35 times more land may be disturbed from mining coal than uranium, on an equivalent power generation basis.[3]

[1]Personal letter from Walter C. Woodmansee, Division of Nonferrous Metals, Bureau of Mines, U.S. Department of Interior, Washington, D.C., September 25, 1972.

[2]"Surface Mining and Our Environment," U.S. Department of the Interior, Washington, D.C., U.S. Government Printing Office, 1967.

[3]"Environmental Survey of the Nuclear Fuel Cycle," U.S. Atomic Energy Commission, Fuels and Materials Directorate of Licensing, Washington, D.C., U.S. Government Printing Office, November 1972.

23. Uranium tailing, containing significant quantities of radium and other radioactive materials, have been piled near uranium mills where they are exposed to erosion by wind and rain.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	10	20	70
Local Leaders	9.2	21.8	69
State Officials	45.8	0	54.2
Utility Managers	36	18	46
Environmental Leaders	73	0	27

Tailings are the solid wastes left after ore is ground up to extract uranium for the nation's atomic energy programs. These uranium tailings have been left in the area of mines or uranium ore mills in Colorado, Utah, New Mexico, Arizona and other western states. Over five thousand acres serve as a permanent storage place for uranium tailings from mills and 12,000 acres form a temporary storage site for tailings from uranium mines.[1]

These uranium tailings contain substantial amounts of radium and other radioactive elements. They can be scattered by the wind and may find their way into nearby streams or rivers. For example, a study of a uranium mill tailing pile near Mexican Hat, Utah, revealed higher levels of radioactivity than natural background levels in the vicinity of the tailings pile and higher levels downwind from the tailings than upwind. Ground water samples in the area also had radioactivity levels above background levels. As a result of his study, researcher Robert Snelling recommended that mill tailings be properly stabilized against wind erosion and monitored for levels of radioactivity. He also suggested that the tailing piles not be released for public use, be covered with uncontaminated soil or fenced in as a radiation area.[2]

Yet, in the past, these uranium tailings were used in the construction of homes, schools and public buildings in the Grand Junction area of Colorado. Recently the AEC found higher than normal radioactivity levels inside the buildings in 11 western Colorado towns and cities. As a result, uranium tailings can no longer be used for construction purposes and the AEC has started to monitor these tailing piles more closely.[3]

[1]Environmental Survey of the Nuclear Fuel Cycle, U.S. Atomic Energy Commission, Fuels and Materials, Washington, D.C., U.S. Government Printing Office, November 1972.

[2]Robert N. Snelling, "Environmental Survey of Uranium Mill Tailings Pile, Mexican Hat, Utah," *Radiological Health Data and Reports*, January 1971, pp. 17-28.

[3]"AEC Joins in Warnings on Uranium Mine Waste," *Milwaukee Journal*, December 8, 1971, Accent.

24. The land acreage requirements of a 3,000-megawatt nuclear power plant would be less than those of a coal-burning plant of comparable size.

The answer is— TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	66.7	20.8	12.5
Utility Managers	-	-	-
Environmental Leaders	-	-	-

A 3,000-megawatt nuclear installation now requires about 400 acres of land while a similar coal plant with on-site coal and ash facilities could require up to 1,200 acres.[1] However, the land requirements of a power plant depend on the type of cooling system used.

With a once-through cooling system, a 3,000-megawatt nuclear plant would require less land than a coal-burning plant of comparable size. If cooling ponds are built for each type of plant the nuclear plant may require as much land or more land than the fossil fuel plant. Nuclear plants are less efficient than fossil plants and reject more waste heat; therefore, they need larger cooling ponds—about 1 acre per megawatt or in this case, a 3,000-acre cooling pond for a 3,000-megawatt reactor. Since a cooling method was not specified, the question was not included in the total knowledge score.

[1]*Electric Power and the Environment*, A Report sponsored by the Energy Policy Staff, Office of Science and Technology, Washington, D.C., U.S. Government Printing Office, August 1970.

25. Solar energy has not been used to generate electricity because a method for harnessing this energy does not exist.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	70.8	25.0	4.2
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Solar energy has been used to generate electricity in space satellites. However, the photovoltaic cells which convert sunlight directly to electricity in spacecraft are too expensive to use for bulk electrical production.[1]

Although solar energy has been characterized as being clean, free and abundant, there are two major reasons why it has not become a major source of energy for producing electricity. (1) The solar energy reaching the surface of the earth is dilute. To acquire enough solar energy for large projects, it must be collected over a large area. This tends to make solar energy expensive to harness even though the fuel is free. (2) Solar energy is also variable. On cloudy days not much sunlight gets through, none arrives at night, and, in winter, less is available than in summer. Storing large amounts of heat or electricity is difficult and expensive.

Nevertheless, scientists at the University of Arizona have proposed a solar power generating system which would produce 1,000 megawatts of electricity by thermal conversion of sunshine to produce steam. They have suggested that conversion can be done by the optical concentration of sunshine in ground collectors spread over desert regions. The collection of enough solar energy for a 1,000-megawatt generating system would require a solar power "farm" covering about an area 3.8 kilometers on a side.[2]

[1]Norman C. Ford and Joseph W. Kane, "Solar Power;" *The Energy Crisis*, Chicago, Illinois, Educational Foundation for Nuclear Science, 1972, pp. 94-99.

[2]Aden Baker Meinel and Marjorie Pettit Meinel, "Is It Time for a New Look At Solar Energy," *The Energy Crisis*, Chicago, Illinois, Educational Foundation for Nuclear Science, 1972, pp. 99-104.

26. The efficiency of electrical generation may be improved within conventional fossil fuel and nuclear power plants by

a) thermonuclear fusion
The answer is—b) MAGNETOHYDRODYNAMICS
c) fuel cells
d) all of the above
e) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	8.3	54.2	37.5
Utility Managers	6	85	9
Environmental Leaders	27	20	53

The term magnetohydrodynamics (MHD) is used to describe electric generating systems which obtain power from conducting fluids as they move through magnetic fields. For example, a MHD converter produces electricity by the rapid flow of very hot gas through a magnetic field. Since high temperatures are required to make most fluids, especially gases, sufficiently conductive, MHD is generally thought of as a topping cycle for conventional steam cycles. Thus, two electric generation systems are usually required—a MHD converter and a conventional steam turbine generating unit.[1]

The MHD system converts a portion of the thermal energy into electricity and rejects the rest to a steam generator which supplies steam to a turbine generator. Such MHD plants have been predicted to achieve overall efficiencies in the range of 50 to 60 percent, as compared to 40 percent for our best fossil-fueled cycles and 33 percent for current nuclear-powered ones. This would also reduce the heat rejection per unit power output by 55 percent (in a fossil fuel plant).[2]

There are several different types of MHD topping cycles—open cycle, closed and liquid metal. Since the liquid metal MHD can operate at lower temperatures than other cycles, it can be combined with either a fossil fuel combustion plant or a nuclear reactor.[3]

However, technical difficulties and high cost will probably prevent MHD from making a dent in commercial generation before 1980.[4]

[1,3] *MHD for Central Station Power Generation: A Plant for Action*, Office of Science and Technology, Panel on Magnetohydrodynamics (MHD), June 1969.

[4] Hans H. Landsberg and Sam H. Schurr, "Energy From New Sources and Processes," *Energy in the United States: Sources, Uses and Policy Issues*, A Resources for the Future study, New York: Randon House, 1968.

27. An atomic explosion is not possible in current light water nuclear reactors.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	45	10	45
Local Leaders	37.9	17.2	44.9
State Officials	45.8	16.7	37.5
Utility Managers	88	3	9
Environmental Leaders	53	7	40

A nuclear power plant cannot explode like an atomic bomb. Bombs require the rapid bringing together of pieces of almost pure uranium-235 metal into a precise, compact shape. A typical nuclear reactor which generates the heat in a power plant uses a stationary ceramic, not the metal, made up of only about 3 percent uranium-235. The remainder of the uranium is composed of uranium which does not fission. Furthermore, bombs are designed to disperse radioactivity while nuclear reactors are designed to contain the radioactive fission products. However, under some special circumstances, ordinary chemical reactions could occur which might damage the containment building and result in the release of radioactivity.[1]

[1] "Nuclear Power and the Environment," by the San Diego Section of the American Nuclear Society, ANS San Diego Section, P. O. Box 608, San Diego, California.

28. A fast breeder reactor produces more nuclear fuel than it consumes.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	30	5	65
Local Leaders	29.3	10.3	60.4
State Officials	58.3	8.3	33.4
Utility Managers	100	0	0
Environmental Leaders	73	7	20

A breeder reactor is a nuclear reactor designed to both produce power and "breed" new fuel at the same time. When fissionable uranium or plutonium is burned (i.e. fissioned) in such a reactor, the volume of new fuel produced from non-fissionable but "fertile" uranium or thorium, also in the reactor, exceeds that of the original fuel. For example, plutonium is burned with the fertile material, uranium-238, to produce more plutonium, and the uranium-233 is burned with thorium-232 to produce more uranium-233. Thus, a breeder makes fuel (fissionable material) by consuming fertile material.[1]

[1] Glen T. Seaborg and Justin L. Bloom, "Fast Breeder Reactors," *Scientific American*, 223, November 1970, pp. 13-21.

