1 of 1

The Advanced Neutron Source

Advanced Neutron Source

ornl

CONTENTS

Introduction	0.3.II.....	1
The Advanced Neutron Source		2
A Global View		3
Neutron Research Improves Our Lives		4
The Challenge		6
The Solution		7
Neutron Research		8
Some Major Applications		10
Environmental, Safety, and Health Considerations		13
Education		14
What the ANS Means for Local Communities		14
What Will the ANS Cost?		15
Appendices		16

[illegible][illegible]

10
 9
 8
 7
 6
 5
 4
 3
 2
 1

[illegible]

The Advanced Neutron Source

- Will provide an unsurpassed user research facility for more than 1000 users annually to conduct scientific experiments
- Will make the United States an internationally recognized leader for neutron beam research
- Will attract new and expanding companies that require neutron scattering research facilities and that in turn will provide new, higher paying jobs
- Will ensure United States leadership in scientific research and in the global marketplace
- Will inspire and recruit national and international students to pursue careers in science and technology

Schedule

2002

Project Complete

2001

Construction Complete

1999

Detailed Design Complete

1996

Preliminary Design Complete/

Construction Begins

1995

Begin Detailed Design & Procurement

1992

Conceptual Design Complete

A Global View

IN ORDER TO REGAIN OUR
POSITION, WE NEED TO
SUPPORT THE RESEARCH AND
DEVELOPMENT THAT WILL LEAD
TO THE ADVANCED NEUTRON
SOURCE AT OAK RIDGE
NATIONAL LABORATORY.

DR. D. B. McWHAN, AT&T BELL
LABORATORIES (IN TESTIMONY
BEFORE THE HOUSE SUBCOMMITTEE
ON ENERGY RESEARCH AND
DEVELOPMENT, MARCH 1990)

While U.S. leadership in neutron research is in steady decline, Europe and Japan methodically strengthen their positions by bettering their capabilities. Japan's most recent investment (\$300 million) in the new JRR-3M research reactor center, commissioned fiscal year 1992, exceeds all U.S. investments for the past 20 years. Since 1970, expenditures in Western Europe on new sources and instrumentation have exceeded those of the United States by a factor of five. France is rebuilding the Institut Laue-Langevin (ILL) reactor, already the world's best for neutron scattering research, in Grenoble. The upgrades will give the reactor another 20 years of life. Germany has just upgraded its research reactors in Berlin and Geesthacht and is designing a new research reactor in Munich. South Korea is following suit. In Switzerland, a steady-state spallation neutron source is under construction.

Meanwhile, no world-class research reactor has been built in the United States since the 1960s — the High Flux Beam Reactor (Long Island, N.Y., 1965), the High Flux Isotope Reactor (Oak Ridge, Tenn., 1966), and the National Institute of Standards and Technology (NIST) Reactor (Gaithersburg, Md., 1969). The two older reactors, especially, are nearing the end of their useful lives. HFIR is the only source in the Western Hemisphere for producing isotopes such

as californium, which has unique uses in medicine and industry. Without a new, world-class research reactor, the United States will effectively be out of the business of neutron scattering research, leaving no choice but to turn to Europe and elsewhere for research and medical isotopes.

Neutron Source	Country	Year
HFBR	US	1965
HFIR	US	1966
NBSR	US	1969
HFIR*	Netherlands	1984
NAEA	Indonesia	1987
JRR-3M	Japan	1990
BER-2*	Germany	1991
ILL*	France	1994
SINQ	Switzerland	1994
PIK	Former USSR	TBA
FRM-2	Germany	2000
FRG-2	Germany	TBA

*The United States has not built a major neutron source since the 1960s. *Indicates upgrade or reconstruction.*

Neutron Research Improves Our Lives

"I CAN THINK OF NO OTHER PROJECT THAT WILL BENEFIT SIMULTANEOUSLY THE RESEARCH OF SO MANY DISCIPLINES."

DR. STEPHEN H. WHITE,
DEPARTMENT OF PHYSIOLOGY AND
BIOPHYSICS, UNIVERSITY OF
CALIFORNIA, IRVINE

From trips to the dentist's office or emergency room, most people have seen the work of X-rays. But few have any notion of how

researchers use neutrons, even though the fruits of neutron research are arguably far greater than those of X-ray technology: high-tech plastics that are lighter and stronger than steel; silicon chips for electronics; computer disks and videotape; geo-

logic maps of oil deposits; and medical procedures that are effectively used millions of times each year in the United States alone.

