ELECTRIC POWER RESEARCH INSTITUTE

1981 ANNUAL REPORT

STATEMENT OF BUSINESS

The Electric Power Research Institute (EPRI) plans and manages research and development on behalf of the nation's electric utility industry and the public. The Institute's objective is to advance capabilities in electric power generation, delivery, and use, with special regard for safety, efficiency, reliability, economy, and environmental considerations.

EPRI was founded in 1972 as a nonprofit corporation to provide professional planning and management of an industrywide research and development program. Financial support of the Institute and its programs is furnished by public and private member utilities in proportion to their electricity sales. Together, EPRI's members produce about 70% of the electricity supplied by U.S. utilities; their aggregate 1981 payments to EPRI were slightly below $260 million.

Two special advisory groups complement EPRI's Board of Directors in furnishing policy and program guidance. The Research Advisory Committee, made up of utility executives, provides technical counsel on EPRI's programs and progress. The Advisory Council, drawn from the spheres of education, business, government, science, and other groups outside the utility industry, advises EPRI's Board and president on the emphasis and direction the Institute's research program should take in meeting the broad needs of society.

Research and development authorized to date has a total estimated cost of about $2.7 billion, of which about 67% will be paid by EPRI and 33% by cosponsoring organizations. ■

Cover: Looking into a gas/oil-fired boiler at Pacific Gas and Electric Co.'s Moss Landing Power Plant.

CHAIRMAN'S MESSAGE

When the Electric Power Research Institute was founded just 10 years ago, its goal was "to promote, engage in, conduct, and sponsor research and development with respect to electricity production, transmission, distribution, and utilization."

This goal remains as valid today as it was in 1972, and we have made progress. Today's business environment, however, bears little resemblance to the conditions that existed in 1972. At that time we believed that although the federal government would continue to fund much electric power research, utilities needed their own institute to develop and administer a coordinated nationwide R&D program for the industry. Groundwork for this initiative had been laid by the Electric Research Council, and as a final catalyst, Congress had challenged the industry to organize a new program or pay special taxes to support one managed by the government.

Today, with the reduced federal role and a critical need for solutions to the myriad problems faced by our industry, the importance of EPRI is even greater than it was in 1972. During the intervening years, EPRI has proved to be one of the wisest investments our industry has ever made. The Institute suffered some of the growing pains any new organization can expect, but it has become a valuable resource in helping utilities respond to a variety of challenges. Now conditions are changing again. Clearly, we must find new ways to protect our investment in research and to make better use of the results already produced.

Probably the largest impact of government funding reductions will fall on large-scale demonstration plants. Because of their size, no utility or equipment vendor can afford to support any such demonstration alone. Major decisions will therefore have to be made concerning which technologies are promising enough to warrant private sponsorship and what cooperative arrangements can best facilitate their development.

The first step of our response must be to conduct a rigorous assessment of industry needs, followed by the setting of priorities among candidate technologies. EPRI's technical staff is already working with utilities to meet this challenge. The next step—arranging private financing for the projects chosen—may require utilities to forge nontraditional affiliations with partners from other industries and countries. Because of the various interests involved, each arrangement will probably be unique. EPRI funding can serve as a catalyst for making such arrangements and provide continuity with existing programs.

Such private sector initiative can be seen in the recently concluded agreement on funding a major demonstration of gasification–combined-cycle technology at Southern California Edison Co.'s Cool Water generating station. As chief executive officer of the host utility, I had the opportunity to observe firsthand the creative role EPRI can play in helping to identify a promising technology and prompting a strong alliance among diverse business partners to support it. The key to success in this case was the willingness of the industry to back the judgment of EPRI's management and technical staff in assuming the risk involved in finding new partners to help share the largest single commitment in the Institute's history.

It is just this sort of backing that is needed to build confidence in any investment. In the years ahead, the utility industry will need to make more confidence-building commitments like this to protect its stake in promising demonstration programs.

Continuity of support is critical to the success of any long-term investment, especially R&D. The problems created by stop-and-go government funding illustrate this principle. Abrupt changes of funding in the middle of the process can set back development by years, or worse, close the window of time available for bringing a promising new technology into practical use. Because of long lead times, continuity of funding and sustained momentum of technical development are particularly important to the successful introduction of new electric power systems.

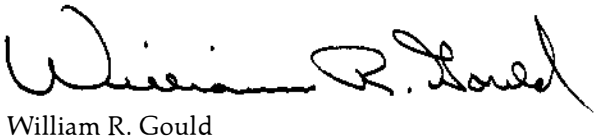
Although temporary interruptions of work may not seem serious at first, prolonged inadequate funding of long-range projects jeopardizes their ultimate availability. Recently, EPRI responded to the industry's current financial problems by reducing its plans for future expansion and concentrating on more near-term goals. Such cutbacks will inevitably decrease the number of technology options that are developed and reduce the speed with which others are pursued. This, in turn, will

increase the risk of failure. If robust support for long-range programs is not resumed soon, the technology needs of our industry may not be met toward the end of this century.

At the same time, it is essential that the results of EPRI research already available be brought quickly into use on utility systems. EPRI's management has launched fresh initiatives to improve the flow of vital information to utilities. Now it's up to us, the member companies, to make sure this information is being received and used.

If potentially vital research results are not to be missed, utilities need to consider how best to emphasize their technology transfer activities, possibly by centralizing responsibility for disseminating the enormous flow of complex information. About 180 member companies have found success by appointing a technical information coordinator whose job it is to see that relevant research results reach the specific utility manager or engineer who can put them to use.

Despite the current problems facing electric utilities, I believe our industry has a bright future. More aggressive use of research results already available can help solve many short-term problems. New arrangements for investment in demonstration facilities can ensure the availability of several promising new technologies by the end of this decade. And a vigorous commitment to long-term research can help the industry face the foreseeable future with a renewed sense of confidence.



William R. Gould
Chairman

Early in 1981 EPRI management foresaw that the already tight financial bind of the electric utilities would likely become worse and prepared for the difficult task of scaling down the Institute's future plans. With the approval of the Board of Directors and the participation of the EPRI advisory structure, we went through a project-by-project review of our R&D program, as well as the needs of our supporting administration. Many important programs were reduced in scope, delayed, or eliminated. As a result, the five-year financial planning guidelines were reduced by a total of $375 million, or roughly 20%. This means that our R&D program will continue at about the 1980 level of real expenditure, keeping even with inflation.

The changes in program content represent a significant shift in EPRI's research strategy: programs that remain fully funded are generally those with payoffs likely in the coming decade. Whereas near-term programs have accounted for about 50% of total expenditure in the past few years, that figure will now approach 70%. Intermediate-term research, with expected payoffs in 10–25 years, has been reduced from 40% to about 27%; and long-term research, with payoffs more than 25 years away, will decline from 10% to 3% of Institute funding.

Our program structure is changing in response to the current needs of the industry. The increasing cost of new facilities, long lead times, and a slackening in the rate of increase of electricity consumption have brought about a significant shift in research emphasis toward projects that will produce methods for improving reliability, increasing efficiency and on-stream availability, improving maintenance techniques and equipment, extending the life of plants, developing technology that promises smaller capacity units, achieving load management, increasing end-use efficiency, improving systems for controlling deleterious effluents, and improving the technical bases for safety and environmental regulation.

These are the areas of greatest immediate financial impact. A reduction of 1% in outage rates of coal and nuclear plants, for example, could save utilities about $2 billion over the next five years. And extending unit life from 40 to 50 years could mean a nationwide reduction in capacity additions of more than 100 GW by the turn of the century.

We are maintaining our support of most of the major projects that are now at demonstration or pilot plant stage, although a few may be canceled or delayed. Let me give a few examples. The 4.8-MW (e) phosphoric acid fuel cell pilot plant on the system of Consolidated Edison Co. of New York, Inc., is almost complete, but the greatly improved replacement cells will be delayed. Plans for the proposed 100-MW (e) atmospheric fluidized-bed demonstration plant have been made, but final design and construction will be delayed significantly. The 100-MW (e) Texaco gasification–combined-cycle demonstration plant (Cool Water) is proceeding and limited participation in KILnGAS is planned, but further large gasifier demonstrations will be delayed. Coal liquefaction projects will be reduced drastically.

Impact of Federal Cutbacks

We have not fully evaluated the impact of massive cuts in the Department of Energy's R&D program. These reductions, made as part of the administration's effort to sharply reduce federal spending, will place a very large new responsibility for research, development, and demonstration on the private sector. In principle, the government will primarily support long-term, high-risk, high-payoff research; support of near-commercial-scale demonstration projects will be primarily the responsibility of the private sector.

This shift of responsibility presents EPRI and the utility industry with its greatest challenge to date. Funding requirements are large for these commercial-scale operating prototypes. Even though they will produce electricity or products that will offset much of the original cost (if they are successful), the payback will be over a period of 20 to 30 years. It must be borne in mind that these are not normal production facilities but rather are the end of the demonstration chain, usually the first and one of a kind. As a result, they involve risk and usually produce at costs higher than competitive prices and the subsequent line of production devices.

In addition to withdrawing large-scale funding and canceling future commitments to demonstration technology, the reductions in the federal energy program are certain to affect every area of our R&D program. Examples of some of the more serious cuts in the federal budget request for FY83 include elimination of support for all work on electrical systems; elimination of

energy storage technology R&D; large reductions in fossil energy development, particularly in coal conversion and clean combustion processes; massive reductions in operating support for second-generation coal liquefaction pilot plants; sharp cuts for civilian nuclear reactor fuel cycle and safety R&D; large reductions in the program supporting geothermal energy; extensive reduction in conservation and the development of solar and wind energy; reduced research on health and environmental effects and processes to clean up effluents.

We have not yet made adjustments for these widespread reductions in R&D support. It is very apparent, however, that we must make changes in our programs to protect the R&D investments in those technologies most important to electric utilities and their customers.

Thus, EPRI and the utilities are faced with a double pincer: massive withdrawal of federal support for energy R&D coupled with real constraints on expansion of utility R&D support. This large and fundamental transition from federally shared energy development to private sector support will place new demands on our institutions, our resources, and our ability to select among vital areas of development. How prudently we draw our priorities and give them our backing will affect the future of the electric utilities, the ratepayers, and ultimately the economy of the United States.

R&D Results and Their Transfer

Application of research results from EPRI is already saving hundreds of millions of dollars for utilities around the country. In the following pages, several specific examples of such applications are discussed, the results of the early years of EPRI-supported R&D. They range from a recently published handbook on how to dispose of PCBs safely to such money-saving pieces of hardware as the improved cable plow. Major cooperative efforts are also discussed, including the BEST Facility, the NDE Center, and the Arapahoe Emissions Control and Test Facility. Design improvements are reported in the areas of transmission line structural foundations, wet stacks, and coal cleaning. New instruments for radiographic inspection of reactor coolant pumps and power plant plume analysis are reviewed. And progress in studies on acid rain, conservation, over/under capacity models, and the correlation of ambient air pollutants and human health effects is discussed. These selected few are a sampling of a much larger list of immediately useful technology. They underline the fact that we are seeing very real payoffs for the R&D investments made by the utilities.

Such innovations are pointless, however, unless they are brought into widespread use on utility systems. To bring about this technology transfer, we must match our industry's well-deserved reputation for reliability with a new determination to accelerate technical progress. Research is the key; applying it is the challenge.

As more projects are successfully completed, their results must be communicated to an increasingly diverse audience. Reports of EPRI work have begun to flow regularly into many professional journals. Individual scientists and engineers are increasingly called upon to advise utilities on the technical aspects of pressing issues. Increased contacts are being encouraged with architect-engineering firms. And among regulatory commissions, there is a growing awareness of the solid information base EPRI has made available, which can assist them in their job.

