ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

May 28, 1976

Honorable Marcus A. Rowden
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: ACTIVITIES OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

Dear Mr. Rowden:

On January 13, 1976, the Committee forwarded a letter (Attachment 1) to Chairman Anders, providing background information on ACRS activities and responsibilities. Subsequent to this letter, the Committee was asked to provide additional information.

As previously indicated, the ACRS reviews applications for construction permits and operating licenses for power reactors, fuel reprocessing plants, and certain test and research reactors. It also reviews applications for standardized plants including applications for the nuclear island (e.g., GESSAR-238), the nuclear steam supply system (e.g., RESAR-41), and the balance-of-plant (e.g., SWESSAR). In addition, it has been the practice of the Committee to review the proposed corrective measures when, because of operational experience or new safety requirements, a facility requires substantial changes in design, changes in operational procedures, or repairs (e.g., Browns Ferry Nuclear Power Station). The Committee also conducts reviews, as requested by the Commission, of non-licensed ERDA and DOD reactors, such as the Savannah River and Hanford Reactors, naval reactor plants, the Fast Flux Test Facility, the CRBR and the Advanced Test Reactor and Engineering Test Reactor at the Idaho National Engineering Laboratory.

In addition to the above, the Committee reviews a large number of generic items related to nuclear plant safety standards and guides and to NRC Regulations. The Committee also provides advice on safety research programs, and from time to time the ACRS has established ad hoc Working Groups to review and make recommendations regarding specific safety issues. Much of the latter effort has been in response to specific requests from the Commission.

I. Review Items - Land Based Light Water Power Reactors

The Committee's review of proposed facilities includes consideration of the General Design Criteria (Appendix A) of 10 CFR Part 50 as well as the requirements of other safety related Appendices to Part 50 (e.g., Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants; Appendix E, Emergency Plans for Production and Utilization Facilities; Appendix G, Fracture Toughness Requirements; Appendix H, Reactor Vessel Material Surveillance Program Requirements, etc.).

These activities include investigation of matters such as the suitability of the proposed site, the effect the reactor may have on the surrounding population, the effect of site-related parameters on the reactor plant itself (e.g., floods, seismicity), the design of the facility including plant security and safeguards for special nuclear material, the competence of the construction and operating organization, the training and qualification of operating personnel, the quality assurance program,the operating and emergency plans, the periodic test and inspection programs for the facility and the results of operating experience at the plant.

In the Committee's review, consideration is given to the development and confirmation of analytical models used in the design and analysis of plant performance, including systems analysis, reliability analysis and accident analysis. Attention is also given to the safety margins provided and the redundancy and diversity incorporated in the plant design.

The Committee has limited its interest in environmental matters to those questions related to public safety in areas within the Committee's purview. Although additional aspects of this subject must be considered by the NRC in accordance with the National Environmental Policy Act, it has been ACRS practice not to become involved in these issues.

The types of expertise needed in the Committee membership can be discerned from the above description. The Committee needs members with substantive knowledge and experience in nuclear power plant design, construction and operation; siting practices; material properties; nuclear fuel design, manufacturing and use; fuel

reprocessing; radioactive materials handling and transport; emergency planning; reliability and risk assessment; nuclear waste management and health physics; nuclear technology; research and development; nuclear industrial security and safeguards; and industrial management of nuclear facilities. The paragraphs which follow provide additional details concerning the types of matters reviewed by the Committee:

1. Site and Environment

   A. Population distribution and how it might influence evacuation and individual and total doses to the population, in the event of an accident. The presence of other activities which might have an impact on reactor safety is considered, e.g., the nearby location of industries involving toxic or explosive material, the presence of airports or missile sites, and transportation routes over which hazardous materials may pass.

   B. Meteorology and its effect on routine and accidental releases of radioactive materials to the atmosphere, and the possible effects of severe atmospheric disturbances such as high winds, tornadoes, and hurricanes on reactor structures.

   C. Seismology, geology and foundation material as they relate to seismic design of the proposed facility including the probability of earthquakes of various magnitudes and intensities which might affect the site through surface faulting, subsidence, dilatancy, and liquefaction.