When you use a credit card or a pocket calculator, watch a satellite weather forecast, drive a jet, or spray a crop, it's a safe bet that the quality of the products or the information has been greatly improved by neutron-based research.

Because the neutron's industrial applications are so broad, America's economic competi-

tiveness, national security, health care industry, and many other aspects of commerce, science, and industry are closely linked to neutron research. That's because most of what we depend on — even some of what we eat — is made

from processed or synthetic materials. A major key to understanding, modifying, and improving their structure or properties is the neutron.

SCIENCE AND INDUSTRY RELY ON RESEARCH REACTORS TO GAIN A BETTER UNDERSTANDING OF THE BASIC PROPERTIES OF MATTER. THIS

KNOWLEDGE LAYS THE FOUNDATION FOR TECHNOLOGICAL ADVANCES IN A VARIETY OF INDUSTRIES, INCLUDING FOOD PROCESSING, COMMUNICATION, MEDICINE, AND MATERIALS RESEARCH.

FOR A SAMPLING OF INDUSTRIES THAT USE NEUTRON RESEARCH, AND HOW THEY USE IT, SEE APPENDIX I.

The Challenge

"IF THE UNITED STATES IS TO BE
A LEADING ECONOMIC
POWER, IT MUST HAVE
FOREFRONT SCIENTIFIC
FACILITIES. TO DO ANY LESS IS
TO RESIGN OURSELVES TO
SECOND-CLASS STATUS."

PROFESSOR ROBERT L. BIRD
DEAN, SCHOOL OF SCIENCE
MASSACHUSETTS INSTITUTE OF
TECHNOLOGY

There was a time when, without a doubt, America led the world in neutron research. But today, just as certainly, the United States is falling behind foreign competitors. Our best neutron research facilities are nearly 30 years old and often aren't fully equipped to do the work needed. Thus, U.S. scientists are increasingly having to use overseas facilities. As a result, America's competitive position in the world weakens.

To compete with countries such as France, Germany and Japan, U.S. science and industry must at least have comparable research facilities. To lead the world, our capabilities must be superior. When the ANS is completed and operational, the United States will regain the position of world leader in the area of neutron-scattering research.

Until the mid-1970s, two-thirds of the major milestone contributions of neutron scattering to materials science, chemistry, and biology came from the United States. Since the mid-1970s, Europe has enjoyed that same margin of dominance, with two-thirds of the contributions coming from laboratories there. Furthermore, European investment in neutron sources, contrasted with a virtually motionless U.S. program, is widening the gap and accelerating the trend toward complete European dominance.

ANS

ANS will give the United States the
world's most powerful neutron
scattering facility.

ANNS will give the
United States the most
powerful neutron scattering
facility in the world.

"RECOMMENDATION 1:

**COMPLETE THE DESIGN AND CONSTRUCTION
OF THE ANS ACCORDING TO THE SCHEDULE
PROPOSED BY THE PROJECT."**

NEUTRON SOURCE FOR AMERICA'S FUTURE
REPORT OF THE BASIC ENERGY SCIENCES ADVISORY
COMMITTEE PANEL ON NEUTRON SOURCES, JANUARY
1993

The Solution

The Administration sees an improved infrastructure as a necessary investment in America's future. President Clinton emphasized this in his address to a Joint Session of the Congress in early 1993 and called for the construction of the Advanced Neutron Source in his report, *A Vision of Change for America*.

In June 1992, at the request of the director of the U.S. Office of Energy Research, a group of experts from science and industry set out to come up with the best plan for the future of American neutron research. They concluded that completion of the Advanced Neutron Source is the "over-riding priority" to prevent a more serious decline of the U.S. neutron community in the next decade, and that the ANS should be the top priority for rapid construction.

The National Steering Committee for the ANS has, since 1986, ensured that the facility meets the requirements of the scientific community. Moreover, the facility will meet all applicable federal and state environmental, safety, and health regulations.

The Advanced Neutron Source, or ANS, is a neutron research laboratory that was allocated \$39 million for 1994, and \$1.2 billion for 1995-98, in the President's recent budget proposal for Department of Energy projects. The conceptual design for the ANS was completed in June 1992.

Conceptual model of the Advanced Neutron Source complex.