29. Utility corridors are corridors of land reserved for

a) use by electric transmission lines only
b) use by gas and oil pipelines only
The answer is—c) USE BY GAS AND OIL PIPELINES AND ELECTRIC AND TELEPHONE WIRES
d) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	66.7	12.5	20.8
Utility Managers	-	-	-
Environmental Leaders	-	-	-

In the future, land may not be available to meet expected demands for rights-of-way by the electric power industry and other industries if present day practices in establishing single purpose rights-of-way for each industry continue to prevail. For example, there are 300,000 miles of overhead electric transmission lines in existence in the United States. The rights-of-way for these transmission lines (which average 110 feet in width) require nearly 4,000,000 acres. Estimates for 1990 indicate that there will be about 500,000 miles of electric transmission lines that will bring the total to approximately 7,000,000 acres of rights-of-way (assuming 115 feet as the average width). Therefore, it is important that land be used more efficiently for all competing demands. This calls for locating utility services whenever possible on the same rights-of-way and planning joint use service or "utility corridors" in order to minimize impact on the environment. [1]

Interstate highways could provide an opportunity for multiple use of rights-of-way, especially for transmission lines which could be placed underground. However, restrictions placed on the use of strips adjacent to the right-of-way line and particularly problems of accessibility have prevented parallel installations of pipeline facilities within the highway right-of-way.[2]

There are also technical problems in establishing joint corridors. One problem is inductive interference caused when an electric transmission line induces a voltage upon a paralleling communication line. Some pipeline companies prefer not to parallel high voltage electric transmission lines because of a fear of corrosive effects. Pipeline failures could also pose a hazard for electric power lines.[3]

However, with long range planning, many of these problems could be overcome. For example, an innovative approach of joint use is now being developed in the Pacific Gas and Electric Company (California) power supply area. Almost 40 miles of water-front properties, essentially all zoned industrial, present the possibility for a unique multiple use solution to the total energy transportation requirement of the area. This "energy corridor" could house not only the utility electric and gas lines, but also raw petroleum and byproducts, chemical feed stocks and countless other possibilities. A regional water quality control plan projects a major sewage collection line which could also be placed within the corridor.[4]

[1-4] *Electric Power and the Environment,* A report sponsored by the Energy Policy Staff, Office of Science & Technology, Washington, D.C., U.S. Government Printing Office, August 1970.

30. Melting scrap to obtain metal requires less electric power than refining ore.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	50	12.5	37.5
Utility Managers	-	-	-
Environmental Leaders	-	-	-

The United States used more metal in the last 30 years than the whole human race had used until then, and demand keeps increasing. However, many metals are found in limited quantities. For example, scientists warn that the world's known reserves of zinc can support the present growth pattern for only 18 more years and that copper and lead will be exhausted in 21 years.[1]

Even the availability of abundant metals such as steel and aluminum may be limited by lack of energy needed to mine, concentrate and smelt the ores. The Oak Ridge National Laboratory compared the energy cost of some everyday materials in the following table.[2]

ENERGY COST OF SOME EVERYDAY MATERIALS

Amount of Energy Measured In Pounds of Coal, Needed to Make One Pound of ...	From Ore	From Recycled Material
Steel	1.11 lb.	.22 lb.
Aluminum	6.09 lb.	.17-.26 lb.
Copper	1.98 lb.	.11 lb.

Regardless of the fuel actually used, the energy required to produce the materials has been converted to its coal equivalent to facilitate comparison, i.e., it is measured in terms of the coal that would be needed to produce a given amount of the heat or electricity used in the mining, beneficiation, and smelting process.[4]

Therefore, in general, using recycled material to obtain metal requires less energy or electric power than refining ore. However, since many individuals felt that the question was too general, i.e. a specific type of metal—steel, aluminum, copper— should have been given, it was not included in the total knowledge score.

[1]Donnella H. Meadows, Dennis L. Meadows, Jorgen Randers and William W. Brehrens III, *The Limits to Growth*, New York: Universe Books, March 1972.

[2,3]Emund Faltermayer, "Metals: The Warning Signals Are Up," *Fortune*, October 1972, pp. 109-113.

31. Direct home heating by natural gas and oil can result in less pollution and waste of valuable energy resources than electric space heating.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	15	45	40
Local Leaders	13.2	63.2	23.6
State Officials	66.7	20.8	12.5
Utility Managers	39	61	0
Environmental Leaders	87	0	13

Resistive heating (electric space heating) is 100% efficient in converting electricity to heat, but very inefficient in terms of utilizing the energy of the original fuel. For example, most steam electric power plants are 32-40% efficient. This means that for every three units of heat formed, one unit goes to produce electricity and two units are discharged as waste heat. Furthermore, as much as 10% of the electricity produced is lost during transmission and distribution. By the time electricity is converted to heat in a home, the total process is only about 30% efficient.[1]

In contrast, a home gas or oil heater may be 70-80% efficient. If gas or oil home heaters are not well adjsuted, the efficiency may drop to 50%. In either case, it is possible to heat with gas or oil in a home and burn less than half the fuel normally used at a power plant to deliver the same amount of heat.[2]

Direct home heating can also result in less thermal and air pollution. For example, since electric power plants burn more oil and gas than home heaters to deliver the same amount of heat, they may also release more waste heat and air pollutants, i.e., sulfur dioxide and nitrogen oxide, to the environment. Furthermore, the combustion of natural gas at high temperatures in power plants result in higher emissions of nitrogen oxide than burning the same amount of natural gas at lower temperatures in home heaters.[3]

Oil burners can be dirtier and less efficient than gas, so if electric utilities install air pollution control equipment in power plants, the advantages of oil heaters over electric space heating are less obvious.

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[1] Neil Fabricant and Robert M. Hallman, *Toward a Rational Power Policy: Energy, Politics and Pollution*, New York: George Braziller, 1971.

[2] Gordon R. Corey, "Electricity in a Changing Environment," based on notes for talks to Nuclear Engineering seminars at the University of Wisconsin, February 1971, and Mass. Institute of Technology, March 25, 1971.

[3] Sam H. Schurr, *Energy Research Needs*, Washington, D.C., Resources for the Future, October 1971, pp. 32-33.

32. Studies of evaporation show that roughly twice as much water would be lost from cooling tower operations as from systems using ponds or lakes.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	37.5	4.2	58.3
Utility Managers	61	12	27
Environmental Leaders	33	7	60

In a "wet" or evaporative cooling tower, the heated water from a power plant condenser falls through an upward-moving stream of air and is cooled mainly by evaporation. These cooling towers can involve the diversion of substantial amounts of water from the cooling source—a river or lake. For example, Southern California Edison Company has estimated that by the year 2000, the amount of water that would be evaporated if it had to utilize wet cooling towers for its plants would equal over one million acre feet of water a year—or about 25 percent of California's allocation of Colorado River water. This, of course, is only one utility in one portion of the country.[1]

A recent report by engineers at Battelle Memorial Institute Pacific Northwest Laboratory found that "studies of evaporation show that roughly twice the water loss can be expected from cooling tower operation as from systems using ponds or lakes."[2]

Evaporative cooling towers also release damaging chemicals and large quantities of moisture to the atmosphere which can cause fog and icing on roads.[3]

[1]Remarks of C. F. Luce, Chairman of the Board of Con Ed, before the FPC 50th Anniversary Ceremony, June 3, 1970.

[2]R. T. Jaske, J. F. Fletcher and K. R. Wise, *Heat Rejection Requirements of the U.S.*, Chemical Engineering Progress, Vol. 66, No. 11, November 1970, p. 20.

[3]Fred W. Decker, "Cooling Towers and Weather," Department of Physics, Oregon State University, February 1969.

33. In a dry cooling tower, the heated water from a power plant condenser falls through an upward moving stream of air and is cooled mainly by evaporation.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	25	33.3	41.7
Utility Managers	-	-	-
Environmental Leaders	-	-	-

A dry cooling tower circulates water through an elaborate array of closed passages so there is no water lost. Heat is transferred to the air flowing over and around the passages much like a radiator in an auto. Therefore, the above statement is false because it describes the operation of a wet cooling tower and not a dry one.

In principle, dry cooling towers should avoid the problems of fogging, mist and icing characteristic of the evaporative types, since there is not routine water loss. These towers discharge only dry heat to the atmosphere. However, at present the environmental effects of discharging large quantities of dry heat from such cooling towers are unknown.[1]

Furthermore, dry cooling towers must be either much larger in size or greater in number to equal the cooling power of evaporative towers. They are also considerably more expensive than wet cooling towers. For example, dry towers do not cool water as effectively as evaporative towers, which reduces plant efficiency and requires more fuel per kilowatt hour of electricity generated.[2]

As a result of these high costs and other factors, adequate dry cooling tower technology has yet to be demonstrated in the U.S. for large steam-electric plants. The largest dry cooling tower in operation today is one at a 120-megawatt power plant in England.[3]

[1,3] *The Economy, Energy and the Environment*, a study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970.