   D. Hydrology in regard to potential flooding in the vicinity of the site, the presence of aquifers which might become contaminated in the event of a serious accident, and the adequacy of the cooling water supply during periods of drought or low water flow.

   E. Tsunamis, seiches, and other types of wave actions and their effects on plant structures for reactors located near large bodies of water.

F. Environmental monitoring programs to establish radiation background levels and to determine the amount and distribution of radioactive materials as a consequence of routine or accidental releases.

2. Reactor

A. The mechanical design including the core (e.g., fuel rods, fuel assemblies, and control elements), reactor internals (e.g., core support plate, core shroud, and thermal shield), and control rod drive assemblies. Included in this review is a consideration of material characteristics such as strength, creep, corrosion resistance, and radiation damage. Also included are possible flow induced vibrations, blowdown forces during a postulated loss-of-coolant accident, seismic response, quality control, testing, and the reliability of components.

B. Nuclear design as it pertains to items such as core reactivity and control requirements, reactivity coefficients, power distribution, spatial stability, and analytical techniques (including comparison of calculations with experiments).

C. Thermal and hydraulic design including considerations of items such as core hydraulics, heat transfer correlations, fuel temperatures, and the ability of the fuel to withstand expected transients throughout its life.

3. Reactor Coolant System

A. A review of the layout and design of the components of the reactor coolant system including the reactor pressure vessel, the steam generator, reactor coolant pumps, the pressurizer, the reactor coolant piping, support structures, and seismic restraints.

B. The design bases for the reactor coolant system including a review of the loading combinations used and the codes which have been applied (e.g., sections of the ASME Boiler and

Pressure Vessel Code). These include the design bases for steady state and transient conditions, as well as the seismic design bases, materials used in the coolant system and their properties (such as the nil ductility transition temperature and the susceptibility to stress-corrosion cracking). Also included are considerations of controls on the chemistry of the water in the reactor coolant system and the secondary system.

C. Tests and inspections of the primary system components. These include the initial nondestructive testing of primary system components, the inservice inspection program, and the evaluation of the significance of any flaws or defects observed.

D. Detection, location and evaluation of leakage from the primary system. Included are the methods and sensitivity of locating and evaluating the leakage.

4. Containment Design

A. The basis and adequacy of the design for various loads on the containment including those which might result from earthquakes, tornadoes, operating thermal stresses, and various accident conditions.

B. The adequacy of the containment materials including inspection, testing, and surveillance programs for the materials.

C. Protection of the plant from missiles generated inside and outside containment, such as those resulting from turbine, pump or pipe failures, and the ability of the containment to withstand missile and aircraft impact, as appropriate.

D. Structural analysis methods used to evaluate matters such as stresses near large openings, possible failure of tendons, thermal and hydraulic loads resulting from actuation of various systems, and seismic loads.

E. Provisions for periodic testing and inspection of containment.

F. Evaluation of the adequacy of various containment design concepts such as pressure suppression containment systems, subatmospheric containment systems, and ice condenser containment systems.

G. Corrosion protection including consideration of items such as grouting vs greasing of prestressing tendons, and the use of cathodic protection.

5. Engineered Safeguards

Review of the adequacy of the design bases, codes, tests, and quality assurance for various engineered safeguards systems. These include items such as emergency shutdown systems, safety injection systems, core spray systems, containment spray systems, and containment building filtration systems.

6. Instrumentation and Control Systems

A. The design bases, system layout, logic system operation, and the initial and periodic testing of the reactor control and protection system instrumentation. Also considered are the adequacy of redundancy, separation, diversity and reliability.

B. These items are also reviewed for the engineered safeguards instrumentation, in-core monitoring systems, and the radiation protection instrumentation.

7. Electrical Systems

Electrical power systems are reviewed, particularly in regard to reliability of both off-site power and on-site emergency power systems, to provide the necessary electrical power to maintain the reactor in a safe condition under various normal and abnormal conditions including assumed failures of part of the electrical power system.

8. Auxiliary Systems

Matters such as the design bases, applicable codes and standards, reliability, quality control, and testing and inspection of various auxiliary systems which affect nuclear safety are considered. These include items such as the chemical and volume control system, the shutdown cooling system, various other cooling systems, the fuel handling system, ventilation systems, and fire protection systems.

