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Testimony Before the
Subcommittee on Energy Research and Development
Committee on Science, Space, and Technology

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Testimony

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Madam Chairman and Members of the Subcommittee, I am grateful for this opportunity to share with you some of my experience as a user of neutron research facilities in many different countries over the past twenty years. This subcommittee has always strongly supported the research and development that has been the basis of our advanced technology, and I look forward to talking to you about the important role of neutron research, and, in particular, the Advanced Neutron Source, in making possible our continued scientific and technical leadership.

Impacts of Neutron Research. Oilmen and Nobel Prizewinning physicists may sound like strange bedfellows, but they get together surprisingly often these days. So do aerospace designers and biologists, farm pesticide manufacturers and nuclear physicists. Their common interest is neutron-based research and development, and they meet at one of the thirty or so worldwide neutron user centers. The resulting research has impacted so many aspects of everyday life that familiarity has made it largely invisible. When you use a credit card or a pocket calculator, view a satellite weather forecast on television, drive an automobile, or spray a crop, it is a safe bet that you are not thinking about how much the quality of the products or the information has been improved by neutron-based research—but it has. There is a very simple, but very basic, reason for this.

To dominate technology, we need to dominate materials. Today, almost everything we use for fabrication, maintenance, or protection, and a substantial proportion of what we eat, is made from a synthetic or processed material. Amazingly often, that synthesis or process has been improved over the past few decades because of our increasing ability to control nature on a finer and finer scale. The key size range is generally somewhat smaller than we can ever see with a microscope using light, but many hundreds or thousands of times the size of a single atom. When this industrial evolution began, neutrons and X-rays were still being used to study atoms. In the intervening period, we have learned to use these tools to study increasingly larger objects. In the past decade or so, the size range studied by neutrons and X-rays has finally overlapped with the most important size range for industry. The resulting research has produced spectactular results. The two methods are often complementary, but for most practical applications, neutrons have a decisive (and often unique) advantage. One reason is that it is difficult to use X-rays to study light materials, which are usually of the greatest technical importance. Aerospace materials are obvious cases where weight must be minimized, but lighter automobile components, for example, help reduce our energy bill. Another reason is the need to study pieces of material large enough to be representative, preferably under end-use conditions; again, this is easy to accomplish with neutrons but often ranges from hard to hopeless with X-rays. Plastics are one of the most important cases where present understanding and future development are intimately linked to neutron research. Try tearing open the paper-thin foil of an airline peanuts bag without starting at the precut point, and the results of this research become vividly evident.

Today's research and development problems are sufficiently complicated that no single technique is likely to solve them, although a particular technique (such as neutrons in the cases cited above) may provide the breakthrough in fundamental understanding that will allow progress to be made across the board. The problems are cross-disciplinary, and a serendipitous feature of neutron user centers has made them remarkably fruitful for attacking these types of problem. Although a given neutron experiment is essentially "small science" of the type found in university laboratories, the need for a centralized neutron source brings all types of neutron experimentalists together on one site. Many of the best results have come from the meetings of people who would not normally come into professional contact and who have found new ideas in common.

So far, I have only discussed materials research. Neutrons are, of course, used for a far wider variety of applications—from fabricating the special silicon used in computer chips to manufacturing a wide range of therapeutic medical radioisotopes. We owe our geological maps of the country's strategic minerals to neutron activation analysis. It is more than probable that at least one recent air disaster could have been averted by neutron radiographic inspection of jet turbine components. Our research reactors are a resource shared by national laboratories, universities, and industries across the country. The fundamental scientific studies that were once the exclusive domain of neutron research still continue, more widely than ever, but they now take place beside nondestructive testing of oil drills, pipelines, aircraft wings, and jet engines. Neutrons are being used to search for expanded reserves of petrochemicals and strategic minerals, which helps to guarantee our future industrial independence, and for trace element analysis of soil, which helps to guarantee our food supply. The Administration's recognition of the importance of neutron research is summarized in a statement by D. Allan Bromley: "Neutrons have had a revolutionary impact on much of science and technology." Perhaps the best indicator of the importance of neutron user centers is found in the total gross annual sales of the top three dozen companies that have used neutron research facilities in the past few years—approaching $1 trillion (Appendix A).