34. Researchers have suggested using waste heat from power plants for

a) DESALTING SEA WATER
b) IRRIGATION
c) HEATING APARTMENTS AND OFFICE BUILDINGS
d) AQUACULTURE

The answer is—e) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	15	35	50
Local Leaders	22.4	29.3	48.3
State Officials	41.7	45.8	12.5
Utility Managers	79	18	3
Environmental Leaders			

Since nuclear and fossil fuel plants are only 32-40% efficient in converting the energy stored in fuel to electricity, almost two-thirds of the heat produced is rejected to the surrounding air and water. For example, in a nuclear plant, for every kilowatt of electrical power produced, the equivalent of two kilowatts is rejected to the environment as waste heat.[1]

More of this energy could be used if electrical generation were not viewed as the sole possible product of the heat produced at a power plant. For example, it is possible to extract steam after it has done some work in the turbine generating electricity and put it to work elsewhere. This extracted heat may be used for heating apartments and office buildings and for desalting sea water.[1]

Waste heat from the condenser water discharge by power plants can also be put to use. In the state of Washington, warm water discharges from a nuclear power plant were used to heat soil in a greenhouse and produced better growing conditions. The warm water circulated in pipes under the soil and presented no open pollution problems.[2] This heated water could also be used in irrigation to extend growing seasons, in aquaculture to increase the production of fish and algae and in melting ice in areas which are closed to navigation in the winter.[3]

[1] "Waste Heat Utilization," *Proceedings of a National Conference at Oak Ridge National Laboratory*, 27-29 October 1971, NTIS Report CONF-711031, May 1972.

[2] "Warm Water, Power Wastes, May Aid Crops," *Milwaukee Journal*, September 9, 1972.

[3] R. F. Harleman and R. M. Parsons, "Heat—The Ultimate Waste," *Energy Technology to the Year 2000*, Cambridge, Technology Review, 1972, pp. 44-52.

35. The approach used by most power plants for disposing of the bulk of waste heat is

a) cooling ponds
The answer is—b) "ONCE THROUGH" COOLING
c) cooling towers
d) 150 ft. stacks
e) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	20	30	50
Local Leaders	19.5	47.1	33.4
State Officials	70.8	16.7	12.5
Utility Managers	94	6	0
Environmental Leaders	60	40	0

The simplest and most traditional method for disposing of excess heat from a steam electric power plant is "once through" cooling. This approach involves pumping water from a river or some other body of water through the power plant to pick up and carry away the waste heat. The heated water is then returned to its original source and its burden of heat energy is ultimately transferred to the air by evaporation, conduction, radiation and convection.

The primary advantages of "once through" cooling are its low costs, its convenience where there are adequate supplies of water, and its low consumptive use of water (i.e., little water is lost from evaporation). The main disadvantage is the possible damage to aquatic organisms which are trapped in the intake water system and those which are subjected to higher temperatures because of the thermal discharges.[1]

However, the large size of new fossil and nuclear plants and the concern with environmental effects of large water temperature changes now combine to limit the locations which can use this form of heat dissipation. Stricter water quality standards are forcing the use of closed cycle cooling methods such as cooling ponds and cooling towers.[2]

[1]R. F. Harleman and R. M. Parsons, "Heat—The Ultimate Waste," *Energy Technology to the Year 2000,* Cambridge: Technology Review, 1972, pp. 44-52.

[2]"Electric Power and the Environment," A report sponsored by the Energy Policy Staff, Office of Science and Technology, August 1970, p. 8.

36. The current method of storing high-level radioactive wastes is

a) solidification and storage in salt mines
The answer is—b) IN BOILING, LIQUID FORM IN METAL CONTAINERS
c) in gaseous form in an underground pipe system at nuclear plant sites
d) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	5	50	45
Local Leaders	1.7	34	64.3
State Officials	20.8	54.2	25
Utility Managers	6	85	9
Environmental Leaders	13	67	20

Over 80,000,000 gallons of high-level radioactive wastes are stored in liquid form in about 200 concrete encased, steel tanks buried at AEC sites in Washington, South Carolina, Idaho and New York. Some of these tanks are cooled. In other tanks, the liquid wastes are allowed to boil with steam siphoned off to prevent rupture.[1] At best, these tanks are expected to last about 20 years before requiring replacement. Since the radioactive fission products are stored as strong nitric acid solutions, it is expected that the tanks will develop leaks. At Hanford, Washington, 15 of the 151 tanks have developed leaks over a period of about 20 years and some 200,000 of the 74 million gallons seeped into the ground.[2]

The AEC feels that this tank storage is an interim approach to radioactive waste disposal. Eventually, they want to convert liquid radioactive wastes to solids and store them in dry geologic formations.[3]

For the last several years, the AEC has studied the possibility of using a salt mine near Lyons, Kansas, as a federal repository for solidified wastes. However, oil and water well holes were found in the area and the possibility of water leaking into the mine became a problem. The Sierra Club and the state of Kansas attempted to block the AEC's use of the Lyons site. The AEC announced on May 19, 1972, that it was abandoning temporarily its plan to bury wastes at the Lyons site. Instead, the AEC plans to store solidified radioactive wastes above ground in concrete bunkers and to continue research on burial sites in Kansas and other states.[4]

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[1]Neil Fabricant and Robert M. Hallman, *Toward a Rational Power Policy: Energy, Politics, and Pollution*, New York: George Braziller, 1971.

[2]"Nuclear Power and the Environment," by the San Diego Section of the American Nuclear Society, ANS San Diego Section, P.O. Box 608, San Diego, California.

[3]Schneider, Bradshaw, et al., "Status of Solidification and Disposal of Highly Radioactive Liquid Wastes from Nuclear Power in the U.S.A.," presented at IAEA Symposium on Environmental Aspects of Nuclear Power Stations, UN Headquarters, New York, August 10-14, 1970.

[4]"U.S. to Store A-Wastes on Surface," *Milwaukee Journal*, May 19, 1972, pt. 1.

37. Since 1940, the use of electricity has been roughly doubling every

a) 5 years
The answer is—b) 10 YEARS
c) 15 years
d) 20 years

	% Correct	% Incorrect	% Don't know
Local Residents	25	40	35
Local Leaders	41.4	28.1	30.5
State Officials	62.5	25	12.5
Utility Managers	100	0	0
Environmental Leaders	73	7	20

The Federal Power Commission (FPC) expects the historic annual growth rate of 7% for electric power consumption—with its doubling time of 10 years—to continue through the 1990s. On this basis, electric energy requirements are expected to increase almost four-fold within the next 20 years from 1.52 trillion kilowatt-hours in 1970 to 5.83 trillion in 1990. These projections are based on historic growth rates and the growth projections made by the electric utility systems and by the staff of the Federal Power Commission. While much of the growth in electric loads is associated with increases in population and general economic expansion, the FPC expects such trends will be accentuated by the continued increase in demand for electricity by residential customers and industry. For example, manufacturing uses more electricity now than in the past. Also, future innovations and improvements such as increased night lighting of streets, highways and outdoor facilities, electrification of railways, the expansion of urban mass transit systems and the use of electric cars may contribute to the rapid growth rate of electrical consumption. [1]

Factors that may decelerate this growth are increased costs of generation, shortages of fuel or power plants and public reaction to adverse environmental effects.

[1] *The Economy, Energy and the Environment,* A study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U. S. Government Printing Office, 1970.

38. At present, the demand for electricity is growing at a faster rate than the population and the national economy.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	75	0	25
Local Leaders	83.3	2.9	13.8
State Officials	95.8	0	4.2
Utility Managers	97	3	0
Environmental Leaders	100	0	0

The projected increase in electrical generation from 1964 to 1980 is put at 200% in comparison with the estimated rise of about 40% in the nation's population during these 16 years and an increase of perhaps 95% in our gross national product (GNP). This projection implies more rapid growth than would result solely from population and income growth. It assumes continuation of the marked intensification of the nation's use of electricity.[1]

[1]*The Economy, Energy and the Environment,* A study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970.

39. The Federal Power Commission projects that nuclear fueled power plants will account for _____% of the electric power generation by 1990.

a) 5%
b) 21%
c) 33%
The answer is—d) 53%

	% Correct	% Incorrect	% Don't know
Local Residents	55	5	40
Local Leaders	34.5	16.1	49.4
State Officials	29.2	54.1	16.7
Utility Managers	39	58	3
Environmental Leaders	40	7	53

In the most recent National Power Survey, the Federal Power Commission projected the distribution of fuel use by power generation over the next 20 years. Nuclear power will account for 53% of the electric power generation in 1990, in comparison to only 2% in 1970. Coal will drop from 54% in 1970 to 30% in 1990. Natural gas will decrease to 8% in 1990 from 29% in 1970. And residual fuel oil, 15% in 1970, will account for only 9% in 1990.