9. Steam and Power Conversion Systems

Consideration is given to the following items as they relate to reactor safety - the turbine-generator and main transformers, main steam dump system, main turbine condensers, condensate and feedwater systems, and auxiliary feedwater systems.

10. Radioactive Waste Systems and Radiation Protection

The design bases for the liquid, gaseous, and solid waste management systems are considered along with matters such as methods of operation, tests and inspections, and operating experience. Radiation protection shielding, area radiation monitoring systems, and general radiological health and safety features as they affect both members of the public and the plant operators are reviewed.

11. Reactor Construction and Operating Organization

Also reviewed are the plant construction and operating organizations, including the quality assurance organization, the plant safety review organization, and the reactor operating organization, and the training and qualification of operating personnel.

12. Accident Evaluation

The Committee reviews a wide variety of possible accidents including occurrences such as a control rod withdrawal accident, a loss-of-coolant accident, and fuel handling accidents, and their consequences. This review involves many aspects of science and engineering, e.g., electrical engineering as it pertains to reactor controls and the operation of engineered safeguards, nuclear physics as it relates to items such as reactivity addition rates and the rate of power generation in the reactor core, chemical engineering as it relates to the release and interaction of radioactive nuclides with other materials, mechanical engineering as it concerns the capability of mechanical components to withstand various forces, civil engineering with respect to the stability and integrity of structures such as the containment, meteorology relative to dispersal of fission products in the atmosphere, and public health in terms of the potential effects on plant personnel and nearby population groups from the inadvertent release of radioactive materials.

II. Review Items - Other Plant Types

In addition to the evaluation of land based light water power reactors, the Committee reviews a variety of items related to other types of reactors. Listed below are several examples of the additional considerations involved in these reviews.

1. Floating Nuclear Plant

   A. Matters of the seaworthiness of floating platforms, the adequacy of anchorage systems, the effects of collisions with the facility by various types of ships (including those containing LNG).

   B. The stability of breakwaters designed to protect floating plants including considerations of wave action, subsidence and liquefaction.

   C. The effects of the release of radioactive materials to an ocean environment.

2. Liquid Metal Fast Breeder Reactors

   A. The effects on materials of the use of sodium as the primary system coolant. The effects of the high temperature environment on material properties and performance are also considered.

   B. An evaluation of the amount of energy which might be released due to various accidents and what energy release should be used as a basis for design.

   C. An evaluation of the need for special safety provisions for this type of reactor, e.g., whether installation of a core catcher should be required and whether a second shutdown system is needed.

3. High Temperature Gas Cooled-Reactors

   A. Special considerations involved due to the presence of a high temperature gas. These include matters such as corrosion, mass-transfer, and the strength and fatigue life of materials.

B. The adequacy of the containment including special considerations such as its need to function for prolonged periods of time at elevated pressure.

C. The use of prestressed concrete pressure vessels.

4. Test and Research Reactors

The review of Test and Research Reactors can involve a number of additional questions such as those pertaining to the potential safety impact of the tests and experiments to be conducted. A specific example is the series of tests proposed for LOFT.

5. Naval Reactors & Production Reactors

These reactors involve additional considerations such as national defense. In the case of nuclear powered vessels, consideration must also be given to their use of service and maintenance facilities in a wide range of locations.

III. Chemical Processing Facilities

In addition to nuclear reactors, the Committee also reviews the safety of nuclear fuel reprocessing plants. Although many of the same topics are reviewed as for nuclear power plants, there is much greater emphasis on chemical engineering and on factors such as safety considerations related to inadvertent criticality.

IV. Reactor Safety Research

The Committee also considers the various aspects of reactor safety research including the types of studies needed and progress being made in this field. It does this for both light water power reactors and for new and advanced reactor types such as the liquid metal fast breeder reactor and advanced gas cooled reactors.

V. Other Subjects

The Committee reviews a number of other subjects on its own volition or at the request of the Commission. These include:

1. Nuclear safeguards and GESMO proceedings which concern matters such as the possible diversion of special nuclear material during the fuel cycle and possible radiation hazards due to the widespread use of plutonium.