The flow of EPRI results ready for immediate introduction to utility systems has now increased to the extent that we must explore new channels of technology transfer. This realization is reflected in the creation of the Information Services Group at the Institute. In addition, new approaches are being established to enable the technical staff to assume transfer responsibilities that go beyond simply publishing research results. In particular, project managers are being encouraged to provide technical support to utilities in their first use of new EPRI-oriented equipment or computer codes.

A New Opportunity

The reordering of the federal government's role in energy development is one of many actions being taken to reduce the economic burden imposed by massive government spending. For the first time in my working career, now 40 years in energy R&D, we have been given a clear signal to reduce our dependence on government for new science and technology in the vital field of energy. This reduction of funds is accompanied by a promise of reduction in onerous or unnecessary government controls and greater diversity of choice. The electric utilities, in concert with other energy industries, now have the clear responsibility to do what is required to provide the United States with a sound long-term program for efficient energy supply and use.

Floyd L. Culler
President

Highlights

EPRI's financial performance in 1981 conformed closely to expectations.

☐ Expenditures for R&D contracts in 1981 totaled $215 million, down slightly from $223 million in 1980. Overall Institute expenditures, including program management, were $258 million.

☐ Revenues for the year were $265 million. Industry payments, the major portion, totaled $259 million, up from $220 million a year earlier. The change reflects EPRI's shift to an essentially pay-as-you-go operation, following three years in which revenues lagged expenditures as the Institute used an earlier revenue accumulation. The 1981 year-end fund balance was $12 million.

☐ In 1982 EPRI expects to spend at least $250 million on R&D activities, a dollar amount well above 1981 but representing only a slight increase in real terms after adjusting for inflation. Disbursements are planned to match revenue flow as nearly as possible. Even so, there may be brief periods this year when short-term bank financing will be needed.

☐ Member payments in 1982 are based on a factor of 0.236 mill per kilowatthour of electricity sold in 1980. Of the funds thus collected, up to 20% may be used for state and local R&D, and the rest is paid to EPRI.

☐ EPRI's 1981 year-end membership of 569 was made up of 159 investor-owned utilities, including their affiliates and service organizations; 177 municipal or regional government utilities; 231 rural electric cooperatives; and the 2 federal systems, Tennessee Valley Authority and Bonneville Power Administration. About 150 nonmember utilities also contributed in some measure to EPRI support.

☐ For the first time since the Institute began, its full-time staff remained virtually unchanged in number. The 1981 year-end total was 690, down 4 from 1980. The figure included 341 technical professionals, 17 of them on loan to EPRI from utilities and manufacturers.

Technical Divisions

EPRI's technical activities continued to be carried out by six technical divisions, whose major responsibilities and 1981 R&D expenditures are as follows.

☐ The Advanced Power Systems Division sponsors development of coal-derived fuels and technologies and manages research on renewable resources. $37 million.

☐ The Coal Combustion Systems Division conducts R&D concerned with the resources, operations, emission controls, and waste disposal problems of conventional and advanced coal-fired power plants. $37 million.

☐ The Electrical Systems Division deals with the design, performance, and maintenance of power delivery systems. $31 million.

☐ The Energy Analysis and Environment Division conducts research on energy planning methodologies and on the environmental effects of electric utility operations. $30 million.

☐ The Energy Management and Utilization Division sponsors R&D related to storage, conservation, and efficient conversion of electric energy. $23 million.

☐ The Nuclear Power Division conducts R&D on the safety, efficiency, maintenance, and availability of nuclear reactors and auxiliary systems. $56 million.

Specially Funded Programs

In addition to the six divisions, there are four R&D activities that draw all or part of their funding from other organizations (as is detailed in the financial pages of this document). The activities and their 1981 R&D outlays are as follows.

☐ The Nuclear Safety Analysis Center was established by EPRI to probe the Three Mile Island accident in detail and then to continue research on generic safety issues of nuclear reactors. $6 million.

☐ The Boiling Water Reactor Program on intergranular stress corrosion cracking focuses on problems in reactor recirculation piping systems. $7 million.

☐ The Steam Generator Program is dedicated to research on problems that limit the performance and availability of PWR steam generators. $8 million.

☐ The PWR Safety and Relief Valve Program is charged with full-scale testing of reactor safety and relief valves. The work of this program is expected to be completed in 1982. $10 million.

A fifth special area of research management, the Utility Acid Precipitation Study Program, was established in October and is scheduled to continue for two and a half years. A monitoring network used in completed EPRI research has been expanded from 9 to 19 stations in the eastern half of the United States. Financial reporting will begin in 1982, as funds from 38 utilities are applied to data collection and analysis.

Facilities

Seven specialized centers under long-term EPRI contract are now operating or being developed at various locations around the United States. In February the Nondestructive Evaluation (NDE) Center in Charlotte, North Carolina, was dedicated. The center's purpose is to develop and demonstrate NDE techniques and pro-

vide NDE training. In May the Battery Energy Storage Test (BEST) Facility in Hillsborough Township, New Jersey, was dedicated. This is the first facility in the world capable of evaluating storage batteries on the megawatt scale needed for utility system load leveling. In September the Coal Cleaning Test Facility (CCTF) in Homer City, Pennsylvania, began operation. The project represents the nation's most advanced coal-cleaning research, development, and demonstration plant. Construction began during 1981 on the Transmission Line Mechanical Research Facility (TLMRF) in Haslet, Texas. The TLMRF programs will include full-scale structural tests to validate computer design programs for transmission towers and lines, as well as experiments on equipment response to severe conditions.

These new facilities join three others already in operation: the Waltz Mill, Pennsylvania, Underground Cable Test Facility; Project UHV for ultrahigh-voltage transmission testing at Pittsfield, Massachusetts; and the Emissions Control and Test Facility at Denver, Colorado, which uses the gas stream from the coal-fired Arapahoe station of Public Service Co. of Colorado to test new environmental control equipment.

Board of Directors

In February 1981, Earl Gjelde, deputy administrator of the Bonneville Power Administration, was appointed to EPRI's Board of Directors, replacing S. Sterling Munro, who had resigned as BPA administrator.

In April, William Gould of Southern California Edison Co. succeeded Floyd Lewis of Middle South Utilities, Inc., as chairman of EPRI's Board of Directors. Charlie Jack of Buckeye Power, Inc., was elected vice chairman after the resignation of S. Sterling Munro.

Thomas Galligan of Boston Edison Co. completed his Board term in April; Thomas Ayers of Commonwealth Edison Co. and Marshall McDonald of Florida Power & Light Co. resigned at that time. John Bugas of Colorado-Ute Electric Association, Inc., also completed his term in April and, to the sorrow of the Board and his industry colleagues, died only six months later.

Four new directors elected in April were Frank Griffith of Iowa Public Service Co., Don Jordan of Houston Lighting & Power Co., Peter McTague of Green Mountain Power Corp., and George Usry of the Athens (Tennessee) Utilities Board.

In August, A. J. Pfister of the Salt River Project was appointed to the Board, replacing Louis Winnard of the Los Angeles Department of Water & Power, who resigned.

Administrative Changes

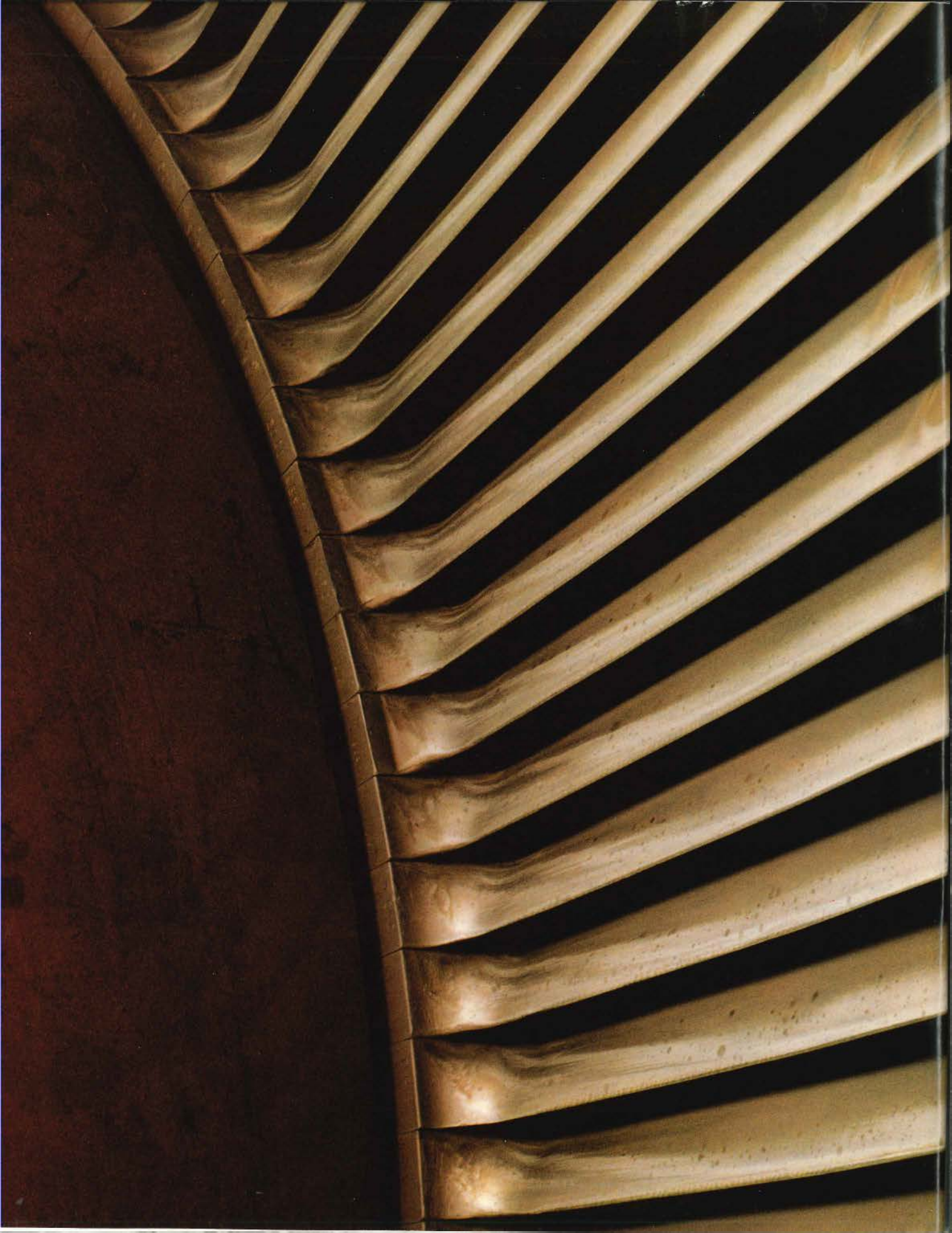
Charles Menefee, new director of EPRI's Finance Division, was elected treasurer, succeeding Edward McSweeney, who resigned.

Reorganization of some of EPRI's nontechnical divisions consolidated the Institute's information-related functions and integrated all planning activities. Richard Rudman was named director of the newly formed Information Services Group, reporting to the president. The group includes the Communications and Technical Information divisions, the Member and International Relations Department, the Regulatory Relations Department, and EPRI's Washington Office.

The new Planning and Evaluation Division, under the vice president for research and development, is headed by Richard Zeren. It consolidates the strategic planning activities of the former Policy Planning Division with R&D program integration already under Zeren's direction.

John Taylor, formerly with Westinghouse Electric Corp., was named director of the Nuclear Power Division. David Rossin, previously director of research for Commonwealth Edison Co., was named director of the Nuclear Safety Analysis Center (NSAC). Originally established as part of the industry's response to the Three Mile Island accident, NSAC became a permanent part of EPRI's Nuclear Power Division at the end of 1981. Earlier in the year, direction and funding of the Significant Events Evaluation and Information Network (SEE–IN) was transferred from NSAC to the Institute of Nuclear Power Operations (INPO) in Atlanta, Georgia. In addition to its support by all U.S. nuclear power utilities, by the end of the year NSAC was being sponsored by government or utility R&D organizations in France, Sweden, Japan, Taiwan, Canada, and Italy.