The report emphasized that the nation's electric power program of the next two decades is "critically dependent on the successful introduction on schedule of large increments of nuclear power." However, the FPC also stated that these forecasts are not to be construed as precise plans but rather as general targets, with adjustments to meet changing conditions. For example, the trend toward nuclear power in the 1990s and 2000 depends upon commercial demonstration, acceptance and application of the breeder reactor.[1]

[1] *National Power Survey*, Federal Power Commisison, Vol. II, Washington, D.C., U.S. Government Printing Office, April 1972.

40. Utilities must reveal plans for new plants and transmission lines at least 10 years in advance of construction.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	62.5	8.3	29.2
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Since states have different siting criteria and do not always deal effectively with siting problems, federal siting legislation has been proposed to provide guidelines and technical assistance to the states. One of the main features of this federal legislation is the requirement that utilities reveal plans for new plants and transmission lines at least 10 years in advance of construction. However, to date such siting legislation has not been passed by Congress.[1]

In Wisconsin, a siting bill has also been introduced in the State Assembly that would require all electric utilities to submit, biennially, ten year plans of proposed operations and construction of facilities to the Public Service Commission. However, this siting bill has not been passed.[2]

[1] Hearings before the Subcommittee on Communications and Power of the Committee on Interstate and Foreign Commerce, House of Representatives, 91st Cong., 1st Sess., ser 92-33, pt. 3 at 1002.

[2] See Appendix A.

41. The choosing of power plant sites and transmission line routes by utilities has to be integrated with regional land use planning in the area

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	0	55	45
Local Leaders	13.8	65.5	20.7
State Officials	37.5	50	12.5
Utility Managers	85	9	6
Environmental Leaders	73	7	20

Regional planning commissions in Wisconsin can conduct research studies, provide advisory services, and act as a coordinating agency but they have no enforcement powers.[1] Thus, state (and federal) regional planning commissions can advise utilities on siting but there is no provision in state or federal law that requires the choice of power plant sites and transmission line routes by utilities to be integrated with regional land use planning in an area.[2]

Under siting legislation introduced in the Wisconsin Assembly, copies of advanced plans for siting power plants and transmission lines must be sent to the director or chairman of a regional planning commission with jurisdiction over any area where a generating plant or transmission line is proposed to be located. However, this siting legislation has not yet been passed, and such legislation still would not require that siting be integrated with regional land use planning.[3]

[1] "The Regional Planning Commission in Wisconsin," Wisconsin Department of Local Affairs and Development, University Extension, The University of Wisconsin, Institute of Governmental Affairs, March 1970.

[2] Private conversation, Edward Gagen, Wisconsin Department of Local Affairs and Development, May 30, 1973.

[3] See Appendix A.

42. In the state of Wisconsin, electric utilities, through application to the state, have the power of eminent domain and may condemn land for transmission lines or plant sites.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	55	15	30
Local Leaders	51.7	20.7	27.6
State Officials	79.2	0	20.8
Utility Managers	-	-	-
Environmental Leaders	-	-	-

The Wisconsin Statutes state that "any Wisconsin corporation engaged in the business of transmitting or furnishing heat, power or electric light for the public..." may acquire land by condemnation.[1] The electric utility does not need a Certificate of Authority from the Public Service Commission before it condemns land for a power plant.[2] The utility may simply file a petition with the court and proceed with condemnation according to rules prescribed by the state.

[1]Wisconsin, Eminent Domain, *Statutes*, Vol. 1, Chapter 32.

[2]Wisconsin, Public Service Commission, *Statutes*, Vol. 2, Chapter 196.

43. At the present projected levels of fuel use, which of the following fuels will be depleted first?

a) coal
b) oil
The answer is—c) NATURAL GAS
d) uranium-235

	% Correct	% Incorrect	% Don't know
Local Residents	20	35	45
Local Leaders	21.8	48.3	29.9
State Officials	45.8	37.3	16.9
Utility Managers	91	9	0
Environmental Leaders	47	13	40

Natural gas is the cleanest and most convenient of fuels but it may be the first one to be exhausted. Since 1968, the United States has been using natural gas twice as fast as it has been finding it. In many parts of the country, gas companies are refusing to make gas available to new homes and are forcing some industrial users to shift back to oil when home-heating demand is high.[1] In 1974, many large industrial customers such as electric utilities will be put on an interruptible basis, i.e., their gas can be cut off any time it is felt necessary to maintain gas supplies for homes and businesses.[2] At the same time, air quality standards are becoming stricter and the industrial demand for natural gas, a relatively clean fuel compared to oil and coal, has increased dramatically.

Many forecasts have been made about how long our supplies of oil, natural gas, coal and uranium-235 will last. These projections depend on numerous factors such as estimation of recoverable reserves, the growth rate of consumption for each fuel, and available technology. Unfortunately, most fuel estimates use a given rate of fuel consumption which doesn't allow for future growth in demand. Many of these estimates also consider only proven fuel reserves, i.e., stocks of a mineral raw material whose location is definitely known and which can be profitably extracted immediately or in the near future under current techniques.

However, a national fuels and energy policy study sponsored by the National Science Foundation did take into consideration growth factors and what they considered to be recoverable reserves—not just proven reserves. According to this study, if the present growth rate in demand for gas and oil continues at 6.2% and 3.9% per year, respectively, then gas would be depleted between 1989-2000 and oil between 1988-2011. However, we now import 27% of our petroleum and 4% of our natural gas. So if future imports are included in these calculations, the supply of natural gas would be depleted between

1993-2010 and oil between 2001-2031. The development of synthetic fuels from coal could extend the availability of gas resources to 2037 and oil reserves beyond 2050.[3] Thus, supplies of oil could last another 80 years and natural gas another 60 years.

In contrast, coal reserves are estimated to last another 300 years or longer.[4] And reserves of uranium-235 may not be depleted for another 100 years, depending on the price that the nuclear industry is willing to pay for uranium. At this time, natural uranium oxide under $10 per pound may only last another 20 years at projected levels of use, but uranium between $10 and $100 per pound will probably be available until 2050 or longer.[5]

[1,5] Edmund Faltermayer, "The Energy Joyride is Over," *Fortune*, September 1972, pp. 99-102, 180-191.

[2] "Natural Gas Bills Might Soar Again," *Milwaukee Journal*, January 15, 1972.

[3] *A National Fuels and Energy Policy Study*, Summary Report of the Cornell Workshop on Energy and the Environment, sponsored by the National Science Foundation for the Committee on Interior and Insular Affairs, U.S. Senate, May 1972.

[4] M. King Hubbert, "Energy Resources," *Resources and Man*, San Francisco: W. H. Freeman and Company, 1969, pp. 147-252.

44. Federal research and development effort for civilian energy production centers on research and development for fossil fuel energy.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	15	25	60
Local Leaders	20.7	19.5	59.8
State Officials	62.5	4.2	33.3
Utility Managers	75	9	16
Environmental Leaders	53	7	40

In the fiscal year 1972, over 75% of the $537 million devoted to energy research and development by the federal government was spent on atomic energy, and the major portion of atomic energy research went toward the development of the liquid metal fast breeder reactors. Thus, the AEC's power program was almost three times larger than all of the other federal energy research and development programs combined.[1]

President Nixon's energy message for 1973 indicated that future federal energy and research development will continue to center on atomic energy, especially the breeder reactor.[2]

[1]"Energy Budget," *Science*, 179, February 9, 1973, p. 549.

[2]"Nixon's Energy Message," *Milwaukee Journal*, Pt. 1, April 18, 1973, p. 1.

45. Supplies of nuclear fuel for generating electricity are less subject to interruption from strikes or other labor disputes than the supplies of coal are.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	41.7	33.3	25.0
Utility Managers	-	-	-
Environmental Leaders	-	-	-

One factor favoring nuclear power is its relative invulnerability to interruptions in fuel supply. This is because a year's supply of uranium is stored right in the reactor. For example, a 1,000 megawatt fossil-fueled plant consumes over two million tons of fuel per year but a nuclear plant of the same capacity needs only around 35 tons of uranium oxide.[1]

In contrast to the constant traffic of coal into and ashes out of a coal-fired plant, a nuclear plant needs only one shipment of fuel in and spent fuel out per year. A few trucks can deliver this annual supply of fuel to a nuclear plant but trains or barges must constantly bring coal to a coal-burning power plant during a year of its operation. Thus, the supplies of nuclear fuel for generating electricity are less subject to interruption from transportation strikes or other labor disputes than are the supplies of coal.[2]

The low volume of uranium required also permits a nuclear plant to obtain its fuel economically from great distances, whereas a fossil-fueled plant is limited to sources from which transportation costs are low. Thus, a coal miners' strike at a nearby coal field that was a major source of fuel for a fossil plant could interrupt the plant's operation.[3]

[1,2,3] Mason Benedict, "Electric Power from Nuclear Fission," *Energy Technology to the Year 2000*, Cambridge, Mass., Technology Review, 1971, pp. 32-42.