2. Nuclear reactor inspection which involves matters such as quality assurance and compliance with NRC Regulations and Technical Specifications.

3. Reviews of NRC Division 1 Regulatory Guides which include a wide range of considerations of reactor safety.

As previously indicated in the January 13, 1976 letter, members of the Committee have backgrounds in technological areas germane to nuclear safety and have, in their careers, performed duties requiring a maturity of judgment appropriate to assessing risks to the health and safety of the public. An updated listing of the specialities of the current ACRS members is given below:

1. Chemical plant design, construction, operation and corporate management.

2. Chemical and nuclear systems thermal/hydraulic performance and nuclear fuel performance.

3. Research and development management, fuel cycle technology, and nuclear materials safeguards.

4. Structural safety, structural research, structural design codes and concrete materials.

5. Electrical and nuclear systems engineering and nuclear reactor operations

6. Radioactive effluent control, radiation protection, and public health.

7. Nuclear reactor thermal/hydraulic performance and safety.

8. Engineering management and nuclear plant equipment design and construction.

9. Applied physics and fluid mechanics.

10. Thermal and fast reactor physics and safety, systems analysis, risk assessment, and nuclear fuel element behavior.

11. Nuclear materials technology including nuclear fuels, radiation damage effects on materials, non-destructive testing, design, construction and operating codes for nuclear system boundaries, corrosion, and system reliability.

12. Mathematical modeling, fast reactor design and safety, neutron transport theory, and theoretical physics.

13. Nuclear engineering systems analysis, particularly in regard to electrical systems, reactor safety systems, shielding design, and nuclear plant design and layout.

14. Nuclear reactor design, construction and startup, pressure vessel design for LWRs, and nuclear engineering.

Since it may also be of some assistance to the Commission, the areas of specialities of the ACRS Consultants whose appointments are presently scheduled for renewal are listed in Attachment 2. This list provides an additional indication of the subject areas where the Committee has believed assistance was necessary and shows to some degree the disciplines needed in ACRS reviews.

In the selection of new ACRS Members, it may be useful to note specific areas in the regulatory process which lie outside the purview of the ACRS. These include the following:

1. Environmental effects (other than those affecting the health and safety of the public).

2. Common defense and security (in licensing cases for commercial plants).

3. Preservation of historical landmarks.

4. Antitrust matters.

5. Cost-benefit analyses.

6. Aesthetic considerations.

7. Financial qualifications.

We hope this additional information will be helpful to the Commission. Should additional questions remain or if we can be of further assistance, do not hesitate to let us know.

Sincerely yours,

Dade W. Moeller

Dade W. Moeller
Chairman

Attachments:
1) Dade W. Moeller Letter to
William A. Anders, dtd 1/13/76

2) List of ACRS Consultants

ATTACHMENT 1

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 13, 1976

Honorable William A. Anders
Chairman
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: ACTIVITIES OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

Dear Mr. Anders:

In response to your request for information that would assist the Commission in selecting new ACRS Members, we are pleased to provide the following information regarding activities carried out by the Committee. Attachment 1 contains copies of Section 29 and 182(b) of the Atomic Energy Act of 1954, as amended, which set forth the legislative basis for the Committee's functions. The ACRS reviews applications for construction permits and operating licenses for power reactors, fuel reprocessing plants, and certain test and research reactors. It also reviews applications for standard plants including applications to manufacture reactor facilities (e.g., the Floating Nuclear Plant), applications to construct and operate nuclear power reactors of essentially the same design to be located at different sites (e.g., Standardized Nuclear Unit Power Plant System), and standard designs for nuclear power plants (e.g., General Electric Standard Safety Analysis Report and Stone & Webster Engineering Corporation Standard Safety Analysis Report) submitted for NRC Staff and ACRS review.