The year ended with more research completed and reported out than in any previous year. But that accomplishment is tempered by uncertainty as we look ahead. Uncertainty and its economic consequences for utilities have been topics of EPRI research: whether it is more costly to be early or late with new system capacity, for example. Uncertainty is no less a problem for EPRI in its own planning: how to establish the timing and amount of funding for various R&D candidates. Today's further uncertainties in the national economy, coupled with the announced energy policy directions of the federal government, produce a working climate that is a real challenge for EPRI's management and staff, as well as for all its industry advisers, in 1982. ■



Some 1300 R&D projects grouped within 40 technical program areas are currently under EPRI contract. Continuing the Institute's evolution toward near-term research, nearly 70% of the R&D expenditures are now earmarked for projects whose initial payoff is anticipated within 10 years. This is beginning to accelerate the flow of useful information, as well as the equipment, systems, and procedures available for commercial transfer. In fact, a wide variety of research results are now being applied by utilities on their systems. On the following pages is a representative sampling of EPRI-sponsored research results that will likely be of significant commercial benefit in the 1980s. In many cases the cost savings for individual utilities from specific technology applications has already been evaluated.

turbine blades

Planning Generation Capacity

How do utilities decide on the amount and type of capacity required to serve consumers at the lowest cost? In 1979 this question faced the Energy Association of New York State, representing the state's investor-owned electric utilities, when it considered a draft of the New York State Energy Master Plan for 1979–1994. The association found the state's planned replacement of costly oil-fired electric generation with coal and nuclear too slow. Partly as a result of an analysis using an over/under capacity planning model developed by EPRI's contractor Decision Focus, Inc., the final master plan incorporates additional coal-fired capacity. The association estimates this additional coal capacity will save the customers of New York's investor-owned utilities $505 million per year from 1990 to 2020. The over/under capacity model as applied to New York state was shown to be a flexible, reliable, and understandable planning tool for both utility representatives and public regulators. (RP1107)

Inspection Tool for Reactor Components

A miniature linear accelerator (Minac) has been developed by Schonberg Radiation, Inc., as a new radiographic inspection tool for utilities. Whereas a conventional linear accelerator, which is used for inspecting thick steel components in the factory, weighs about a ton, the portable Minac, which is used for inspecting the same components inside a containment, weighs less than 700 lb. In 1981, Rochester Gas & Electric Corp., Wisconsin Electric Power Co., and Florida Power & Light Co. used Minac to perform first-of-a-kind inspections of reactor coolant pumps. Minac is placed inside the pump by remote control, X-ray film is placed outside the pump, and when Minac is switched on, radiographs are acquired of the pump welds, which vary from about 9 to 11.5 inches in thickness. Rochester Gas & Electric estimates a $50,000 one-time savings in revenue requirements due to the Minac project. Minac radiography has also identified incorrect seating of main steam isolation valves at one of Consolidated Edison Co.'s plants. The new tool is licensed and available for commercial inspection service. (RP822-6)

Transmission Tower Foundations

For years, utilities facing the problem of constructing single-pole transmission lines have been heard to complain about having to "spend as much money below the ground for foundations as above it." This may have been attributable to the inability of analytic techniques to accurately predict the strength of the drilled-pier foundations designed to resist high overturning loads, thus encouraging overdesign of foundations. As a result of EPRI-sponsored research by GAI Consultants, Inc., the strength of these foundations can be better quantified, often leading to smaller and more cost-effective foundations. A computer program, PADLL, which was developed and verified in fourteen utility-sponsored full-scale field tests, is available through EPRI's Electric Power Software Center. Comparing foundations designed by using PADLL with those designed according to present procedures, it is apparent that size and cost can be reduced as much as 50% with PADLL. (RP1280)

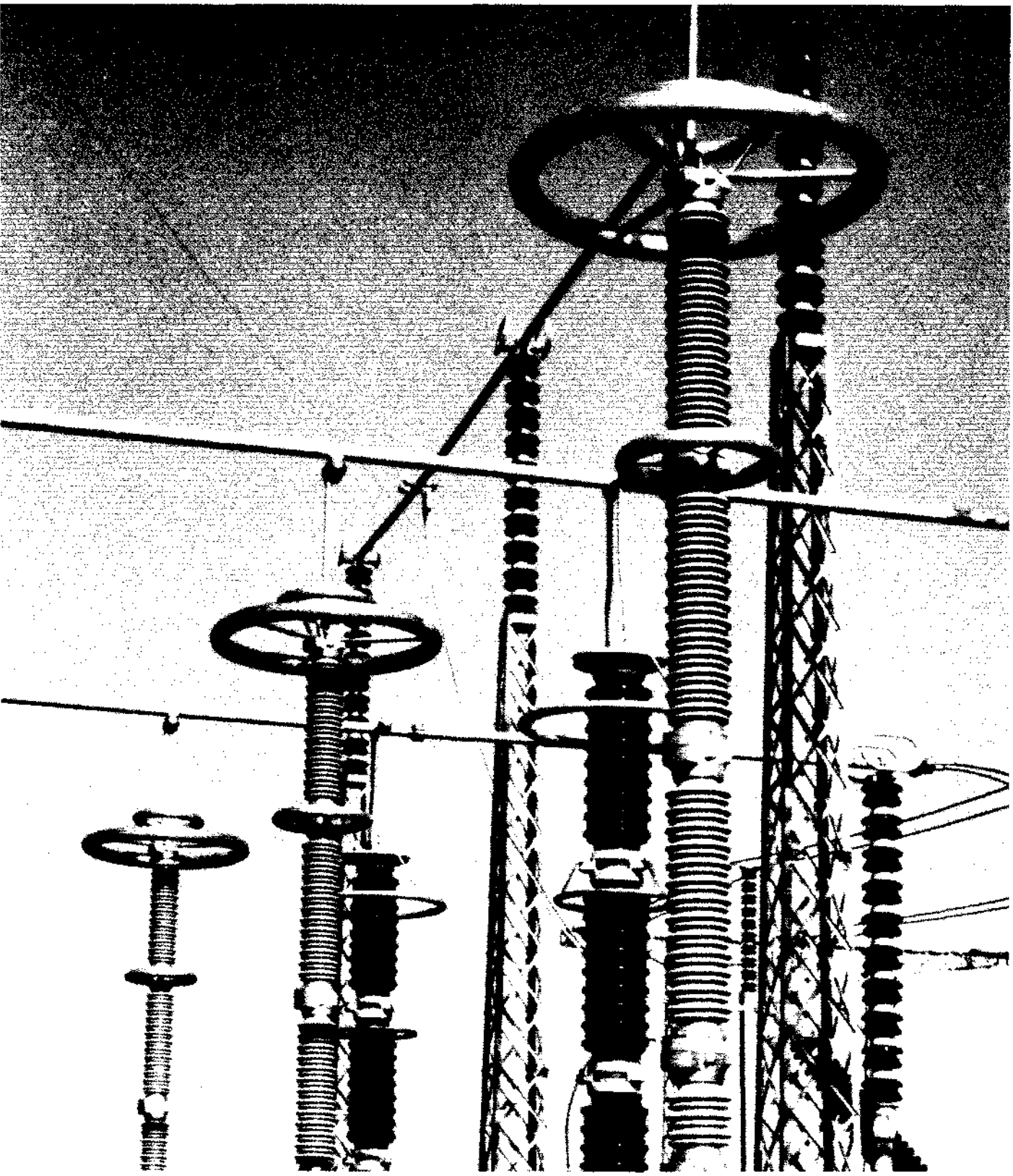
Surge Arresters

Surge arresters play a critical role in electrical systems by limiting overvoltages caused by lightning strikes and switching operations. The advent of metal-oxide varistor technology offers a unique opportunity to improve the performance and reduces the cost of overvoltage protection devices such as surge arresters. Under EPRI contract, McGraw-Edison Co. developed the basic varistor technology for a variety of power system applications and invested $12.7 million in a new plant to manufacture varistor blocks for distribution-class arresters. The design concept for the dead-front arresters has resulted in significant savings. Solely by the use of 34-kV dead-front cable arresters, Virginia Electric & Power Co. estimated annual savings on their system of $500,000. Through an EPRI project with Westinghouse Electric Corp., totally gapless arrester designs have become available for all transmission voltages. This technology has resulted in other applications, such as series capacitor protection schemes, ferro-resonance suppression on coupling capacitor voltage transformers, surge suppressors for circuit breakers, and a metallic return transfer breaker for high-voltage dc systems. (RP425, RP657)

Thermal Property Analyzer

The thermal properties of soil are important factors in the design and rating of direct-buried underground cable for utility transmission and distribution systems. Existing methods of analyzing soil thermal resistivity require time-consuming soil excavation and laboratory tests. Some utilities simply assign an overly conservative value of thermal resistivity for their entire region. EPRI and contractor Ontario Hydro have developed a portable thermal property analyzer that provides accurate data cheaper and faster than the conventional method. The equipment is operated in the field by a technician without any laboratory support. Soil thermal stability and diffusivity can also be measured with the new instrument. Arizona Public Service Co. found that the instrument worked so well in field tests that the utility used it to adjust the ratings of existing underground cables and for planning new substations. (RP7861-1)

Metal-oxide varistor technology made possible the development of a new gapless surge arrester (foreground) shown at TVA's West Point station. Used for overvoltage protection, the new surge arresters will give better performance at lower cost.



Wood Transmission Poles

Factors to be considered in designing wood pole transmission lines include material properties of wood and extreme meteorological loads that lines must resist, such as high winds and ice. Design of these lines must be based on a rational procedure that accurately accounts for the variability and the uncertainty in these factors. Present design procedures allow for these variabilities through high overload capacity values that may produce overconservative and uneconomical designs. EPRI has developed a probability-based design procedure for unguyed, single-pole, wood transmission lines that provides utilities with a means for producing cost-effective and reliable designs. An EPRI computer program, POLEDA-80, enables each utility to integrate its own information on wood pole properties and local weather conditions. The program is available through EPRI's Electric Power Software Center. A full-scale wood pole testing program continues to develop information on the strength of both new poles and poles removed from service. Nondestructive evaluation procedures are being improved to allow utilities to determine the in-service strength of poles. (RP1352)

Tightening budgets vie with unnecessarily high safety factors in the construction of wood pole transmission lines. The use of EPRI-developed design tools, coupled with field and laboratory testing, can reduce the need for ultraconservative designs.