46. Delays in nuclear power plant construction and operation are the result of

a) EQUIPMENT FAILURES
b) SUPPLY DELAYS
c) ENVIRONMENTAL CONCERNS
d) b & c
e) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	5	75	20
Local Leaders	14.4	75.8	9.8
State Officials	33.3	62.5	4.2
Utility Managers	37	63	0
Environmental Leaders	47	53	0

A survey by Edison Electric Institute of 85 large steam generating plants (nuclear and fossil fuel) installed during 1966-68 indicated about two-thirds of the total were delayed in being put into service. Equipment component failures, late delivery of major equipment and a shortage of construction workers were the most frequent causes of delay found in the survey. The report predicted that between 1968 and 1971, late delivery of equipment would be the prime reason for delay. For example, there was a rush to order nuclear plants in the late 1960s. Reactor manufacturers promised nuclear plants at attractive prices, and soon the manufacturers and utilities were both overcommitted.[1]

When supplies for the construction and operation of the nuclear plants did arrive, utilities were plagued with equipment failures. A 1973 AEC safety report presented at the emergency core cooling hearings stated that "the number of defects, equipment malfunctions, or failure events that have been encountered during construction, pre-operation testing and routine nuclear power operations to date has been large...."[2] For example, a routine 10 week refueling at Wisconsin Electric Power Company's Point Beach grew into a five month closedown for turbine and steam generator repairs. In Connecticut, the Millstone Point nuclear power plant was closed down between September 1972 and March 1973 because seawater seeped into the reactor and corroded hundreds of parts. When the nuclear plant was inspected, workmen found unrelated mistakes in key parts and the repair work cost over $10 million. Last July, two workers in Virginia Power Company's Surry nuclear plant were killed in the act of inspecting a set of malfunctioning valves when still another valve exploded. An AEC investigation attributed the accident to improper design in the piping system. Vermont Yankee Nuclear Power Company and Commonwealth Edison have complained of receiving defective fuel supplies. The operating licenses of six plants were restricted because of fuel problems.[3]

Although environmental concerns were not responsible for the delays in nuclear plant construction and operation before 1970, recent environmental intervention has caused delays. A court decision in the case of Calvert Cliffs nuclear plant required the AEC to prepare environmental impact statements for all nuclear plants licensed after the National Environmental Policy Act took effect. This court decision resulted in delays of six months to a year in the start-up date of all nuclear reactors under construction or planned. In the future, environmental concerns could have a major impact on whether nuclear plants are built or operating on schedule.[4]

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[1]*The Economy, Energy and the Environment*, a study prepared for the Joint Economic Committee, U.S. Congress, Washington, D.C., U.S. Government Printing Office, 1970.

[2]Robert Gillette, "Nuclear Safety: AEC Report Makes the Best of It," *Science*, 179, January 26, 1973, pp. 260-263.

[3]Thomas Ehrich, "Atomic Lemons," *Wall Street Journal*, May 3, 1973.

[4]Harry Perry, "Fuels for Electricity Generation," unpublished paper presented at Sierra Club Conference on Electric Power Industry, Johnson, Vermont, January 14-15, 1972.

47. There is a shortage of trained men to build and operate nuclear power plants.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	45	20.8	34.2
Utility Managers	-	-	-
Environmental Leaders	-	-	-

At public hearings on nuclear plants, utility officials have complained of a shortage of qualified welders to construct nuclear power plants. Welders must be brought to a particular plant site from all over the country. Since these welders are in high demand, a utility company must compete against other companies and industries for their services.[1]

In a study of the scientific and technical manpower requirements of the atomic energy field, the AEC predicted a shortage of technicians or engineering specialists by 1973. Since the nuclear industry has shifted its orientation from one of research to product development, the greatest growth in personnel demand occurred in the technician category. In the case of electric utilities, the majority of on-site plant personnel are technicians responsible for the operational aspects of running nuclear plants. However, since nuclear power plants have not been built or put into operation as quickly as the nuclear industry anticipated, this shortage of reactor operators has not been serious.[2]

[1] Private conversation with employee (nuclear engineer) of Kewaunee Nuclear Power Plant, Kewaunee, Wisconsin, November 1972.

[2] *Scientific and Technical Manpower Requirements of Selected Segments of the Atomic Energy Field*, Division of Nuclear Education and Training, USAEC Washington, D.C., U.S. Government Printing Office, June 30, 1971.

48. The costs of electricity will increase in the future because of

a) ENVIRONMENTAL PROTECTION AND ENHANCEMENT FEATURES
b) INCREASING COMPETITION FOR FOSSIL FUELS
c) RISING COSTS OF "CAPITAL"

The answer is—d) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	15	65	20
Local Leaders	50.6	39.1	10.3
State Officials	87.5	8.3	4.2
Utility Managers	94	6	0
Environmental Leaders	72	21	7

A 1972 report by the Federal Power Commission indicates that the average costs of electricity—1.54 cents per kilowatt hour in 1968—will increase approximately 1.83 cents by 1990. Allowing for inflation, the average cost in current dollars would be about 3.48 cents in 1990, more than double the 1968 level. These higher costs are based on environmental and enhancement features; sharply increasing competition for fossil fuels; and the rising fixed charges for this extremely capital-investive industry.[1]

For example, electric utilities will have to raise over $350 billion in new capital by 1990 for power plant construction. At the same time, fossil fuel costs are expected to rise from 2.72 mills* per kilowatt hour in 1968 to 3.79 mills in 1990. Also, stricter air pollution standards will require the purchase of low sulfur fuels which are already in short supply.[2]

Improving the appearance of power facilities and preserving scenic and related values have also became significant expense items in the electric utility programs.[3]

Additional environmental costs include the installation of air pollution control equipment and closed cycle cooling systems. For example, at a public hearing on the revision of Wisconsin's water quality standards, Chairman William Eich of the Wisconsin Public Service Commission said that the new restriction on thermal discharges would mean closed cycle cooling facilities at six power plants on Lake Michigan or Green Bay. This would cost the utilities over $200 million and result in higher electric bills for consumers.[4]

*Mill—one tenth of a cent, $.001.

[1,2,3] *National Power Survey*, Federal Power Commission, Vol. II, Washington, D.C., U.S. Government Printing Office, April 1972.

[4] "Eich Fears Result of DNR Water Plan," *Milwaukee Journal*, May 1, 1973.

49. The AEC has ruled that the requirements of the National Environmental Policy Act would not be applied to already licensed nuclear facilities.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	29.2	37.5	33.3
Utility Managers	-	-	-
Environmental Leaders	-	-	-

The National Environmental Policy Act (NEPA) of 1969 requires the Atomic Energy Commission, as well as other federal agencies, to consider the total environmental impact of major nuclear facilities; whether particular facilities are actually needed; and possible alternatives to such facilities.[1]

The AEC ruled that the requirements of NEPA would not be applied to facilities licensed before NEPA became law and that environmental challenges could only be made with respect to license applications filed after March 4, 1971. These AEC rulings were made to avoid unreasonable delays in construction and operation of nuclear power plants.[2]

Many individuals felt that this question was ambiguous because it was not clear whether "already licensed nuclear facilities" referred to nuclear plants licensed before or after NEPA. Therefore, the question was not included in the total knowledge score.

[1]Statement byL. Manning Muntzing, Director of Regulation, U.S. Atomic Energy Commission, 1973 Authorization Hearings Before the Joint Committee on Atomic Energy, March 9, 1972.

[2]Transcript of Press Conference, Dr. James R. Schlesinger, Former Chairman, U.S. Atomic Energy Commission, December 6, 1971, Denver, Colorado.

50. To construct a nuclear power plant in Wisconsin, the utility must first obtain a permit or approval from the

The answer is—a) STATE PUBLIC SERVICE COMMISSION
b) Division of Economic Development of the State Department of Local Affairs & Development
c) State Department of Health and Social Services
d) State Administrative Office
e) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	30	20	50
Local Leaders	62.1	10.3	27.6
State Officials	83.3	8.4	8.3
Utility Managers	100	0	0
Environmental Leaders	80	0	20

The two basic considerations in granting the CA are:

(1) "if the public convenience and necessity require such work," i.e., if it is needed, and

(2) if it is economically feasible and does not involve unreasonable expenditures.

Under the Wisconsin Environmental Policy Act of 1972, the Commission must also consider the environmental impact of major utility construction.[1]

Even after obtaining a permit from the PSC, the Utility must also get permits or approvals from federal agencies such as the Atomic Energy Commission, the Environmental Protection Agency and the Army Corps of Engineers and state agencies such as the Department of Natural Resources.

[1]Wisconsin, Public Service Commission, *Statutes*, Vol. 2, Chapter 196.