We taught the world. The United States can take great pride in the invention, at Oak Ridge National Laboratory (ORNL), of reactor-based neutron research, but we showed the world the importance of this field all too well. The lessons learned have been applied more extensively overseas than at home in recent years. We can take great pride in the award of a 1989 Nobel Prize in Physics to a distinguished American researcher, Professor Norman Ramsey. For the past fifteen years, however, Professor Ramsey has had to go to Europe to continue the neutron research he once performed in this country, because our facilities have not kept pace with new developments. The United States, which led the development of neutron techniques until the 1970s, has fallen far behind Western Europe, and lately Japan, in investment in this field. As I speak, researchers in Japan are preparing for the start, on March 22, of their newest research reactor. The most modern American research reactor was designed *thirty years ago*, before the Berlin wall had even been erected. In Malaya, new neutron research facilities are being built because of the practical importance of neutron scattering to understanding rubber, one of their major exports. Investment in new facilities, such as the Leon Brillouin Laboratory in Paris, has taken Western Europe to a commanding lead in neutron research, while investment to upgrade existing facilities has provided Europeans with the training ground for the many new scientists entering the field. The neutron technology developed is now being exported from Europe to countries such as China, Indonesia, and the United States.

Let me remind you of what "thirty years old" means in terms of scientific and technical development. Many of the materials you are wearing, surrounded by, or using everyday could not actually have been made with the technology of 1960. Thirty years ago, color television was something of a novelty, Japanese cars were almost unknown, and many companies were still trying to conceive of a use for Xerox machines. Ball-point pens were leaky, and the technology of fiber-tipped pens or polymer-based mechanical pencils was still awaiting the understanding that eventually came from neutron studies of the materials. I am sure you can think of many other examples. Imagine what your workplace would be like if your key equipment was designed thirty years ago, and then imagine trying to recruit staff. This is the situation that we face today in trying to attract a new generation of scientists to work in U.S. research reactors, and the consequences are about what you can imagine. If the field is not rejuvenated soon, a later injection of capital in an attempt to catch up may not succeed. We shall no longer have enough scientists trained in the subject, and the competition will advance further during the time required to train them.

This subcommittee is to be commended for encouraging Congress to fund some laudable intermediate measures, such as the spallation neutron facilities at Argonne and Los Alamos and the new cold neutron facility at the National Institute of Standards and Technology (NIST). These efforts are sincerely appreciated by the neutron community, and we hope that further new initiatives, such as the upgrade proposed at Brookhaven National Laboratory, will continue to be supported. Maintenance of our existing facilities is of tremendous importance to continuity in the research, and the quality of the work performed is a tribute to the ingenuity of our scientists. Finally, however, it is a case of putting new wine in old skins. If we are to attract the next generation into this vital research area, students must see tangible evidence that it has a future.

The Advanced Neutron Source. The Advanced Neutron Source (ANS) at Oak Ridge National Laboratory will be the world's most exciting center for neutron research. It will let us regain the lead that we lost to Western Europe a decade ago and will attract a new generation of researchers, while it caters to the needs of the present generation. The centerpiece will be the finest research reactor ever built, designed using every advance made since our last generation of research reactors to ensure safe, reliable performance. More than 1000 scientists and engineers per year are projected to use one of the more than thirty instruments that the ANS will provide for experiments on materials and basic nuclear science. The neutron analytical facilities incorporated in the ANS will permit unbelievably sensitive and precise chemical analysis of environmentally important chemicals and pollutants. The ANS will also take over the role of the High Flux Isotope Reactor in providing irradiation testing and creating special isotopes, using the handling facilities already present at ORNL to effect a substantial reduction in cost. The ANS is the top scientific priority at ORNL, reflecting the importance that the Department of Energy, the National Academy of Sciences, and others attach to the project as an essential element of our national research and development strategy.

We appreciate the strong support that Congress has already given to the Advanced Neutron Source project, which is a multilaboratory effort under the guidance of ORNL as the lead laboratory. We are currently collaborating with Argonne National Laboratory, Brookhaven National Laboratory, Idaho National Engineering Laboratory, Lawrence Livermore Laboratory, Los Alamos National Laboratory, and several universities. The project has made remarkable progress and has completed the preconceptual design phase with a safe, viable design concept that will re-establish the United States as the world leader in this essential field. All aspects of the project have been subjected to extensive, serious review by independent experts at approximately monthly intervals (Appendix B). This has ensured that the work is of the highest quality and that the appropriate technical, financial, environmental, and safety issues are being correctly addressed.

We are concerned, however, that the current funding is not at a level which will allow timely completion of the task in a manner consistent with the nation's needs. Basic Energy Science (BES) has been very supportive of the ANS but has faced increasingly tight budget constraints over the past few years (Appendix C). The Administration's operating budget request of $4.25M for the ANS in FY 1991 is less than half of last year's funding. This amount is not sufficient to maintain the momentum now built up by the project, and would require disbanding the excellent design team which has been assembled over the last four years. The real need is for $12M in FY 1991. We ask your help, once again, to obtain this amount in order to keep this vital project intact and on track.