When, because of operational experience or new safety requirements, a facility requires substantial changes in design, changes in operational procedures, or repairs (e.g., Browns Ferry Nuclear Power Station), the ACRS reviews the proposed corrective measures and provides advice to the Commission as to whether the proposed measures insure adequate protection for the health and safety of the public. The Committee conducts reviews, as requested by the Commission, of non-licensed ERDA and DOD reactors, such as the Savannah River and Hanford Reactors, naval reactor plants, the Fast Flux Test Facility, and the Advanced Test Reactor and Engineering Test Reactor at the Idaho National Engineering Laboratory.

The Committee's reviews in all of these areas involve technical evaluations of those factors which affect the health and safety of the public. These factors include items such as: site characteristics, plant design, quality assurance, and operating, emergency, test, and inspection procedures. Specific topics within these categories include: seismicity, geology and meteorology, population distribution, plant design features and related analytical model assumptions and techniques, fuel element design, core peaking factors, primary system boundary design, design of engineered safety features such as ECCS, and design of control and safety systems. The results of plant operations are of interest to the Committee in considering the effectiveness of plant design features and the operating organization.

In addition to its reviews of specific projects, as outlined above, the Committee also reviews a large number of generic items. Attachment 2 is a list of typical generic matters on which the Committee has issued reports, and Attachment 3 is a partial list of subcommittees established for continuing review of generic matters. An important activity in this latter category is the review of NRC Division 1 Regulatory Guides. The Committee also provides advice on safety research programs.

The Committee has established from time to time ad hoc Working Groups to review and make recommendations regarding current matters, frequently in response to specific requests from the Commission. A list of these Working Groups is included as Attachment 4.

Members of the Committee have a background in one or more technological areas germane to nuclear safety and have performed duties requiring a maturity of judgment appropriate to assessing risk to the health and safety of the public. The specialities of the twelve present members are listed below:

1. Chemical plant design, construction, operation and corporate management.

2. Chemical and nuclear systems thermal/hydraulic performance and nuclear fuel performance.

3. Research and development management, fuel cycle technology, and nuclear materials safeguards.

4. Structural safety, structural research, structural design codes and concrete materials.

5. Electrical and nuclear systems engineering and nuclear reactor operations.

6. Radioactive effluent control, radiation protection, and public health.

7. Nuclear reactor thermal/hydraulic performance and safety.

8. Nuclear power reactor operations and radioactive waste management.

9. Engineering management and nuclear plant equipment design and construction.

10. Applied physics and fluid mechanics.

11. Thermal and fast reactor physics and safety, systems analysis, risk assessment, and nuclear fuel element behavior.

12. Nuclear materials technology including nuclear fuels, radiation damage effects on materials, non-destructive testing, design and construction codes for nuclear system boundaries, corrosion, and system reliability.

It has been the experience of the Committee that its members should possess the following qualifications:

a) Competence in an area of science or engineering related to the matters coming before the Committee.

b) Mature judgment in their fields of specialization and the ability to extend that judgment to the evaluation of other scientific or technological matters outside those fields.

c) Administrative and management experience and ability as required to fulfill the duties of a subcommittee chairman responsible for the development of information and the preliminary review of nuclear plants and generic problems or studies.

The Committee has attempted to have a membership representing a varied group of applicable disciplines, but it is not possible to have every discipline represented. This has not proved to be a problem because of the use of consultants in support of the Committee.

There are a number of areas regarding nuclear facilities that the Committee does not consider specifically in its review. Although the Committee is concerned with the radiological consequences to man of possible accidents and routine radiological releases, it does not perform environmental reviews, per se, for reactor projects or fuel reprocessing plants. The Committee does not review such items as financial qualifications of an applicant or antitrust considerations.

Sincerely yours,

Dade W. Moeller

Dade W. Moeller
Chairman

Attachments:
1. Excerpt from the Atomic Energy Act of 1954, as amended
2. Titles of ACRS Generic Reports
3. ACRS Subcommittees Dealing with Generic Items
4. ACRS Ad Hoc Working Groups

Committee or Reactor Safeguards. 42 U.S.C. sec. 2039.