51. Any person whose interest may be affected by an Atomic Energy Commission licensing proceeding of a nuclear plant may file a petition for leave to intervene.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	50	0	50
Local Leaders	63.2	2.9	33.9
State Officials	66.7	4.2	29.1
Utility Managers	97	3	0
Environmental Leaders	60	20	20

The AEC issues a hearing notice to consider a construction or operating permit at least 30 days in advance. Any person whose interest may be affected by a licensing proceeding may file a petition for leave to intervene (which gives him full powers of cross examination) or make a limited appearance to present his viewpoint. The petition should state the person's interest in the proceeding, how it may be affected by the proposed licensing action and the person's contentions in reasonably specific detail. Petitions stating contentions relating only to matters outside the Commission's jurisdiction will be denied.[1]

In April 1973, Director of AEC Regulation L. Manning Muntzing announced that the regulatory staff will now invite intervenors and potential intervenors in individual licensing proceedings to meet informally with the AEC staff at an early stage in the review process. In the past, the regulatory staff has routinely met, as part of its review process, with representatives of the applicant for a construction or operating license, reactor manufacturers and others concerned with application but never with intervenors.[2]

[1]Atomic Energy Commission, U.S. Code of Federal Regulations, Vol. X, pt. 50, 1972.

[2]"AEC Takes New Step to Help Public Participate in Licensing Process," Information for Press, Radio and TV, Chicago Operations Office, USAEC, Argonne, Illinois, April 9, 1973.

52. A provisional permit for nuclear plant construction may be issued even if technical details related to plant safety are still in the developmental stage.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	35	25	40
Local Leaders	46	27	27
State Officials	62.5	0	37.5
Utility Managers	73	21	6
Environmental Leaders	80	7	13

According to federal regulation, the AEC may issue a construction permit when an applicant has not supplied all of the technical information required to complete the application. In this case, the utility must identify any safety features or components which require further research and development and conduct a program to resolve these safety questions.[1]

[1]Atomic Energy Commission, Code of Federal Regulation, Vol. X, pt. 50 p. 230, 1972.

53. Public hearings are required before the AEC grants an operating permit for a nuclear plant.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	70	0	30
Local Leaders	79.9	4.6	15.5
State Officials	58.3	16.7	25
Utility Managers	94	0	6
Environmental Leaders	80	7	13

Public hearings are mandatory before the AEC grants a construction permit for a nuclear plant. However, at the operating permit stage, public hearings are not required. A finding must be made that a substantial new safety development has occurred since the construction permit was issued in order to hold a hearing. Thus, the hearing would automatically be a contested one.[1]

Many people answering this test interpreted this question to mean "public hearings are required at some stage during the AEC licensing procedure before an operating permit is granted." In this case, the answer would be TRUE. Therefore, the question was not included in the total knowledge score.

[1]Atomic Energy Commission, U.S.Code of Federal Regulations, Vol. X, pt. 50, 1972.

54. When a cooling water intake or discharge structure of a nuclear plant in Wisconsin extends into navigable water, the utility must obtain a permit from the

a) Department of the Interior
b) STATE DEPARTMENT OF NATURAL RESOURCES
c) ARMY CORPS OF ENGINEERS
The answer is—d) b & c
e) all of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	50	41.6	8.4
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Under the provisions of the Rivers and Harbor Act, the Army Corps of Engineers must issue permits for dredging, filling and excavation in the navigable waters of the U.S. Thus, where a cooling water intake or discharge structure of a nuclear plant extends into navigable water, the utility or a construction company acting for the utility must obtain a construction permit from the Corps.[1]

The Bureau of Water and Shoreline Management of the Department of Natural Resources must also review and approve cooling water intake or discharge structures that extend into navigable water in Wisconsin. The bureau will normally grant the utility a permit if the intake structure doesn't obstruct navigation or reduce the effective flood flow capacity of a stream and is not detrimental to the public interest.[2]

[1]Private conversation, Mr. Ron Johnson, Operations Office, Army Corps of Engineers, Chicago, Illinois, June 9, 1972.

[2]Private conversation, Mr. Edward Brick, Bureau of Water and Shoreline Management, Wisconsin Department of Natural Resources, Madison, Wisconsin, July 14, 1973.

55. The utility may construct facilities such as a turbine building and water intake and discharge structures before the issuance of a construction permit by AEC.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	29.2	25	45.8
Utility Managers	-	-	-
Environmental Leaders	-	-	-

In March 1972, the Atomic Energy Commission adopted amendments to its regulations to better insure that environmental factors were taken into account during the licensing process for nuclear power plants.[1]

AEC regulations prohibit the beginning of construction of nuclear power plants and other licensed facilities until a construction permit has been issued. Previously, construction included pouring the foundation for, or the installation of, any portion of the permanent facility on the site. It did not include, for example, the construction of non-nuclear facilities such as turbine buildings.[2]

Under the new amendments, "commencement of construction" was defined, for facilities subject to environmental review, to include any clearing of land, excavation or other substantial action that would adversely affect the natural environment of a site and the construction of non-nuclear facilities (such as turbo-generators and turbine buildings).[3] Thus, utilities can no longer construct facilities such as a turbine building before the issuance of a construction permit by the AEC.[3]

[1,2,3] "AEC Adopts Further Regulation Amendments to Protect Environmental Values," *Press Release*, Chicago Operations Office, Argonne, Illinois, March 20, 1972.

56. In order to receive a construction permit from the AEC, the utility compiles a preliminary safety analysis report which is reviewed by the

a) ADVISORY COMMITTEE OF REACTOR SAFEGUARDS
b) AEC DIVISION OF REACTOR LICENSING
c) ATOMIC SAFETY AND LICENSING BOARD
d) b & c

The answer is—e) ALL OF THE ABOVE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	16.7	33.3	50
Utility Managers	-	-	-
Environmental Leaders	-	-	-

The Division of Reactor Licensing reviews a utility's application to construct a nuclear power plant. The division supplements the safety analysis report with conferences with the technical staff of the applicant and may ask the applicant for further information. This division also prepares an evaluation of the safety aspects of the proposed power reactor for the Advisors Committee on Reactor Safeguards (ACRS).[1]

The ACRS is an independent committee established by law to advise the Commission on safety aspects of reactors and is composed of scientists and engineers qualified in various fields related to reactor technology. The Advisory Committee considers the applicant's preliminary safety analysis report, together with the evaluation prepared by the Division of Reactor Licensing. Representatives of the applicant and members of the technical staff of the Division of Reactor Licensing meet with the ACRS to deal with questions that arise during the Committee's review of the reactor. Usually a subcommittee meeting is held, often at the proposed site, before the ACRS report is made public.

Finally, a public hearing on the application for a construction permit is conducted by the Atomic Safety and Licensing Board which is composed of two technical experts and one lawyer drawn from a pool of people within the AEC, the industry, and various teaching positions. The board is appointed by the Commission and the lawyer serves as chairman.[2]

If the application is uncontested, the hearing usually involves only the presentation of testimony by representatives of the applicant and the AEC regulatory staff. The board's role is to determine whether the application and the record (including the safety report) contain "sufficient information" and whether the regulatory staff's review has been adequate to support findings that must be made for issuance of the construction permit. In contested cases, evidence is presented by representatives of the applicant, the AEC regulatory staff, and by witnesses called by the intervenors. In these proceedings, the board is required to evaluate from scratch the evidence with respect to the matters that are in controversy.[3]

[1-3]Hearings before the Subcommittee on Legislation of the Joint Committee of the United States on AEC Licensing Procedure and Related Legislation, 92nd Congress, 1st Session, pts. 1-4.

57. The power to set federal standards for permissible doses, exposures and concentrations of radiation is held by the

a) Atomic Energy Commission
The answer is—b) ENVIRONMENTAL PROTECTION AGENCY
c) Federal Radiation Council
d) International Council on Radiation Protection
e) none of the above

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	62.5	12.5	25
Utility Managers	3	85	12
Environmental Leaders	27	60	13

The Environmental Protection Agency (EPA) is responsible for setting radiation protection standards for application to the environment. It also has the responsibility to "advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all federal agencies in the formulation of radiation standards and in the establishment and execution of programs of cooperation with the states."[1] These responsibilities were transferred to the EPA from the AEC and from the federal Radiation Council by "Reorganization Plan No. 3 of 1970."[2] The AEC retains responsibility for controlling emissions by its licensees and contractors so the EPA standards are met.[3] Thus, in the case of nuclear reactors, the actual license conditions for radioactive emissions are specified by the AEC, but must conform to EPA general guidance and any specific EPA standards that exist.

EPA intends to issue standards for individual classes of radiation sources whenever it feels this is necessary. In the case of nuclear power plants, the new AEC proposed regulations for power reactors have been found tentatively acceptable by EPA and the agency has not yet found it necessary to issue more restrictive standards in this case.[4] (However, these new AEC standards which would be much stricter than previous emission standards have not yet been adopted.[5])

The basic standards for human radiation exposure were set by the federal Radiation Council.[6] These are undergoing a detailed review which is being coordinated by the EPA. The EPA will have the responsibility for proposing any indicated changes in basic standards.

The Environmental Protection Agency was probably the best answer to this question; however, the Atomic Energy Commission could be a partially correct answer since this Commission was responsible for setting the present reactor emission standards. Consequently, this question was not included in the total knowledge score.