Preventing Eagle Electrocution

Power lines can have a fatal attraction for large birds of prey. Golden eagles, for example, use utility poles as perches from which to hunt and may be electrocuted by contact with the power lines. Studies indicate that 98% of eagle electrocutions could be prevented by modifying just 2% of power poles. Identifying these poles, however, is a formidable task. EPRI and contractor Brigham Young University undertook to find out exactly what it was about a power pole that might attract eagles to it. The recently completed project discovered two lures: surrounding prey population (such as rabbits) and preferred perch characteristics (such as distance between poles, position and elevation of poles, and nearby topographic features). By considering both the prey and perch preferences of eagles, utilities can identify potentially dangerous poles, modify only them, and still protect most of the eagles. (RP1002)

Compressed-Air Energy Storage

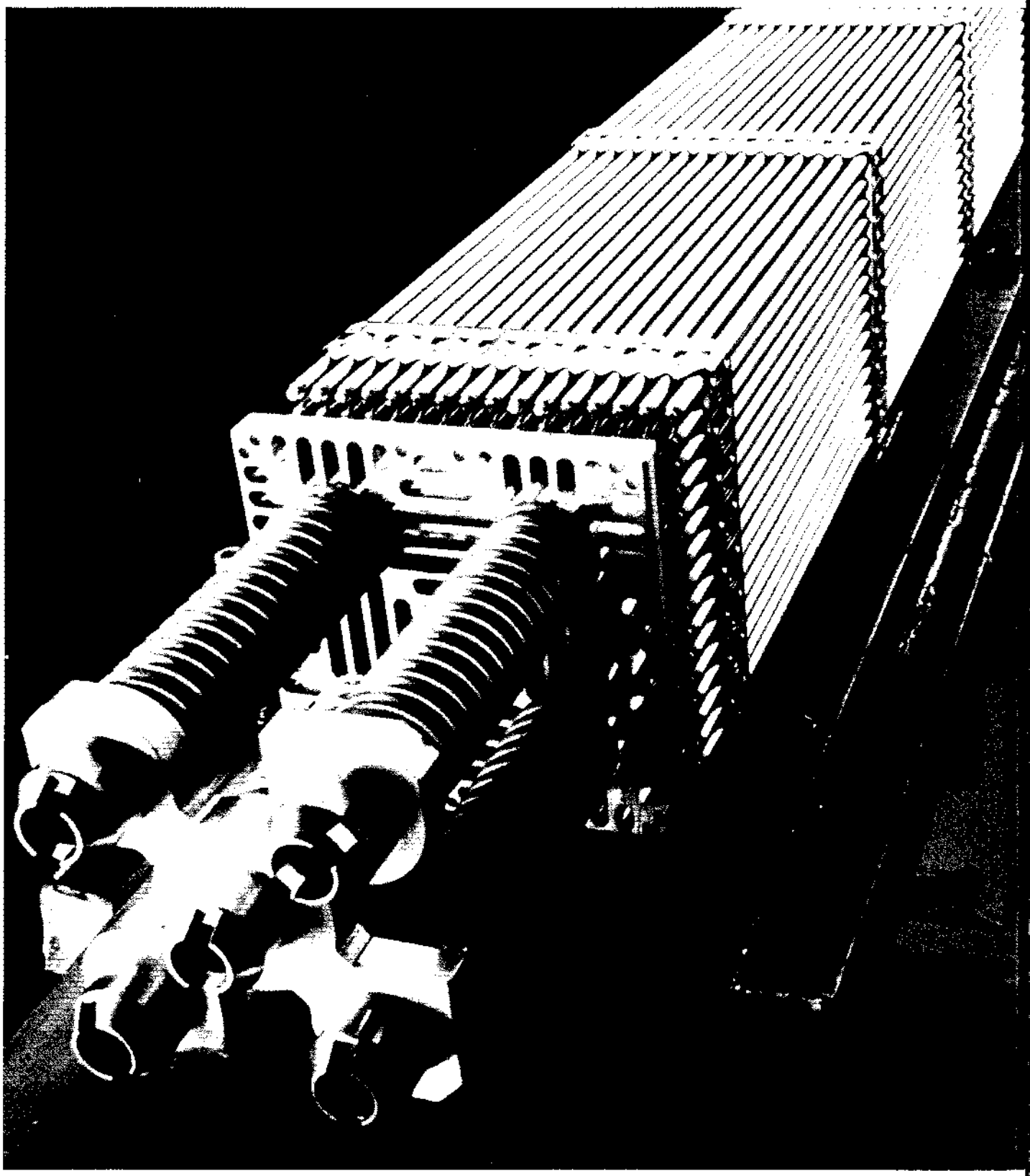
When it comes to meeting peak power demands, utilities have limited options. Oil-fired peaking has become very expensive since oil prices have skyrocketed. Baseload energy stored in pumped-hydro installations is less expensive, but sites for conventional surface reservoirs are increasingly difficult to find and license. One promising alternative storage technique is compressed-air energy storage (CAES). Recent EPRI–DOE studies have developed preliminary plant designs for CAES, together with methods for site and systems selection. The EPRI–DOE research concluded that with some design improvements, CAES is ready for utility service. Encouraged by these and other studies, in 1981 Soyland Power Corp. decided to build what will be the first CAES plant in the United States, the second in the world. The 220-MW unit will have 11 hours of storage capacity in its hard-rock caverns. The plant is expected to begin operation in 1986. (RP1081)

Alternative Piping Materials

Intergranular stress corrosion cracking (IGSCC) near girth welds in stainless steel piping has proved to be a costly problem in BWRs. EPRI and the BWR Owners Group initiated an extensive test program to identify IGSCC-resistant materials. The program produced specifications for nuclear-grade stainless steels that are resistant to IGSCC under BWR piping service conditions. NRC has accepted these nuclear-grade stainless steels as an effective remedy for BWR pipe cracking, and they are now directly substitutable for conventional stainless steels in BWR piping applications without the need for piping redesign or augmented in-service inspection. The new piping is now being adopted for use in 18 BWRs under construction in the United States. Use of the piping in new plants will eliminate capacity losses associated with IGSCC and could save the nuclear industry about $100 million over the next 10 years, based on 39,000 MW of projected new BWR capacity. (RPT111-1)

PCB Detection, Reduction

Under EPA regulations, utility industry transformers containing certain amounts of polychlorinated biphenyls (PCBs) require special handling and disposal. To facilitate this, utilities need quick, inexpensive field tests to determine equipment's PCB content. Under EPRI guidance, Horiba Instruments, Inc., has modified one of its X-ray fluorescence instruments to measure chlorine content of transformer oil and, by inference, estimate PCB content. Salt River Project developed handling procedures for the portable instrument, and it is now undergoing field trials at selected utilities. Cost per sample is less than $5 and 100–200 samples can be tested in a day. EPRI is also working on ways to reduce PCB levels in transformer oil so that the oil can be reused. From processes researched by General Electric Co., an extraction process has been selected for scale-up to a demonstration unit; Franklin Research Center is also studying a unique extraction process. Meanwhile, samples of oil treated with other PCB removal processes are being tested to ensure that the oil is suitable for reuse in transformers. (RP1713, RP2028-1, -2)



Nuclear Fuel Design

To expand the operating limits of nuclear fuel assemblies, suppliers have redesigned fuel bundles. The new, larger fuel arrays have improved heat transfer characteristics, but NRC requires pre- and post-irradiation measurements of dimensional changes in fuel rods and bundles before the new assemblies can be approved for extended operating limits. EPRI funded research by Combustion Engineering, Inc., to precharacterize fuel pellets and rods and take post-irradiation measurements of the new 16 × 16 fuel assemblies. An irradiated fuel inspection stand was also developed to gather data from irradiated fuel at Arkansas Power & Light Co.'s ANO-2 nuclear unit and other reactors. AP&L now has sufficient data to verify fuel design margins for expanded operating limits. AP&L estimates its savings will be $1.9 million from 1976 through 1983. Similar PWR plants with 16 × 16 assemblies will be able to use the data from this project to avoid possible lengthy licensing reviews of this new fuel configuration. (RP586)

The new 16 × 16 fuel assembly configuration for nuclear power plants must undergo careful study before it can be approved for extended operating limits. EPRI research has provided the necessary verification data.

Wet-Stack Design

Flue gases that enter the stack after being subjected to lime/limestone–slurry spraying in a wet SO_2 scrubber contain water vapor and droplets. As the gases rise in the stack, the vapor condenses on the stack lining, forming drops and rivulets of corrosive liquid, some of which are reentrained and ultimately escape into the atmosphere. The moisture remaining in the stack can cause damage by corroding stack linings. Both situations must be avoided. Some plants evaporate the moisture by reheating the flue gases, but this method is costly—about $6 million per year for a typical 500-MW plant. To try to solve the problem without reheating, EPRI and its contractor Dynatech R/D Co. have studied the effect of surface roughness of stack lining materials and flue gas velocity on the reentrainment of the liquid. Techniques of draining the liquid from the stack have been identified, and design changes have been developed to improve droplet collection in the stack, thus preventing reentrainment. (RP1653)

Mobile Geothermal Laboratory

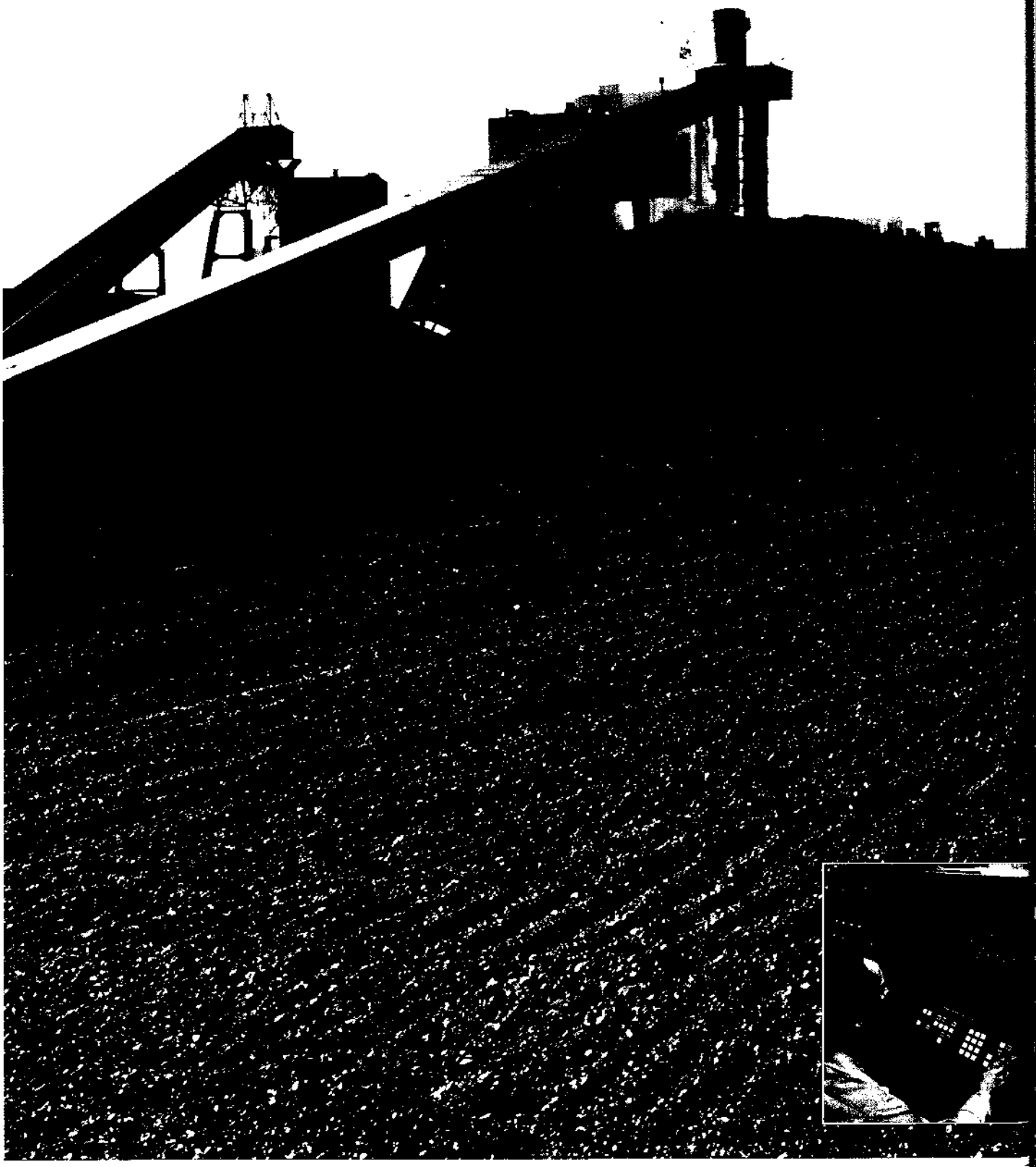
Geothermal fluids are being explored as a source of heat for electric power generation. In the past, fluid samples had to be taken to off-site laboratories for chemical analysis. Resultant delays caused chemical and phase changes in the samples, often yielding misleading results. Rigorous on-site sampling and analysis were needed to solve the problem, so EPRI and contractor Rockwell Energy Systems developed a mobile geothermal chemistry laboratory that can study brine chemistry in the field with increased accuracy by preserving sample integrity and by immediate analysis. The laboratory can perform a wide range of tests, including preparatory tests, repetitive tests, and complete chemical signature analyses. Standard equipment and procedures are used to quantify minerals, gases, and trace elements that may affect plant operation or influence environmental decisions. The laboratory has supported field tests at several sites, including Southern California Edison Co.'s Brawley plant. SCE expects to save approximately $129,000 over a five-year period. (RP741-1)