"SEC. 29. ADVISORY COMMITTEE ON REACTOR SAFEGUARDS.—There is hereby established an Advisory Committee on Reactor Safeguards consisting of a maximum of fifteen members appointed by the Commission for terms of four years each. The Committee shall review safety studies and facility license applications referred to it and shall make reports thereon, shall advise the Commission with regard to the hazards of proposed or existing reactor facilities and the adequacy of proposed reactor safety standards, and shall perform such other duties as the Commission may request. One member shall be designated by the Committee as its Chairman. The members of the Committee shall receive a per diem compensation for each day spent in meetings or conferences, or other work of the Committee, and all members shall receive their necessary traveling or other expenses while engaged in the work of the Committee. The provisions of section 163 shall be applicable to the Committee.[24b]

[24b] Public Law 85-256 (71 Stat. 576) (1957), sec. 5, added sec. 29.

ACRS Report.
Sec. 182

"b. The Advisory Committee on Reactor Safeguards shall review each application under section 103 or section 104 b. for a construction permit or an operating license for a facility, any application under section 104 c. for a construction permit or an operating license for a testing facility, any application under section 104 a. or c. specifically referred to it by the Commission, and any application for an amendment to a construction permit or an amendment to an operating license under section 103 or 104 a., b., or c. specifically referred to it by the Commission, and shall submit a report thereon which shall be made part of the record of the application and available to the public except to the extent that security classification prevents disclosure.[6]

[6] Public Law 85-256 (71 Stat. 576) (1957), sec. 6, added subsec. b, and relettered former subsecs. b. and c. as subsecs. c. and d. Public Law 87-615 (76 Stat. 409) (1962), sec. 3, amended subsec. b. Before amendment, it read: "b. The Advisory Committee on Reactor Safeguards shall review each application under section 103 or 104 b. for a license for a facility, any application under section 104 c. for a testing facility, and any application under section 104 a. or c. specifically referred to it by the Commission, and shall submit a report thereon, which shall be made part of the record of the application and available to the public, except to the extent that security classification prevents disclosure."

TITLES OF ACRS GENERIC REPORTS

Report on Water Reactor Safety Research

Report on Turbine Missiles

High Temperature, Gas-Cooled Reactor Safety Research

Safety Research for Sodium-Cooled Fast Reactors

Problems Arising from Primary System Rupture

Report on Seismic Research

Report on Proposed Reactivity Accident Test Program

Proposed Study of the Reactor Hazard and Criteria Problem

Report on Review of Siting Policies for Licensing Nuclear Facilities

Safety of Operating Reactors

Reactor Safety Study - WASH 1400

Status of Generic Items Relating to Light-Water Reactors

Report on Industrial Sabotage

Proposed Regulation on Transport of Radioactive Material

Crack Propagation Rate in Sensitized Stainless Steel

Alternatives to Staff Position Regarding Anticipated Transients Without Scram (ATWS)

Intermediate Vessel Tests of the HSST Program

Report on EXXON Nuclear Company ECCS Evaluation Model for Reload Cores in PWR's

Systems Analysis of Engineered Safety Systems

Control Rods

Attachment 2

ACRS SUBCOMMITTEES DEALING WITH GENERIC ITEMS

Accident Evaluation

Architect-Engineer Balance of Plant

Chemical Processing Plants

Codes, Standards, & Criteria

Containment: Concrete

Containment: Steel

Electrical Systems, Control and Instrumentation

Emergency Core Cooling Systems

Environmental Matters

Generic Items, Resolution of

Inspection & Enforcement Activities

Nuclear Merchant Ships

Reactor Fuel

Reactor Pressure Vessels: Concrete

Reactor Pressure Vessels: Steel

Reactor Safety Research

Regulatory Guides

Reliability & Accident Probabilities

Safeguards for Special Nuclear Material

Seismic Activity

Siting Evaluation

Waste Management

Attachment 3

ACRS AD HOC WORKING GROUPS

Anticipated Transients Without Scram (ATWS)

Double Ended Pipe Break

Fire Protection

Hydrogen Generation & Control

Hypothetical Core Disruptive Accident for Fast Reactors

Makeup of Independent Review & Audit Groups

Neutron Noise Analysis

Peaking Factors

Plutonium Shipping Packages

Reactor Safety Study (WASH-1400)