[1,2]Proposed Rule Making. Atomic Energy Commission, 10 CFR, Pt. 50, "Licensing of Production and Utilization Facilities," *Federal Register*, XXXVI, No. 111, June 9, 1971, 11113-11117.

[3]Personal letter, Jared J. Davis, Assistant Director for Site and Health Standards, Directorate of Regulatory Standards, Atomic Energy Commission, Washington, D.C., October 17, 1972.

[4]Personal letter, Allan C. Richardson, Assistant to Director for Standards Development Criteria and Standards Division, Environmental Protection Agency, Rockville, Maryland, October 16, 1972.

[5]Proposed Rule Changes as of October 15, 1972, Nuclear Safety, Vol. 14, no. 1, January-February, 1973, P. 72.

[6]U.S. President, Memorandum, Federal Radiation Council, Radiation Protection Guidance for Federal Agencies, *Federal Register*, May 18, 1960, 4402-4403.

58. Present radiation standards take into account the total accumulation of radiation individuals receive from all emitting sources.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	10	40	50
Local Leaders	9.2	48.9	41.9
State Officials	16.7	58.3	25
Utility Managers	43	33	24
Environmental Leaders	67	0	33

The present standards for permissible doses and exposures of radiation take into account only sources from peaceful uses of atomic energy—they do not take into account medical radiation.

The Federal Radiation Council (now superseded by the Environmental Protection Agency) was responsible for setting the present radiation standards which are

5 rads per year for workers in nuclear technology
.5 rad per year for any individual in the general population
.17 rad per year as an average individual dose for large segments of the general population

These standards are important because they are used as a basis for calculating maximum permissible concentrations (MPC) of various radioactive isotopes in air and water and for permissible rates of discharge of such isotopes from nuclear power plants and related activities.[1]

However, Dr. Karl Z. Morgan, the first U.S. member of the International Committee on Radiation Protection, has stated that medical sources of radiation should be included in these radiation standards. He points out that therapeutic and diagnostic uses of radiation in medicine now average 0.06 rad per person per year in this country (more than 90% of all man-made radiation exposure).[2]

The National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation has also criticized the present standards and has urged that they be tightened if the U.S. is to avoid an increase in cancer deaths over the next 30 years.[3]

The committee estimated that if the U.S. population were exposed to the .17 rad (the amount of radiation in about four chest X-rays) a year of radiation now considered the maximum to maintain safety standards, anywhere from 1,100 to 27,000 Americans would become afflicted with serious genetic-linked diseases per year, as well as 3,000 to 15,000 additional cancer deaths annually.[4]

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[1]Atomic Energy Commission, U.S. Code of Federal Regulations, Vol. X, pt. 20 1972.

[2]Karl Z. Morgan, "Adequacy of Present Radiation Standards," *The Environmental and Ecological Forum 1970-1971*, Oak Ridge, Tennessee, U.S. Atomic Energy Commission, 1972, pp. 104-130.

[3]*The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, Report of the Advisory Committee on the Biological Effects of Ionizing Radiation, Washington, D.C., National Academy of Sciences, 1972.

[4]"The BEIR Report," National Academy of Sciences *News Report*, December 1972, pp. 2-8.

59. Cost, not technology, is the primary constraint on reducing and perhaps eliminating radioactive discharges from nuclear power plants.

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	25	10	65
Local Leaders	25.3	40.2	34.5
State Officials	45.8	29.2	25
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Babcock and Wilcox and Combustion Engineering (nuclear manufacturers) have stated that reduction to virtually any level of radioactive release is feasible, depending on the amount of money the utility is willing to spend. Westinghouse Electric Company has also announced the availability of "an essentially zero radioactivity release" plant, although it stresses that this applies primarily to krypton and to tritium released in the cooling water.[1]

However, the methods for eliminating radioactive discharges from nuclear plants are complex and very expensive. AEC officials feel that routine releases of radioactive wastes are now so low that the extra cost to reduce or eliminate these wastes is not really justified.[2]

[1] *Nucleonics Week*, May 7, 1970, pp. 1-2.

[2] Morton I. Goldman, "Management of Nuclear Fuel Reprocessing Wastes," *Proceedings on a Student Conference on Nuclear Energy and the Environment*, Madison, Wis., April 3-4, 197, pp. VIII 1-7.

60. States may set radioactive emission limits more strict than those of the federal government.

The answer is—FALSE

	% Correct	% Incorrect	% Don't know
Local Residents	-	-	-
Local Leaders	-	-	-
State Officials	66.7	16.7	16.6
Utility Managers	-	-	-
Environmental Leaders	-	-	-

On April 3, 1972, the Supreme Court upheld lower court rulings against state radiation emission standards which were tougher than those of the Atomic Energy Commission.

Lower courts had held that Congress, by enacting the Atomic Energy Law, had given the federal government exclusive jurisdiction of nuclear power. The Supreme Court agreed in a brief announcement without hearing the case.[1]

The case specifically involved Minnesota state restrictions on the Northern States Power Company regarding the dumping of nuclear power plant waste materials. The restrictions were part of the process of granting a permit to the company to build a nuclear power plant on the Mississippi River. (Wisconsin was among 12 states which adopted plans similar to those in Minnesota for regulating radioactive waste discharges. Wisconsin joined in the suit but had not put the stricter rules into effect while awaiting the Supreme Court decision.)[2]

The Minnesota Pollution Control Agency imposed radioactive effluent limits that were lower than AEC regulations. Minnesota and other states argued that states should have the right to set limits lower than federal standards and that they have availed themselves of this authority in some instances—such as the amount of hydrocarbons permitted from automobile exhaust pipes or the temperature of the water discharged from a power plant. The AEC counter-argument was that radioactive limits should be uniform from state to state because different limits in each state would be intolerable burdens on the nuclear industry.[3]

[1,2] "Law Asked Upsetting Atomic Waste Ruling," *Milwaukee Sentinel*, April 5, 1972.

[3] Walter H. Jordan, "The Issues Concerning Nuclear Power," *Nuclear News*, October, 1971, pp. 43-49.

61. The thermal standards for lakes and rivers in Wisconsin are set by the

a) Environmental Protection Agency (EPA)
The answer is—b) STATE DEPARTMENT OF NATURAL RESOURCES WITH THE APPROVAL OF EPA
c) Department of the Interior
d) National Oceanic and Atmospheric Administration
e) Council on Environmental Quality

	% Correct	% Incorrect	% Don't know
Local Residents	45	10	45
Local Leaders	46	14.4	39.6
State Officials	95.8	0	4.2
Utility Managers	94	3	3
Environmental Leaders	80	0	20

Wisconsin statutes authorize and direct the Department of Natural Resources (DNR) to set water quality standards.[1] In accordance with this law and the Federal Water Pollution Act, the DNR has set thermal standards for the lakes and rivers in Wisconsin. These standards state that thermal discharges cannot raise the receiving water temperature more than 3° F above the existing natural temperature at the boundary of the mixing zones established by the department.[2]

In the future, DNR will issue permits for thermal discharges. Under the 1899 Refuse Act, industries applied to the U.S. Corps of Engineers for permits to discharge wastes (including heated water) into waterways. Without revoking the 1899 Refuse Act, the Federal Water Pollution Control Act of 1972 establishes a new permit system to be controlled by the federal Environmental Protection Agency (EPA) and the states. EPA must issue effluent guidelines which will be used by the states in granting permits to individual dischargers. In addition, EPA must rule on the adequacy of any state permit program before allowing that state to issue a permit.[3]

[1]Wisconsin Department of Natural Resources, *Statues*, Vol. 2, Chapter 144, 1972.

[2]*Notice on Public Hearing to Consider Revisions to Wisconsin Water Quality Standards and an Environmental Impact Statement*, Department of Natural Resources, April 1973.

[3]Environmental Protection Agency, "State Program Elements Necessary for Participation in the National Pollutant Discharge Elimination System," *Federal Register*, XXXVII, No. 247, December 22, 1972, 28390-28402.