Improving Nuclear Fuel

Nuclear reactor fuel rods contain uranium dioxide fuel pellets surrounded by Zircaloy cladding. In 1972, flattened or collapsed sections of fuel rods were observed in some reactors. The evidence suggested that fuel pellets were shrinking under irradiation, thereby allowing the pressurized primary coolant water to significantly deform the cladding under certain conditions. Existing data could not account for the pellet shrinkage, so operating restrictions were imposed on some reactors, reducing power levels to about 95% of their rated value. EPRI, the Edison Electric Institute, and eleven industrial sponsors funded research at Battelle, Pacific Northwest Laboratories that related the amount of shrinkage of fuel pellets to their microstructure and to reactor operating conditions. Researchers were able to show that fuel types could be produced that resist shrinkage if some parameters used to fabricate pellets were changed. As a result, such nuclear fuels are now fabricated by all commercial nuclear fuel vendors. (RP131)

Flue Gas Conditioning

Electrostatic precipitators are used to control particulate emissions at coal-fired power plants. Yet variable ash properties, such as electrical resistivity, can degrade precipitator efficiency. Flue gas conditioning, in which a chemical agent modifies ash properties, can improve precipitator performance, but utilities needed more information about specific chemical reactions, injection methods, and application rates. EPRI commissioned Southern Research Institute to study the various agents used; in one case, Tampa Electric Co. volunteered its Gannon-6 unit for the necessary field tests. Nonproprietary ammonium sulfate proved effective in flue gas conditioning at Gannon, and Teco is saving approximately $2.2 million over five years (which is 50% of its chemical costs) at three plants. Local procurement of nonproprietary chemical agents also avoids transportation delays and eliminates dependence on a single source for proprietary chemicals. (RP724)



Improved Coal-Cleaning Design

One way to remove high-density impurities, such as ash and pyritic sulfur, from coal is to crush and size the coal, mix it with magnetite, and feed it into a dense-media cyclone separator. The cyclone removes the impurities, the coal and magnetite are then separated, and the magnetite is reused. Magnetite losses can be reduced by magnetic recovery methods, but entrapped coal fines in the reclaimed magnetite can cause control problems when reintroduced to the process. Research funded by EPRI and performed by Eriez Magnetics, Inc., resulted in a method of coal particle size optimization and an improved magnetite recovery system. This in turn enabled Pennsylvania Electric Co. and New York State Electric & Gas Corp. to construct magnetite recovery systems that are capable of reducing magnetite losses and controlling fines entrapment in recycled magnetite. The redesigned coal-cleaning circuitry is now fully on-line, with over $9 million projected savings in total operating costs over a five-year period. (RP1338-2)

Coal cleaning can rid fuel of ash and sulfur, rewarding utilities with higher efficiency, reliability, and availability. EPRI is testing improved systems at its coal-cleaning test facility in Homer City, Pennsylvania.

Improving Cable Insulation Material

The polyethylene pellets from which underground cable insulation is fabricated can contain impurities that disrupt insulating properties and lead to premature failure of the cable. EPRI contractor Reynolds Metals Co. and its subcontractor Food Technology Corp. have developed highly sensitive equipment that detects and rejects individual contaminated pellets before they reach the cable extruder. An optical sorting device scans the entire stream of pellets and detects small differences in light transmission through the pellets, caused by dark-colored impurities. The device activates an air ejector that removes contaminated pellets and loose contaminants from the pellet stream. Reynolds Metals has incorporated two detectors into its cable manufacturing process and Aluminum Co. of America is using one on an experimental basis. The detector will also be considered for purchase by other U.S. and European cable manufacturers and materials suppliers. (RP7865)

Preventing Turbine Damage

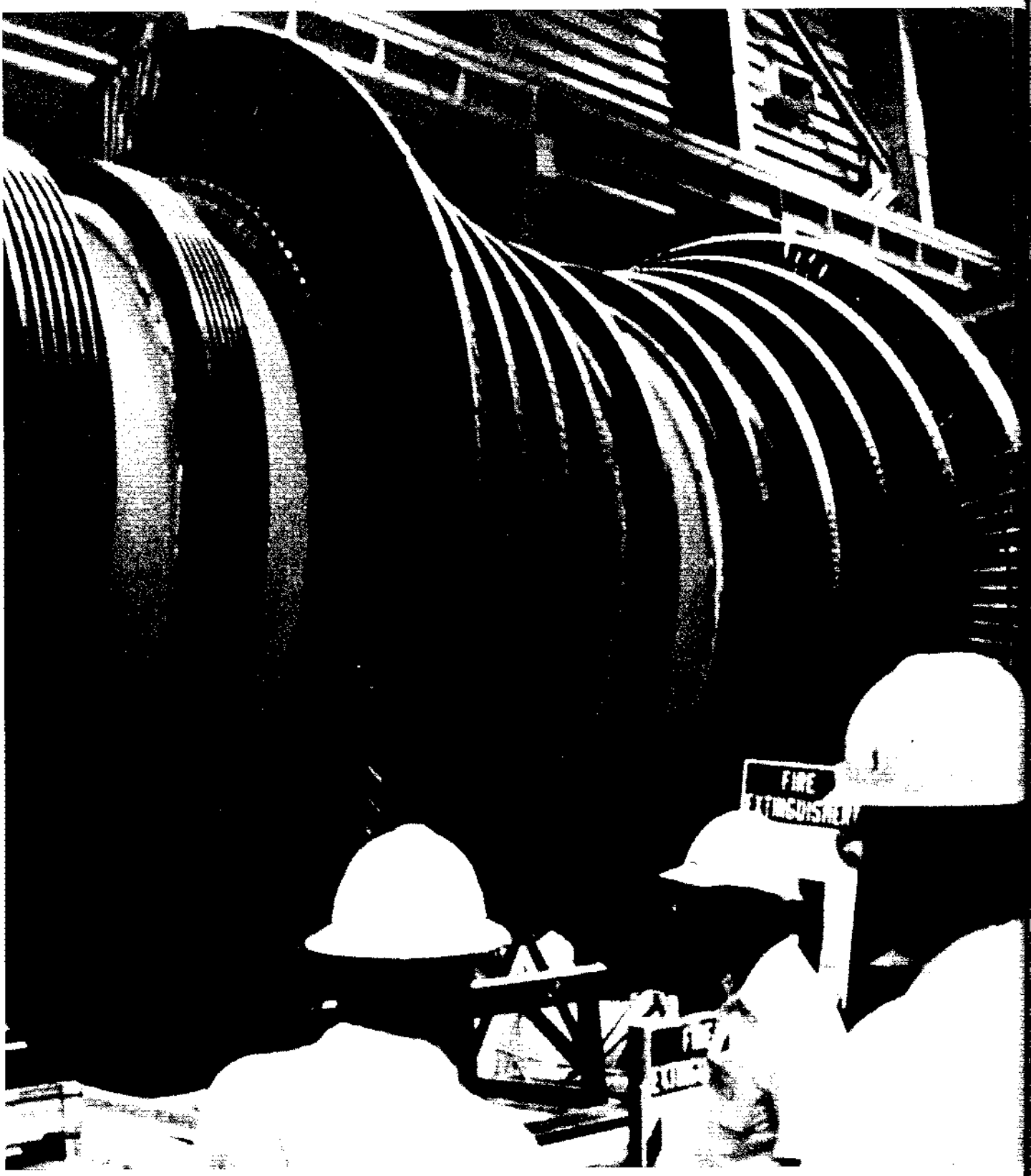
Inside the superheater and reheater tubes and in main steam lines of power plants, an iron oxide scale is constantly forming and flaking. The hard particles of scale are carried along the pipes to the steam turbine, where they erode turbine components, necessitating costly repairs. Under EPRI contract, Foster Wheeler Development Corp. developed an in situ method of coating the inside of superheaters, reheaters, and steam lines with a chromium-enriched surface layer that resists oxide growth. The first full-scale application of this chromate process was completed in January 1982 at the Glenwood station of Long Island Lighting Co. First, scale was removed with a chemical cleaning solvent from the boiler, waterwalls, economizer, superheater, and main steam line. Then, a concentrated solution of chromate was pumped through the system at high pressure and heated to over 500°F. The solution was held in the system for 48 hours to ensure a hard coating. After the system was drained, the coating was further hardened with a hydrazine solution. Recovery of the chromate and other constituents from the first solution was also demonstrated. (RP644)

Cable Plow

Installing underground cable by plowing instead of trenching appears to have technical and economic advantages. Until recently, however, most cable plows exhibited problems with ground disturbance, cable feed and tension, and expensive, time-consuming mobilization and cleanup. Under EPRI contract, Oretek Laboratory, Inc., has overcome these problems, producing a lightweight, highly maneuverable and powerful cable plow capable of continuous plowing to a depth of 42 inches in a variety of soil conditions. A unique vibratory plow blade transfers energy into the ground rather than losing energy in the blade mount as in conventional models. In addition, high-powered water jets on the leading edge of the plow blade help soften, cut, and lubricate the soil as the plow advances. Either of two cable feed shoes can be attached to the back of the plow blade: one to install a single cable, the other to install multiple cables. A demonstration is planned by Southern California Edison Co. this year. (RP1518)

PCB Handbooks

Working with the polychlorinated biphenyls (PCBs) once used in electrical capacitors and transformers can be both confusing and costly for utilities. EPRI and contractor Stearns, Conrad, and Schmidt, Consulting Engineers, Inc., have developed a series of three handbooks that provide information about cleanup and disposal options. The first handbook gives general information on PCB production and use; details on regulations; projected requirements for disposal capacity; and an overview of available disposal technology. The second and third books provide guidelines on how to develop spill prevention techniques and control plans to ensure that risks associated with PCB activities are minimal. Included are model operation plans for servicing of PCB-filled components, proper use and maintenance of these components, and spill-containment procedures. A fourth book, by Acurex Corp., details test incineration of PCB-filled capacitors. (RP1263-1, -2)


FIRE

Air Pollution and Health

The Environmental Protection Agency (EPA) conducted epidemiologic studies to evaluate the association between air pollutants and human health as a basis for establishing national air quality standards and emission regulations for the utility industry. EPRI and others questioned whether EPA's conclusions could be supported by the data in the Community Health and Environmental Surveillance System (CHESS) studies and sponsored a reanalysis of the CHESS results. The reanalysis concluded that no consistent statistical associations exist between sulfates, nitrates, and asthma. Consequently, the CHESS studies do not support further tightening of air quality standards by EPA or other regulatory agencies. Southern California Edison Co. challenged proposed standards in California on the basis of these findings as well as on the results of some of its own studies. Because it was found to be unnecessary to further reduce emissions to protect health, projected savings of over $1 billion will accrue to SCE ratepayers over the next 20 years. (RP1642, RP681-1)

Attacks by steam, oxygen, and stress can promote cracking in the low-pressure turbine rotor disks used at power plants. New EPRI data on cracking and companion calculation methods can help utilities decide when these turbine rotor disks must be repaired.