Safety of Operating Reactors

Security of Nuclear Facilities

Spent Fuel Storage Capacity

Standardization of Nuclear Plants

Systems Analysis of Engineered Safety Features

Attachment 4

ATTACHMENT 2

ACRS CONSULTANTS

NAME	SPECIALITY
Allemann, Dr. Rudolph T.	Blowdown Heat Transfer and Fluid Swell, ECCS Analysis
Ames, Dr. Lloyd	Inorganic Ion Exchange, Soil-Radioactive Waste Interaction
Bailey, Mr. Eugene C.	Mechanical Engineering, Waste Management
Bair, Dr. William J.	Biological Effects of Pu
Bell, Dr. George I.	Fast Reactor Physics
Bement, Prof. Arden L.	Radiation Effects on Core
Benedict, Dr. Manson	Nuclear Engineering
Bennett, Mr. Carl A.	Reliability Engineering
Bryan, Mr. Robert H.	Reactor Siting
Carbiener, Mr. Wayne A.	LOCA Blowdown Heat Transfer
Castleman, Prof. A. W., Jr.	Fission Product Release & Transport
Catton, Dr. Ivan	Heat Transfer, Natural Convection Relative to Core Meltdown Situations, and Fluid Dynamics
Corten, Prof. Herbert T.	Fracture Mechanics, Reactor Vessel Design & Operating Conditions
Crowley, Mr. William	Shipment of Radioactive Materials
Croach, Mr. Jesse W.	Reactor Engineering
Daniels, Dr. Raymond	Soils Scientist
D'Appolonia, Dr. Elio	Soils, Foundations & Structures
Ditto, Mr. Steve	Instrumentation
Dukler, Dr. Abraham E.	Heat Transfer, Fluid Flow, ECCS Analysis
Durant, Mr. William S.	Reactor Engineering
Epler, Mr. Elbert P.	Instrumentation & Controls, ATWS
Fauske, Dr. Hans K.	Core Thermal-Hydraulics
Foley, Mr. John	Safeguards
Fontana, Mr. Mario H.	Fuel Failure Propagation
Foster, Dr. Richard F.	Aquatic Biologist
Fuquay, Mr. James J.	Meteorogy
Gall, Mr. W. R.	Strength of Materials for Reactor Components
Garlid, Dr. Kermit	Two-phase Flow and Computer Model Development, ECCS Design and Reliability
Gifford, Dr. F. A., Jr.	Meteorology, Atmospheric Diffusion
Goldin, Dr. Abraham S.	Radioactive Waste Management, Radiological Health and Related Areas

ATTACHMENT 2 (CONT'D)

ACRS CONSULTANTS

NAME	SPECIALITY
Hall, Dr. David B.	Nuclear Physics
Healy, Dr. John W.	Radiological Health, Radwaste Handling
Koffman, Mr. Eugen	Mechanical Engineering
LaQue, Mr. Francis L.	Metallurgy & Corrosion of High Nickel Alloys
Leendertse, Dr. Jan J.	Breakwater Design and Behavior, Dynamics of Fluid Flow, Simulation of Fluid Flow Effects
Lipinski, Dr. Walter C.	Instrumentation & Control Systems, Design Reliability
Loeding, Mr. John W.	Chemical Processing Plant Design and Operation
Loss, Mr. Frank	Fracture Mechanics
Lottes, Dr. Paul A.	Core Thermal Hydraulics
MacCready, Dr. Paul B., Jr.	Meteorology - Windspeeds for Reactor Design and Dispersion/Diffusion Effects
Mandel, Prof. Philip	Barge Design and Sea Worthiness
Mathieu, Capt. Charles E.	Barge, Mooring System & Breakwater for Barge-Mounted Nuclear Power Plants
Maxwell, Dr. John C.	Geology
Mercer, Mr. Basil	Ion Exchange Systems,Radioactive Waste Managem.
Mirshak, Mr. Samuel	Reactor Engineering
Morgan, Dr. Karl Z.	Health Physics
Nicholson, Mr. Richard B.	Fast Breeder Reactors (Nuclear Excursion)
Nicholson, Dr. Wesley	Reliability Engineer and Statistician
O'Kelly, Dr. Arlie A.	Chemical Engineering
Oldendorf, Mr. Lawrence E.	Fire Protection
Oliver, Dr. Jack E.	Geology and Seismology
Orth, Dr. Don A.	Chemical Processing Plant Design & Operation
Page, Dr. Benjamin M.	Geology
Palladino, Dean Nunzio J.	Nuclear Engineering
Parker, Dr. Frank L.	Radioactive Waste Management
Parker, Dr. Herbert M.	Health Physics
Parsly, Mr. Lewis F., Jr.	Spray System Technology
Pense, Prof. Alan W.	Metallurgy (High Alloy Steels), Fracture Mechanics, Reactor Pressure Vessel Reliability
Pickel, Dr. T. W.	Strength of Materials for Reactor Components, Structural Design Analysis
Philbrick, Dr. Shailer S.	Geology