62. If a major nuclear power plant accident occurred, the damage would be paid in large part by the

a) U.S. government
b) insurance companies
c) utility company
d) affected persons
The answer is—e) DON'T KNOW

	% Correct*	% Incorrect	% Don't know*
Local Residents	55	45	55
Local Leaders	42	58	42
State Officials	37.5	62.5	37.5
Utility Managers	27	73	27
Environmental Leaders	-	-	-

*The correct answer is Don't know

This question is difficult to answer because a "major" nuclear power plant accident is not defined. In designing nuclear plants, scientists and engineers consider several classes of postulated accidents at a reactor facility. These range from trivial accidents to the most severe accident considered possible, "loss of coolant," where one of the large pipes that brings cooling water to the reactor vessel ruptures. A "loss of coolant" accident would be considered a major accident but the consequences of such an accident are difficult to predict. If the fuel core melted, the radioactive fission products could be contained within the reactor or they could escape to the environment.[1]

In 1957, the AEC published a report on the theoretical possibilities and consequences of a major reactor accident. Depending upon the type of accident and the amount of radioactive wastes released, the report predicted that the effects of a major accident might range from none killed or injured to 3,400 people killed and about 45,000 injured. Property damage might range from 1/2 million to 7 billion dollars due to contamination of the land by radioactive fission products.[2] Many AEC experts contend that the worst possible accident postulated in the report, where 50% of the fission products escape and are transported by unfavorable weather conditions to regions of high population, is an impossible situation. So they believe damages in the range of 7 billion dollars are unrealistic.[3]

However, AEC critics point out that the reactor considered in this report was only 250 megawatts. The worst consequences of an accident with this reactor could be duplicated with a 3% release of radioactive fission products from a modern 2000 megawatt thermal reactor. This much radioactive material represents less than one-seventh of the reactor's volatile or gaseous fission products—all of which could be released in a major accident. Therefore,

these scientists believe the results of such an accident could be even greater than 3,400 killed and 7 billion dollars in property damage.[4]

At present, the utility operator purchases 166 million dollars worth of insurance, $82 million liability and $84 million property damage insurance. This is the maximum amount of coverage that insurance pools will provide for nuclear power plants. Through the Price Anderson Act, Congress provides another $478 million in liability insurance, bringing the total to $560 million.[5]

Therefore, if a major accident in a nuclear power plant occurred and fission products did escape into the environment, insurance companies would pay the first $84 million to the surrounding community and the federal government would pay up to $478 million more for personal and property damage. Any community that was the site of a nuclear accident resulting in billions of dollars of damage might be eligible for federal relief funds but in this case, affected individuals would probably bear the bulk of the costs, including any long term cancer or genetic damage.

Perhaps the best answer to this question is "don't know." The question was not included in the total knowledge score.

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[1]"A Study of Social Costs for Alternative Means of Electrical Power Generation for 1980 and 1990," Argonne National Laboratory, February 1973, pp. II 339-347.

[2]Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants, U.S. Atomic Energy Commission, Report WASH-740, 1957.

[3]Peter A. Morris, "Power Plant Reactor Safety and Risk Appraisal," presented at the American Medical Associations' Congress on Environmental Health, Chicago, Illinois, April 29-30, 1973.

[4]Ian A. Forbes, Daniel F. Ford, Henry W. Kendall, and James J. MacKenzie, "Nuclear Reactor Safety: An Evaluation of New Evidence," *Nuclear News*, September 1971, pp. 32-40

[5]"Nuclear Power and the Environment," by the San Diego Section of the American Nuclear Society, ANS San Diego Section, P.O. Box 608, San Diego, California.

63. The current rate structure of utilities

a) increases the unit cost of electricity as consumption increases
The answer is—b) DECREASES THE UNIT COST OF ELECTRICITY AS CONSUMPTION INCREASES
c) retains the same unit cost of electricity regardless of consumption

	% Correct	% Incorrect	% Don't know
Local Residents	25	15	60
Local Leaders	62.6	15.6	21.8
State Officials	75	12.5	12.5
Utility Managers	-	-	-
Environmental Leaders	-	-	-

In general, the rate structure of utilities features a per kilowatt hour (kwh) price that decreases as consumption increases. For example, bulk users like industry pay lower prices per unit of electricity than homeowners or small businesses. The Federal Power Commission has estimated that the average American homeowners pays 2.22 cents for each kwh, while industry pays an average of 1.02 cents.[1]

Electric utilities have used this rate structure because by selling in large amounts to single customers, they can achieve economies of scale and produce more electricity cheaper. However, at recent Wisconsin Public Service Commission hearings, several economists testified that with the high costs of fuels and new plants, it was no longer possible to produce cheaper electricity by expanding capacity. They claimed that large users were now primarily responsible for the increased costs of electrical production that lead to additional rate increases. As a result, some citizen groups have requested that the rate structure be flattened so there would be less difference between what residential and industrial users pay per kilowatt hour. And others have suggested that the rates be inverted so the price of electricity increases as consumption goes up. With inverted rates, the cost of electricity for small residential users would probably decrease but large users like industry would pay more.[2]

[1]Paul G. Hayes, "Battle Lines Drawn on Power Pricing System," *Milwaukee Journal*, August 25, 1972.

[2]Testimony by Charles E. Olson before the Wisconsin Public Service Commission, Docket No. 2-U-7423, Vol. III, October 17, 1972; testimony by C. J. Cicchetti before the Wisconsin Public Service Commission, Docket No. 2-U-7423, Vol. IV October 18, 1972; testimony by Leo Brodzeller before the Wis. Public Service Commission, Docket No. 2-U-7423, Vol. II, September 11, 1972.

Note: On March 8, 1974, the Wis. Public Service Commission ordered the Wisconsin Power & Light Co. to charge higher rates to large users of electricity. The PSC granted rate increase on sliding scale with residential customers paying only 1% more for first 100 kilowatt hours but up to 10% more on usage over 1,500 kwh. Industrial customers will pay a 23% increase on first 50 kwh, 28% on the next 150 kwh, and 34% increase on kwh over 200.

64. Advertising costs are included in the operating expenses which are recoverable in the rates that utilities charge customers

The answer is—TRUE

	% Correct	% Incorrect	% Don't know
Local Residents	55	0	45
Local Leaders	66.1	8.6	25.3
State Officials	87.5	4.2	8.3
Utility Managers	-	-	-
Environmental Leaders	-	-	-

Advertising is normally a legitimate cost of doing business. Thus, utilities have always included advertising costs in their operating expenses which are recoverable in the rates charged to customers.

However, with the threat of power shortages in the past few years, several state utility commissions have limited or restricted the type of advertising expenses that may be recovered in electric rates. For example, the Virginia utility (public service) commission prohibited Virginia Electric Power Company from advertising air conditioning or other peak period uses and ordered the company to reorient its advertising toward conservation of energy. Similar steps have been taken by utility commissions in Vermont, New York, North Carolina and California.[1] Bills to limit or prohibit public utility advertising have also been introduced in the Wisconsin Assembly.[2]

[1]Personal letter, Robert M. Hallman, Center for Law and Social Policy, Washington, D.C., November 7, 1972.

[2]"Utility Ads Debated," *Milwaukee Journal*, February 9, 1973.

Note: In March 8, 1974 order re: Wisconsin Power & Light Company rate increase, the Wisconsin Public Service Commission ruled that only half of the annual advertising costs could be passed on to customers. The PSC allowed only advertisements which are directed toward promoting efficient use and conservation of electric energy.

65. In order to obtain a change in rates, a utility must ordinarily file a formal application with the

a) Federal Power Commission
b) Department of Health, Education and Welfare
The answer is—c) STATE PUBLIC SERVICE COMMISSION
d) State Administrative Office

	% Correct	% Incorrect	% Don't know
Local Residents	40	20	40
Local Leaders	70.7	17.3	12
State Officials	91.7	0	8.3
Utility Managers	-	-	-
Environmental Leaders	-	-	-

The Wisconsin Statutes state that "no change shall be made by any utility in its [rate] schedules except by filing the change as proposed with the [Public Service] Commission." If the change constitutes a decrease in rates, it will be effective the time specified in the formal application, unless the Commission, either by complaint or its own motion, suspends operation of the proposed change. The Commission then has four months to investigate the case and a hearing may be held on any revisions in the rate schedule. However, no change in schedules which constitutes an increase in rates can be made except by order of the commission, after an investigation and hearing.[1]

[1]Wisconsin, Public Service Commission, *Statutes*, Vol. 2, Chapter 196.

MATCHING

MODERATOR	1) a substance that slows down the neutrons produced by fission in a nuclear reactor
CONTROL RODS	2) used to slow down or speed up the fission chain reaction in a nuclear reactor
HALF-LIFE	3) refers to the time required for the processes of decay to reduce the concentration of a radioactive substance by 2
REACTOR CORE	4) consists of the fuel, the moderator, and the control rods in a nuclear reactor
FUEL ROD	5) contains nuclear fuel in the form of uranium dioxide pellets
CURIE	6) describes a quantity of radioactive material (number of disintegrations occurring per second in one gram of radium)
FUSION	7) a reaction in which nuclei come together to form more complex nuclei with the release of energy
CLADDING	8) the metal or carbon jacket around the fuel in nuclear reactors
REM	9) expresses the effect of radiation energy upon biological materials (the term means Radiation Equivalent Man)
FISSION	10) a reaction in which the most complex nuclei such as uranium or thorium split up into lighter components with the release of energy

	% Correct									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Local Residents	15	25	25	40	30	15	15	15	15	20
Local Leaders	14.9	25.3	31.6	36.8	34.5	14.4	30.5	21.3	11.5	27
State Officials	79.2	83.3	83.3	87.5	87.5	79.2	87.5	83.3	83.3	95.8
Utility Managers	81	90	90	93	87	51	81	78	54	75
Environmental Leaders	58	80	100	87	73	66	87	87	66	93