Sodium Treatment for ESPs

To satisfy sulfur dioxide emission regulations, utilities frequently choose to burn low-sulfur coal. But such coal generally produces a high-resistivity ash that is difficult to collect in an electrostatic precipitator (ESP), one of the standard emission control devices. Because resistivity decreases with higher temperatures, ESPs at some utilities were installed upstream (on the hot side) of the air preheater. However, hot-side ESPs have often not performed as expected. For coals with low sodium content, hot-side ESP performance rapidly deteriorated. One economic countermeasure is to add a chemical agent to the coal to change the properties of the ash particles. At Gulf Power Co.'s Lansing Smith plant, collection efficiency continually deteriorated, requiring the power plant to be shut down while the ESP plates were washed. A test was conducted jointly by EPRI, Southern Co. Services, Gulf Power Co., and the Environmental Protection Agency in which small quantities of dry sodium sulfate were added to the coal. ESP performance dramatically improved, the need for washing was eliminated, and boiler reliability was not affected. An estimated $552,000 in annual revenue requirements was saved. (RP724-2)

Airborne Lidar

Once power plant emissions leave the stack, it is difficult to collect the particles and gases for analysis. A truck-mounted lidar (light detection and ranging) unit exists but its usefulness is limited by low speed and the need to follow roads. SRI International developed a lidar system for EPRI that is carried by a medium-sized airplane. Its dual-frequency laser beams provide a real-time chart recording of shape, density, cross section, and altitude of plumes. The Salt River Project (SRP) used the SRI lidar aircraft to map plumes at ranges up to 100 km from its power plants. To ensure better data and reduce the number of sampling flights, SRP had another specially equipped sampling aircraft accompany the lidar plane. The second aircraft was provided by Meteorology Research, Inc. Compared with the next best plume-sampling method, the SRI system provides superior data on plume dispersion and saved SRP $300,000 in costs. The system is available to electric utilities and other operators of emissions sources. (RP1308-2)

Turbine Rotor Disk Cracking

Steam, oxygen, and stress can combine to promote cracks on the 1800-rpm low-pressure turbine rotor disks used at modern power plants. Research conducted by Southwest Research Institute under EPRI contract and supported by over 30 related research projects sought to understand the causes of turbine disk cracking. When turbine disk cracks were discovered at Northeast Utilities' Connecticut Yankee facility during a routine refueling outage, shutdown for reinspection during a subsequent operation cycle was indicated. But EPRI's new data and calculation methods, together with Northeast Utilities' research, confirmed that it was safe to run the turbines until the next refueling outage. NU estimated it saved $6 million in replacement power costs that three weeks of unscheduled shutdown would have cost. The new EPRI data and methods can assist other utilities in making informed run-retire decisions on their own turbine rotor disks. (RP1398)

Man-Machine Interface

Power plants have evolved into highly sophisticated, complex machines, and their control panels are not always easy to read. This can lead to increased operator reaction time and possible error. EPRI has funded a wide range of projects on human factors engineering, and one, by Failure Analysis Associates, was of particular interest at Pacific Gas and Electric Co.'s Geysers plant. This project studied the relationship between human-factor-related errors and control-room layout. Using information from the study and from PG&E's own operations people, control panels in Units 17 and 18 (then under construction) were redesigned with the man-machine interface as a primary consideration. Based on a 100-h/yr reduction in forced-outage hours, PG&E could save up to $728,000 in annual levelized costs (over five years, beginning in 1982) as a result of this engineering. (TPS77-715)

Geothermal Liquid Turbine

When high-temperature geothermal hot water is directly flashed to steam to drive a turbine generator, some of the process energy is lost with the residual water when it is reinjected into the rock formation. To recover this energy, a device known as a rotary separator–turbine (RST) has been designed and tested under EPRI contract. In this device, a high-speed jet of steam and hot water, produced by an expansion nozzle, drives a rotating drum. In the drum the steam is separated from the water by centrifugal force and goes to a conventional steam turbine. The kinetic energy of the water is extracted by a liquid turbine component of the RST and is used to drive a generator. A prototype commercial RST has produced over 1000 kW of electric power during tests performed by Biphase Energy Systems, Inc., and Utah Power & Light Co. in a cost-shared EPRI research project near Milford, Utah. Previously, an experimental 20-kW RST achieved a power output equivalent to a 15–20% increase over single-stage, direct-flash systems. Tests at Milford could lead to commercially available RST units in 1986. (RP1196)

Superconducting Generator

EPRI and Westinghouse Electric Corp. have reached the development stage of a project to design, manufacture, and factory-test a 300-MVA superconducting generator. Successful demonstration of the generator in the Tennessee Valley Authority's Gallatin power plant will confirm that the anticipated benefits of this type of generator are attainable for the electric utility industry. These benefits include greater efficiency resulting from a potential reduction of 50% or more in electrical losses normally incurred during the generation process. This virtually loss-free flow of electric current is made possible by superconductivity, a property of certain metal alloys (used in the rotor winding) when they are cooled to temperatures near absolute zero by liquid helium. Superconductivity also renders the generator more resilient to variations in load. In addition, this type of generator has a lower capital cost than conventional types because it is smaller and thus requires less construction material. (RP1473)

Regional Air Quality

Accumulated emissions from multiple power plant sources in one region can affect air quality in another region. EPRI sponsored a $7 million program, the Sulfate Regional Experiment (SURE), that examined the relation between local emissions of sulfur dioxide and regional ambient air quality. Interest in regional air quality stems from concern over visibility impairment, human health effects, and acid precipitation. Environmental Research & Technology, Inc., conducted an extensive program involving measurements of emissions, as well as measurements of air quality. The SURE program is complete, and a new program, Regional Air Quality Studies (RAQS), has begun. This program comprises studies of sulfur dioxide and other compounds, both in the atmosphere and in simulated atmospheric conditions. Results will form the basis for a better understanding of air quality in the eastern and western United States. (RP862, RP1630)

Cost-Effectiveness of Conservation

Conservation and load management programs designed to alter the shape and level of future electricity loads have become increasingly important in utility resource planning. A major problem for utilities is the high degree of uncertainty regarding the costs and net benefits of utility investment in such programs. In an attempt to reduce the uncertainty, EPRI and its contractor Arthur D. Little, Inc., are developing methods to measure the cost-effectiveness of candidate utility conservation programs for residential customers. Researchers will focus on such factors as customer acceptance of conservation programs and the way it varies with levels of utility investment. In addition, they will determine energy savings to the utility and the customer, and the impact of programs on utility revenue requirements and on customer costs (for example, in insulating a house). Reports on the experience and data from this research will be available in mid-1983. (RP1587, RP1918)

Advanced Emissions Control Technology

Reducing costs of environmental controls for coal-fired power plants while maintaining acceptable emissions control is the objective of research at EPRI's Emissions Control and Test Facility at Arapahoe station, Denver. This unique facility provides emissions control research capabilities in an environment that simulates authentic utility operation. It has addressed design changes for improving performance of electrostatic precipitators (ESPs) in 10-MW- and 1-MW-equivalent pilot plants and fabric filters (baghouses) in a 10-MW-equivalent pilot plant. A recent expansion of capabilities will allow development of an integrated-systems approach for meeting air and water quality regulations, as well as meeting solid-waste disposal requirements. The integrated environmental control pilot plant (2.5 MW equivalent) permits a systems examination of control of particulates (ESPs and fabric filters), SO_2 (spray drying and wet scrubbers), and NO_x (selective catalytic reduction), in conjunction with reuse of cooling-tower blowdown. These projects are expected to identify cost-saving designs and operating procedures for immediate and long-term application. (RP1646)

Fuel Cell Demonstration

Fuel cell power plants are ideally suited for urban locations: they are clean, quiet, and quickly installed in modular units. They are also efficient over a wide range of loads and respond quickly to load changes. In Manhattan, control and checkout tests are

Fabric filters are part of an integrated environmental control pilot plant at EPRI's Emissions Control and Test Facility.

under way at the 4.5-MW fuel cell demonstration, of which EPRI is a major sponsor. The demonstration is being conducted on Consolidated Edison Co. of New York, Inc.'s grid, and operation should begin later this year. A similar plant owned by Tokyo Electric Co. is also expected to be in operation in 1982. Meanwhile, EPRI has developed preliminary specifications for commercial prototype fuel cell power plants of 11 MW, a likely size for urban sites, and a fuel cell users group continues to attract new utility members committed to working with manufacturers, EPRI, and the government to get the fuel cell into commercial service by 1985. (RP842, RP1677, RP1777)

Cool Water Coal Gasification

Coal gasification has the potential for environmentally clean, economical, efficient power generation. Several second-generation gasification processes have been tried at small scale, and one is being advanced to demonstration scale in the Cool Water project. Initiated in 1979 by Southern California Edison Co. and Texaco, Inc., and supported by EPRI and others, the project calls for construction of a 100-MW gasification–combined-cycle (GCC) plant that uses a 1000-t/d Texaco gasifier. The integrated plant will include coal receiving and slurry preparation, an oxygen-blown gasifier, particulate and sulfur removal, sulfur recovery, and combined-cycle generation equipment. Construction has already begun at SCE's Cool Water station near Daggett, California; operation and testing are expected to begin in 1984 and will continue for about seven years, supplying the information needed to build large commercial baseload GCC plants. (RP1459)

Nuclear technicians train with advanced equipment and techniques for nondestructive examination at EPRI's NDE Center.

Fluidized-Bed Combustion

Atmospheric fluidized-bed combustion could provide the utility industry with self-contained emissions control, increased reliability, and greater fuel flexibility as soon as 1990. The AFBC boiler is a bed of coal and limestone fluidized by air. Limestone absorbs the SO_2 formed during combustion. Relatively low bed temperatures resulting from improved heat transfer reduce NO_x formation and eliminate slagging. Recent AFBC research focused on EPRI's 6-by-6-ft, 2-MW (e) development facility at Babcock & Wilcox Co.'s Alliance (Ohio) Research Center, where combustion efficiencies of more than 99% have been achieved. This year construction was completed at TVA's 20-MW (e) AFBC prototype at Paducah, Kentucky. Shakedown and preoperation tests are under way, and full testing of hardware and designs developed from the EPRI 6-by-6 facility will begin this fall. EPRI provided TVA with technical assistance in design and R&D planning for the new facility, and is cosponsoring a four-year operational test program with TVA. A 100–200-MW (e) utility demonstration is planned for later this decade. (RP718, RP1860)

NDE Center

The nondestructive examination (NDE) techniques used to detect potentially troublesome materials flaws in nuclear power plants continue to be improved by research. But beyond research, utilities require field-ready equipment and procedures, as well as trained technicians to carry out these examinations. EPRI's NDE Center at University Research Park, Charlotte, North Carolina, answers that need. At the center, opened in 1981, staff quantify the performance of inspection systems; modify prototype systems for field use; evaluate inspection systems on full-size plant components; and develop the performance data bases necessary for realistic inspection requirements. Three NDE inspection systems were evaluated during the center's first year. The facility also trains technicians to use the new equipment and procedures, and a number of training programs and workshops have already been held at the center. (RP1570-2)

BEST Facility

Acceptance tests have been completed at the Battery Energy Storage Test (BEST) Facility in New Jersey, and evaluation of advanced batteries developed for utility energy storage is almost ready to begin. A 500-kWh zinc chloride unit from Energy Development Associates, first in a planned 10-year test series of candidate units, will be delivered later this year. The $17 million facility was organized under joint sponsorship of EPRI, DOE, and Public Service Electric and Gas Co., with PSE&G acting as prime contractor and host for the program. Operating costs are shared equally by EPRI and DOE. Modules from 500-kWh to 10-MWh storage capacity will be evaluated in the facility, which is connected to the PSE&G grid. The modules will be representative of the 100-MWh designs that could provide energy storage service for utilities and their customers by the late 1980s. (RP255, RP226)