ATTACHMENT 2 (CONT'D)

ACRS CONSULTANTS

NAME	SPECIALITY
Plaine, Mr. Herzel H. E.	Legal
Raichlen, Dr. Fredrick	Water Waves & Effects
Reethof, Dr. Gerhard	Reliability Engineering, Accident Probability
Richart, Dr. Frank E.	Soils Engineer
Richmond, Dr. Chester	Pu Biological Effects & Transport
Row, Mr. Thomas H.	Spray System Technology
Russell, Mr. John H.	Fast Reactors, Nuclear Transient Effects
Saunders, Dr. Sam C.	Mathematical Statistics, Systems Reliability, Fault-Tree Analysis
Seale, Dr. Robert L.	Nuclear Engineering
Seed, Dr. H. Bolton	Geology, Seismology, Soil Liquefaction (Soils Engineer)
Shappert, Mr. Lawrence	Shipment of Radioactive Materials
Shewmon, Dr. Paul G.	Physical Metallurgy, Surface & Volume Diffusion, Thermodynamics of Surfaces, Kinetics of Reactions in Solids
Shumway, Mr. Rex W.	ECCS, Code Development
Siegel, Dr. Sidney	Fast Reactors, High Temperature Material and and Sodium Reactors
Snyder, Mr. Arthur I.	Pipe Failures
Solbrig, Dr. Charles W.	ECCS, Code Development
Sozen, Dr. Mete A.	Concrete Structures
Squires, Mr. Lombard	Reactor Engineering
Stannard, Dr. John Newell	Biological Effects of Plutonium
Steinbrugge, Mr. Karl V.	Engineering Design of Structures to Withstand Seismic Loadings
Steindler, Mr. Martin J.	Chemical Processing Plant Design & Operation
Stevenson, Dr. M. G.	Computer Codes Regarding Core Disruption
Stratton, Dr. William R.	Fast Reactor Design, HCDA's for Fast Reactors, Reactor Safety Calculations
Swanson, Mr. A. Einer	Reactor Operations
Tetelman, Dr. Alan S.	Fracture Characteristics of Steel & Other Materials, Reactor Pressure Vessel Design
Theofanous, Prof. Theofanis G.	Fluid Flow & Heat Transfer, ECCS Analysis, Pressure Suppression, Containment, Systems Analysis

ATTACHMENT 2 (CONT'D)

ACRS CONSULTANTS

NAME	SPECIALITY
Thompson, Dr. George A.	Geophysics, Geology, and Seismology
Trifunac, Dr. Mihailo D.	Seismology
Vesely, Dr. William	Statistical Evaluation of Pressure Vessel Reliability and Accident Probability
White, Dr. Merit P.	Performance of Materials & Structures Under Seismic Loadings
Wilson, Dr. Basil W.	Oceanographic Engineering
Wilson, Dr. Richard	Reactor Siting
Wilson, Dr. James T.	Seismology, Geophysics
Woodcock, Mr. Sidney H.	Plant Security
Ybarrondo, Dr. Lawrence	LOCA, ECCS, Code Development
Zaloudek, Dr. Frank	Heat Transfer, ECCS Analysis, Pressure Suppression Containment, Systems Analysis
Zittel, Mr. H. E.	Reactor Safeguards Spray Systems
Zudans, Dr. Zenons	Mechanical Design, Prestressed Concrete Pressure Vessels