APPENDIX A

Some Recent Applied Research Using Neutron Facilities

3M Company	Polymers
Aerojet Heavy Metals	Residual stress in materials
Allied Chemical Corporation	Polymer blends
Allied Signal	High-Tc superconductors Melt-spun metallic glasses
American Dental Association	Alloys
AMOCO	Catalysis
AT&T Bell Laboratories	Magnetic materials Fluid mixtures High-Tc superconductors Porous materials
Bell Communications Research	High-Tc superconductors
BP	In-situ catalyst temperatures
Chevron Oil	Polymers
Corning	Ceramic heat treatments
Dow Chemical	Polymer processing
E I duPont de Nemours	Catalysis Polymer fabrication High-Tc superconductors
Eastman Kodak	Activation analysis Polymer latexes Polymer blends
EG&G	Residual stress in materials
EXXON	Micelles, microemulsions Polymer blends Aggregates in heavy oils Residual stress in materials Polyelectrolytes
Firestone Tire and Rubber	Polymer blends
Food and Drug Administration	Activation analysis
Ford Motor Company	Polymers
General Electric Company	Residual stress in materials

	Jet engine turbine blades
General Motors	Magnetic materials
GTE Laboratories	High-Tc superconductors Ceramic composites
Goodyear Tire and Rubber	Rubber
Hercules, Inc.	Polymer latexes
IBM	Polymer interfaces, films, and melts Polymer blends Plasticized polymers
Imperial Chemical Industries	Catalysis
Lockheed Missile and Space	Solid fuel blends
Monsanto	Plasticized polymers
Mound Laboratories	Polymers
National Institutes of Health	Vesicles
Naval Research Laboratory	Crystalline materials Lipids
Nuclear Metals	Residual stress in materials
Philips	Magnetic recording media
Raychem Corporation	Polymers
Rolls Royce	Jet engine lubrication Jet turbine blade temperatures Arcjet space vehicle engines
Schlumberger-Doll	Catalysis Porous materials
Sid Richardson Oil Company	Carbon black
Smithsonian Institute	Ancient bronze sculptures Paintings
Standard Oil	Ceramic composites
Unilever	Complex fluids under shear
Union Carbide Corporation	Synthetic materials
U.S. Army	Residual stress in materials Kinetic energy penetrators Artillery shells
Xerox Corporation	Polymer blends

APPENDIX B

Recent External Reviews, Workshops,
National Steering Committee (NSCANS) Meetings,
and Presentations to Professional Societies
Concerning the Advanced Neutron Source

DOE-BES Review, March 1988

NSCANS Executive Committee Review, April 1988

NSCANS Meeting, May 1988

DOE-BES Advisory Committee (BESAC) Review, July 1988

ANS Safety Workshop, October 1988

ANS Aluminum Corrosion Workshop, November 1988

NSCANS Materials Irradiation Group Review, November 1988

NSCANS Neutron Sources Group Review, January 1989

Martin Marietta Energy Systems Independent Review, January 1989

NSCANS Executive Committee Review, March 1989

Milloway-Manning Group QA Review, March 1989

DOE-BES Review, April 1989

ORNL Advisory Board, April 1989

NSCANS Meeting, June 1989

Martin Marietta Energy Systems Independent Review, June 1989

ORNL/BNL International Workshop on Neutron Instrumentation, June 1989

ORNL Research Reactor Independent Review, October 1989

DOE-EH Quality Review, October 1989

Presentation to American Nuclear Society, November 1989

Presentation to Materials Research Society, November 1989

Milloway-Manning Group QA Review, January 1990

APPENDIX C

Recent History of the Advanced Neutron Source

1984	ORNL begins preconceptual design using internal funds.
1984	Major Materials Facilities Committee of the National Research Council recommends Advanced Photon and Advanced Neutron Sources as the two highest national priorities for new materials facilities (Seitz-Eastman report).
1984	ORNL begins detailed consultation with the scientific community with a Workshop on Instrumentation for the ANS.
1984	Shelter Island Workshop affirms the need for a new, high-flux neutron source.
1985	Energy Research Advisory Board (ERAB) supports the Seitz-Eastman report.
1985	Gaithersburg Workshop examines neutron source concepts and scientific needs.
1986	National Steering Committee for the Advanced Neutron Source (NSCANS) formed under the Chairmanship of Dr. John J. Rush.
1986	$2.5M in FY 1987 DOE budget for the "Advanced Steady-State Research Reactor at Oak Ridge."
1987	$7.7M written into FY 1988 DOE budget for the ANS (DOE request was $3.0M).
1988	$8.7M written into FY 1989 DOE budget for the ANS (DOE request was $3.7M).
1989	$9.5M written into FY 1990 DOE budget for the ANS (DOE request was $4.5M).