Relief Valve Program

After Three Mile Island the NRC required utilities operating pressurized water reactors to demonstrate the operability of the relief and safety valves used to protect reactor coolant systems. These utilities, some 42 in all, requested that EPRI conduct a comprehensive test program that would establish the operability of these valve designs under the full range of operating conditions; vendors and foreign organizations also supported the effort. Because of the size and complexity of the program and the prescribed time for its completion, EPRI used three different test facilities. One was Duke Power Co.'s Marshall Steam Station, Terrill, North Carolina. The other two, built by EPRI specifically for the program, were in Norco, California, and Windsor, Connecticut. All required tests are now complete, and results are being prepared for a submission to the NRC by PWR owners; complementary research by foreign organizations continues. (RPV102) ■

FINANCIAL REPORT

Statement of Financial Position

Statement of Revenues and Expenses and Changes in Fund Balances

Statement of Changes in Financial Position

Notes to Financial Statements

Report of Independent Accountants

Electric Power Research Institute, Inc.
Statement of Financial Position
December 31 (thousands of dollars)

	1981						1980
	Base Program	SGP	NSAC	BWRP	RVP	Combined	Combined
ASSETS							
Current assets:							
Cash and short-term marketable securities (Note 2)	$ 53,774	$ 11,130	$ 5,484	$ 4,831	$ 8,325	$ 83,544	$ 51,719
Amounts due from members (Note 1)	22,405	194	1,314	739	1,133	25,785	47,704
Accrued interest receivable	120	98	36	43	78	375	318
Other current assets (Note 3)	7,708	12	48	2	1	7,771	4,970
	84,007	11,434	6,882	5,615	9,537	117,475	104,711
Property, facilities, and equipment (Note 3)	26,181	–	–	–	–	26,181	18,356
Funds held by trustee (Note 4)	4,185	–	–	–	–	4,185	10,914
Total assets	114,373	11,434	6,882	5,615	9,537	147,841	133,981
LIABILITIES							
Current liabilities:							
Research and development expenses payable	75,799	3,274	1,465	1,826	2,422	84,786	84,063
Accounts payable and other accrued liabilities	5,931	60	1,413	27	172	7,603	8,180
Current portion of long-term debt and obligations under capital lease (Notes 4 and 5)	1,606	–	–	–	–	1,606	65
Interest payable	97	–	–	–	–	97	97
	83,433	3,334	2,878	1,853	2,594	94,092	92,405
Long-term research and development expenses payable	1,191	14	6	49	–	1,260	–
Long-term debt (Note 4)	14,521	–	–	–	–	14,521	16,087
Obligations under capital lease (Note 5)	3,620	–	–	–	–	3,620	3,661
Total liabilities	102,765	3,348	2,884	1,902	2,594	113,493	112,153
Commitments (Notes 5 and 6)							
FUND BALANCE	$ 11,608	$ 8,086	$ 3,998	$ 3,713	$ 6,943	$ 34,348	$ 21,828

See accompanying notes to financial statements.

Electric Power Research Institute, Inc.
Statement of Revenues and Expenses and Changes in Fund Balances
Years Ended December 31 (thousands of dollars)

	1981						1980
	Base Program	SGP	NSAC	BWRP	RVP	Combined	Combined
REVENUES							
Industry payments (Note 10)	$258,389	$ 2,167	$ 12,889	$ 9,977	$ 14,928	$ 298,350	$ 254,636
Interest income	5,869	2,288	682	653	704	10,196	7,774
Other income	257	–	5	–	–	262	337
Total revenues	264,515	4,455	13,576	10,630	15,632	308,808	262,747
EXPENSES							
Contract research and development (Note 9)	214,551	8,299	3,023	7,431	9,912	243,216	250,041
Program management and in-house research	39,685	1,336	7,258	480	575	49,334	46,123
Seminars, workshops, and special studies	3,578	153	–	7	–	3,738	4,744
Total expenses	257,814	9,788	10,281	7,918	10,487	296,288	300,908
EXCESS (DEFICIENCY) OF REVENUES OVER EXPENSES	6,701	(5,333)	3,295	2,712	5,145	12,520	(38,161)
FUND BALANCE, BEGINNING OF YEAR	4,907	13,419	703	1,001	1,798	21,828	59,989
FUND BALANCE, END OF YEAR	$ 11,608	$ 8,086	$ 3,998	$ 3,713	$ 6,943	$ 34,348	$ 21,828

See accompanying notes to financial statements.

Electric Power Research Institute, Inc.
Statement of Changes in Financial Position
Years Ended December 31 (thousands of dollars)

	1981						1980
	Base Program	SGP	NSAC	BWRP	RVP	Combined	Combined
Cash was provided (used) by operations:							
Excess (deficiency) of revenues over expenses	$ 6,701	$ (5,333)	$ 3,295	$ 2,712	$ 5,145	$ 12,520	$ (38,161)
Add (deduct) items not affecting cash in the period:							
Depreciation	1,139	–	–	–	–	1,139	592
Decrease (increase) in amounts due from members	16,930	1,697	(296)	205	3,383	21,919	6,086
Decrease (increase) in other current assets except cash and short-term marketable securities	2,225	165	(64)	(33)	(65)	2,228	(914)
Increase (decrease) in liabilities, excluding debt and capital lease	1,695	537	1,685	(573)	(1,938)	1,406	27,447
Total	28,690	(2,934)	4,620	2,311	6,525	39,212	(4,950)
Cash was used for:							
Additions to property, facilities, and equipment	8,964	–	–	–	–	8,964	11,016
Construction advance	5,086	–	–	–	–	5,086	–
Payment of long-term debt	66	–	–	–	–	66	562
Total	14,116	–	–	–	–	14,116	11,578
Increase (decrease) in cash and short-term marketable securities before financing activities	14,574	(2,934)	4,620	2,311	6,525	25,096	(16,528)
Financing activities:							
Bond proceeds	–	–	–	–	–	–	13,900
Withdrawal from (deposit with) bond trustee	6,729	–	–	–	–	6,729	(10,914)
Increase (decrease) in cash and short-term marketable securities	$ 21,303	$ (2,934)	$ 4,620	$ 2,311	$ 6,525	$ 31,825	$ (13,542)

See accompanying notes to financial statements.

Electric Power Research Institute, Inc.
Notes to Financial Statements

NOTE 1—Description of organization, mission, and summary of significant accounting policies:

Organization

The Electric Power Research Institute, Inc. (the Institute), was organized in 1972 under the District of Columbia Nonprofit Corporation Act. The mission of the Institute is to conduct a national research and development program relating to the production, transmission, distribution, and utilization of electric energy. The Institute's activities include technological assessment of both near-term and long-term research needs, their arrangement into an orderly strategic plan, the assignment of priorities and allocation of funds, the implementation and management of the resultant projects, which, for the most part, are performed by independent contractors, and dissemination of the information gained. These activities are carried out under the sponsorship of public, private, and co-operative sectors of the U.S. electric utility industry and constitute EPRI's base program for the Institute (the Base Program). In addition to the Base Program, the Institute is conducting four separately funded research efforts. These are the Steam Generator Owners Group Program (SGP), the Nuclear Safety Analysis Center (NSAC), the Boiling Water Reactor Owners Group Intergranular Stress Corrosion Cracking Program (BWRP), and the Pressurized Water Reactor Safety and Relief Valve Program (RVP).

Summary of Significant Accounting Policies

The Institute employs the accrual basis of accounting and, accordingly, records contribution commitments as revenue in the year to which the commitment relates; records interest as income when earned; and records contractresearch and development expenses, program management, and in-house research expenses as they are incurred.

Under some research contracts, the Institute agrees to reimburse its contractors for the cost of specialized equipment needed to perform the work. In such cases, it is the Institute's policy to retain title to such equipment and to charge to expense the cost thereof when such cost is invoiced by the contractor. At the conclusion of the contract, such equipment may be transferred to other work. Otherwise, the proceeds, if any, from the sale or other disposition of the equipment are credited to other income.

The cost of buildings and land leaseholds for use by program management is amortized over the shorter of their estimated useful lives or the respective lease terms, and depreciation is computed by using the 150% declining-balance method for buildings and the straight-line method for land leaseholds. Structures and equipment having an individual cost exceeding $250,000 and used in conducting multiple research projects are capitalized, and depreciation is computed by using the straight-line method over their expected useful lives. Costs associated with individual research and development projects conducted at these facilities are charged to expense as incurred.

Program management and in-house research expenses incurred by the Institute are allocated to all research activities, including those that are separately funded.

NOTE 2—Cash and short-term marketable securities:

Cash and short-term marketable securities, at cost that approximates market, comprise the following.

	1981	1980
	(thousands of dollars)	
Cash (net overdraft)	$ (1,980)	$ 7,903
Time deposits	–	6,859
Bankers acceptances and certificates of deposit	7,889	5,973
Commercial paper	77,635	30,984
	$83,544	$51,719

It is the Institute's current policy to solicit contributions for the Base Program from its members each year only for the funds required for that year's total estimated cash disbursements. Through December 31, 1981, members have committed $235,100,000 for 1982 cash disbursements. For 1982, member payments are scheduled to be received in four equal quarterly installments, due in the second month of each quarter.

NOTE 3—Property, facilities, and equipment:

	1981	1980
	(thousands of dollars)	
Buildings and land leases	$26,245	$ 7,071
Equipment and leasehold improvements	2,337	1,898
Construction in progress:		
Office buildings	–	5,414
Research facilities	–	5,235
	28,582	19,618
Accumulated depreciation and amortization	(2,401)	(1,262)
	$26,181	$18,356

During 1977, the Institute purchased the remaining 37-year leasehold interest in an office building at 3412 Hillview Avenue in Palo Alto, California (the Original Site), for $2,299,000. The building is subject to a land lease with Stanford University that expires in 2014. Subsequent to acquisition of the leasehold interest, the Institute executed a mortgage loan on the building for a term of 27 years.

Also in 1977, to accommodate new office buildings adjacent to the Original Site, the Institute entered into a 51-year lease with Stanford University for approximately 13 acres of land (the Adjacent Site) at a total lease cost of $965,000. In 1978, as part of a subsequent lease arrangement in connection with three buildings constructed on the Adjacent Site, the Institute assigned its interest in the land and improvements to a third party and entered into a long-term sublease from the same third party. The building lease is accounted for as a capital lease, its initial term of 30 years expires in 2008, and there are options to renew for two successive 10-year periods, the latter period being subject to rental renegotiation. The capitalized cost of $3,807,000 is included in buildings and land leases.

Construction of additional office space on the Adjacent Site began in March 1980 and was completed in June 1981 at a cost of $7,812,000. Expenditures through 1980 amounted to $5,414,000 and were included in construction in progress.

Included in other current assets is $5,086,000, which represents funds advanced for construction expenditures through December 31, 1981, for a research test facility. This facility, which will be owned and operated by another organization, will be used extensively for Institute research over the next 10 years. During 1982 owner financing is expected to be obtained and the Institute reimbursed for this construction advance.

NOTE 4—Long-term debt:

	1981	1980
	(thousands of dollars)	
Mortgage	$ 2,186	$ 2,214
Bonds	13,900	13,900
	16,086	16,114
Less current portion	1,565	27
	$14,521	$16,087

The mortgage loan is secured by a deed of trust on the Original Site, which has an aggregate cost of $2,299,000. The loan is payable in equal monthly installments, including interest to 2004, and bears interest at the rate of 9% per annum. Interest cost on this loan, which was $198,000 in 1981 and $200,000 in 1980, has been included in program management and in-house research expenses.

In 1979, the Institute entered into a contract for the construction of a facility near Homer City, Pennsylvania, to be used in conducting research involving coal-cleaning methods. Construction was financed from the proceeds of a $13,900,000 issue of tax-exempt Industrial Development Revenue Bonds issued by the Indiana County Industrial Development Authority (the Bonds), which are secured by a Crocker National Bank eight-year irrevocable letter of credit. The irrevocable letter of credit is subject to certain covenants. These include maintaining (a) relationships of long-term debt to annual revenue, annual principal and interest payments on long-term debt to annual revenues, and the sum of cash, marketable securities, and total member commitments to current liabilities and (b) member commitments in excess of a specified amount. The Bonds bear interest at 8⅜% and are subject to mandatory redemption, as follows.

1982	$ 1,535,000
1983	1,665,000
1984	1,805,000
1985	1,960,000
1986	2,125,000
1987	2,305,000
1988	2,505,000
	$13,900,000

Total 1981 and 1980 interest costs for the Bonds were $1,164,000 and $663,000, respectively, of which $416,000 has been capitalized and is included at December 31, 1981, in Property, Facilities, and Equipment. The remaining interest costs ($820,000 in 1981 and $591,000 in 1980) are included in contract research and development expenses. There is an interest and call premium reserve of 13% on the outstanding balance. At December 31, 1981, $4,185,000, representing the remaining proceeds, the reserve, and related interest earned, was on deposit with the Trustee in accordance with the Trust Indenture established at the time of the issuance of the Bonds.

NOTE 5—Commitments:

The Institute has entered into lease arrangements under operating leases for research, office, and storage

facilities, and for equipment. Rental expense under these leases was $1,448,000 in 1981 and $1,168,000 in 1980.

The terms of certain of these leases provide that the Institute is liable for property taxes, insurance, and maintenance expenses and, in certain cases, renewal options are included.

Future minimum lease commitments by year and in the aggregate, under capital and noncancellable operating leases with initial or remaining terms of one year or more at December 31, 1981, were as follows.

	Capital lease	Operating leases	Total
		(thousands of dollars)	
1982	$ 336	$1,310	$ 1,646
1983	336	1,303	1,639
1984	336	1,294	1,630
1985	336	1,201	1,537
1986	336	1,181	1,517
Thereafter	7,248	2,247	9,495
	8,928	$8,536	$17,464
Less amount representing interest	(5,267)		
Present value of minimum capital lease commitment	$3,661		

Interest cost on the capital lease is included in program management and in-house research expenses and was $298,000 in 1981 and $301,000 in 1980.

The present value of the minimum capital lease commitment of $3,661,000 is included in the accompanying statement of financial position as current and noncurrent obligations of $41,000 and $3,620,000, respectively.

NOTE 6–Funding of research projects:

As the Institute identifies prospective research projects, the maximum amounts that may be expended on such projects and annual appropriations for them are approved. One responsibility of the Institute's staff is to negotiate research contracts with suitable persons or organizations that result in contractual commitments for a given year falling within the appropriated amounts.

The funding of research projects is summarized as follows.

	1981	1980
	(thousands of dollars)	
BASE PROGRAM		
Cumulative research expenditures made through the prior year-end on contracts since inception	$ 946,726	$ 723,311
Research expenditures, current year	214,551	223,415
Unexpended contract commitments	12,632	7,873
Amounts expended or committed under contracts since inception	1,173,909	954,599
Amounts appropriated, not committed	13,277	21,504
Amounts authorized to be appropriated in future periods	529,281	440,967
Total amounts authorized since inception	$1,716,467	$1,417,070
SEPARATELY FUNDED PROGRAMS		
Cumulative research expenditures made through the prior year-end on contracts since inception	$ 35,477	$ 8,851
Research expenditures, current year	28,665	26,626
Unexpended contract commitments	4,847	4,886
Amounts expended or committed under contracts since inception	68,989	40,363
Amounts appropriated, not committed	5,295	8,872
Amounts authorized to be appropriated in future periods	17,572	25,925
Total amounts authorized since inception	$ 91,856	$ 75,160

Total amounts authorized since inception represent the cumulative research expenditures made on contracts plus estimated additional expenditures that will be required for approved research projects. In addition to the unexpended contract commitments at December 31, 1981, in late 1981 the Institute entered into additional commitments with certain contractors for reimbursement of their 1982 research costs in the amount of $77,573,000 for the Base Program and $4,146,000 for the separately funded programs. Generally, the Institute has the right to cancel research and development contract commitments on 30 days' notice.

NOTE 7–Income tax status:

The Institute has been determined to be exempt from federal income taxes as a scientific organization under Section 501(c)(3) of the Internal Revenue Code. Hence, only unrelated business income, as defined in the Code, is subject to federal income taxes. This year, as in prior years, the Institute has no taxable income.

NOTE 8–Pension plans:

During 1981, the Institute replaced its previous pension plans, a defined benefit plan for administrative employees and a defined contribution plan for scientific/technical employees, with a new defined contribution retirement plan approved in 1980 by the Institute's Board of Directors. The new plan became effective January 1, 1981, for all current administrative employees and for all employees hired after January 1, 1981. All administrative employees chose to have the accrued benefits under the former plan placed into the new defined contribution plan. Scientific/technical employees were included in the new plan on September 1, 1981, or one year after hire, whichever was later. The new defined contribution plan conforms in all material respects to the provisions of the Employee Retirement Income Security Act of 1974. It is the Institute's policy to fund pension costs accrued. Pension expense was $2,278,000 for 1981 and $1,866,000 for 1980.

NOTE 9–Research and development expenses:

Research and development expenses for the Base Program by division and for separately funded programs are as follows.

	1981	1980
	(thousands of dollars)	
Base Program Divisions		
Advanced Power Systems	$ 37,370	$ 45,229
Coal Combustion Systems	37,349	34,899
Electrical Systems	30,786	36,160
Energy Analysis and Environment	29,560	32,405
Energy Management and Utilization	23,309	20,050
Nuclear Power	56,171	54,378
Planning and Evaluation	125	82
Other	(119)	212
	214,551	223,415
Separately funded programs	28,665	26,626
	$243,216	$250,041

NOTE 10–Industry payments:

Industry payments for the years ended December 31 are as follows (thousands of dollars).

	1981						1980
	Base Program	SGP	NSAC	BWRP	RVP	Combined	Combined
U.S. electric utilities:							
Investor-owned corporations	$223,309	$ 1,747	$ 9,541	$ 8,544	$ 11,954	$ 255,095	$ 219,462
Nonfederal government agencies	18,763	–	738	453	422	20,376	17,217
Federal government agencies	9,955	–	511	365	340	11,171	9,535
Cooperatives	6,362	–	268	168	156	6,954	6,617
Other sources	–	420	1,831	447	2,056	4,754	1,805
	$258,389	$ 2,167	$ 12,889	$ 9,977	$ 14,928	$ 298,350	$ 254,636

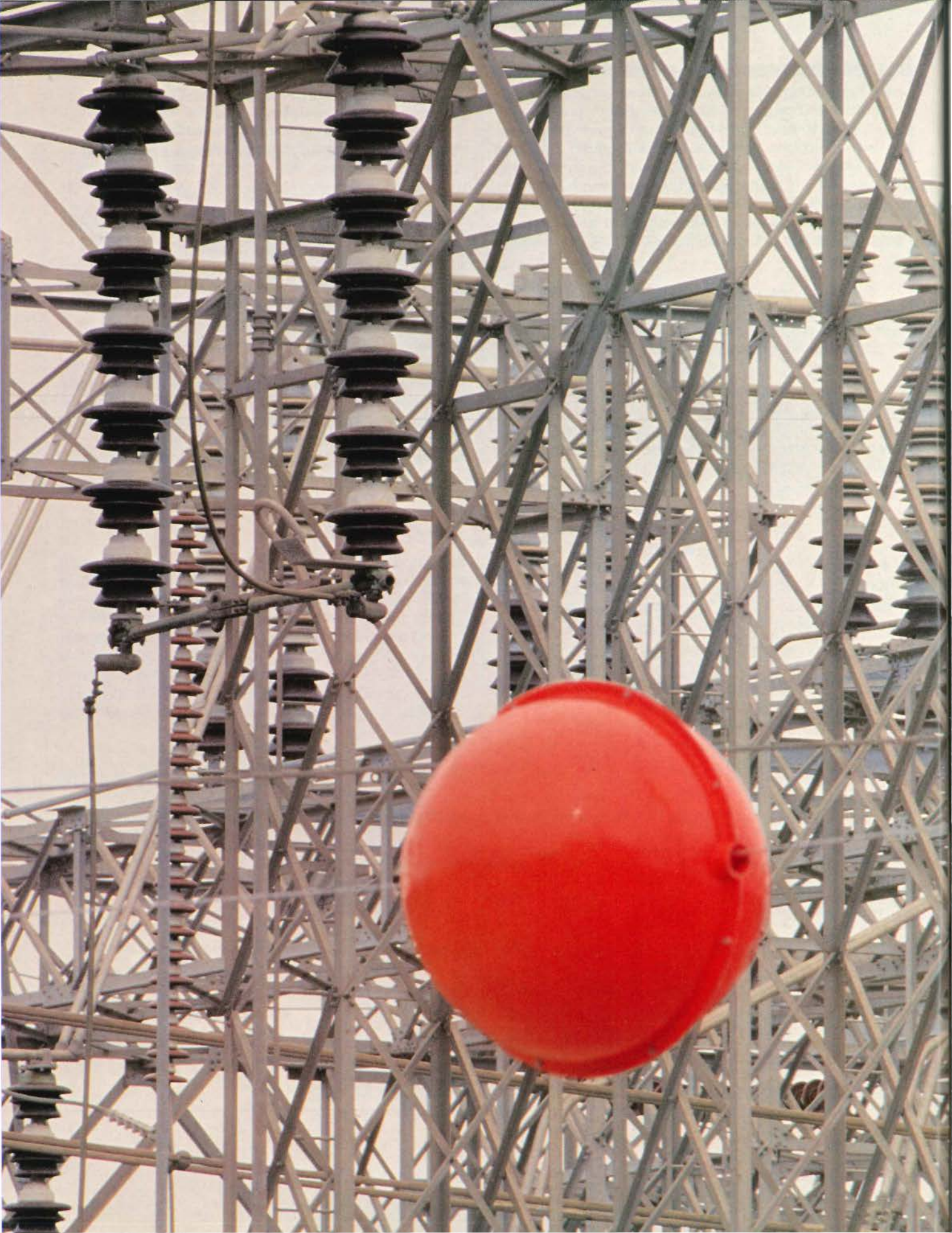
REPORT OF INDEPENDENT ACCOUNTANTS

To the Board of Directors of Electric Power Research Institute, Inc.

In our opinion, the accompanying combined statement of financial position and the related combined statements of revenues and expenses and changes in fund balances and of changes in financial position present fairly the financial position of Electric Power Research Institute, Inc., at December 31, 1981 and 1980, and the results of its operations and the changes in its financial position for the years then ended, in conformity with generally accepted accounting principles consistently applied. Our examinations of these statements were made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances, including at December 31, 1981 and 1980, confirmation of cash and securities owned by correspondence with the depositaries.

Price Waterhouse

San Jose, California
March 4, 1982



ORGANIZATION

To best carry out its goals, EPRI is organized into six technical divisions, each focusing on a major R&D area, as well as several functional divisions and departments that provide service to the various technical groups within the Institute. More than 400 utility industry executives and engineers serve on various committees that provide continuing technical guidance to EPRI in the formation and implementation of its research efforts. The Research Advisory Committee, made up of senior utility industry representatives, counsels EPRI's president and Board of Directors on changing industry needs. Leaders from state regulatory agencies, education, business, labor, environmental groups, and other public sectors serve on the Advisory Council that reports to EPRI's Board of Directors and president. Reflecting public needs and attitudes, this Council maintains a communications link between the public and the Board.

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