Neutron Research

What Is A Neutron?

A neutron is one of the basic parts of an atom, along with protons and electrons. But unlike protons, which have a positive charge, and electrons, which have a negative charge, neutrons are neutral. That's why they are so good for materials research. When neutrons are beamed into most materials, their lack of charge lets them sail right through. It's similar to the way light will shine through glass, or an X-ray will go through skin and muscle, allowing exploration of the interior.

How Will the ANS Produce Neutrons?

Unlike electrons, which whiz through power lines conducting electricity, neutrons do not exist separately in nature. Producing them requires

that atoms, most often uranium or plutonium atoms, be split apart, releasing neutrons. This happens in the process known as fission. As uranium atoms split apart, they release, on average, two or three neutrons. Each of these neutrons, in turn, has the ability to split other uranium atoms, releasing more neutrons, and so on. This creates the self-sustaining atomic reactions that produce the high flux, or neutron flow, of the ANS.

How Will the ANS Use Neutrons?

Materials research will be one of the greatest strengths of the ANS. Every major advance in technology has come from improved materials. Industries such as plastics, steel, computers, and communications often grow by leaps with a seemingly minor advance in materials.

Some experiments at the ANS will be done very near the reactor's core. Others will be done in laboratories adjacent to the reactor building. Neutron guides, like pipelines, will carry neutrons from the core to laboratory instruments. Scientists can place samples of material directly in the path of the neutron beam to see how the material affects and is affected by the neutrons. How neutrons are scattered by the sample reveals an amazing amount of information about the material.

Not all neutrons scatter in the same manner, and some simply aren't good for scattering purposes because they

are too energetic; they move too fast. On average, the likely speed of a neutron increases or decreases with the temperature of its source and its proximity to the core, producing three major categories of neutrons: fast, thermal, and cold.

Computer model of the ANS neutron guides, used to direct neutrons from the reactor core (lower left) to instruments in an adjacent laboratory.

Fast Neutrons

When an atom fissions, neutrons shoot out with very high energy. These are called fast neutrons. Because of their high energy, fast neutrons may change the atomic structure of a material placed in their path. By putting a sample of material very close to the reactor's core where fast neutrons are most plentiful, scientists can study the effects of intense radiation on different materials. This helps engineers decide on the best materials to use in designing fusion reactors, a potential energy source of the future, or in maintaining and upgrading the world's many fission reactors used for producing electricity today.

FAST NEUTRONS

—used to study radiation effects

THERMAL NEUTRONS

—used for scattering & radiography

Thermal Neutrons

As the fission-produced neutrons move away from the reactor's core and out through water that surrounds it, they lose energy and slow down. When they reach their final average speed in the water, they are referred to as thermal neutrons. Thermal neutrons are non-destructive, so they can be used for scattering without changing a material's atomic framework. They are also valuable for radiography experiments, in which technicians can essentially look within structures, such as aircraft wings, to find signs of corrosion. Hairline cracks in metal, for example, are likely to expand under the stress of operations, with potentially catastrophic results if undetected.

COLD NEUTRONS

—used in biology, chemistry, & materials science

Cold Neutrons

Slow, or cold, neutrons have even more applications than the thermal variety. Whereas thermal neutrons are allowed to cool to the temperature of the water surrounding the reactor core, cold neutrons are subjected to an area within the reactor that contains a supercooling agent, such as liquid hydrogen. This drastically reduces the energy of the neutron, slowing it down even more. Increasingly, over the last 20 years, cold neutrons have been the key to new discoveries and applications for plastics, alloys, and even biochemical systems, such as cells and membranes. Some U.S. reactors have been retrofitted with moderate

Neutron Type	HFBR	HFIR	ILL	ANS
Hot	0	0	470	470
Thermal	350	410	1,600	11,500
Cold	30	0	700	16,000
Very Cold	0	0	35	250
Ultra Cold	0	0	460	2,800

Most fundamental breakthroughs in applications of neutron sources during the last 40 years have been directly linked to increases in available neutron flux. The neutron flux at ANS will be the highest in the world, nine to ten times that of today's premier research reactor, the ILL, located in France.

capabilities to produce cold neutrons at an intensity suitable for routine experiments, but not for the cutting-edge work that will typify the ANS.

Some Major Applications

Neutron Scattering

In their trip through a material, neutrons may hit atomic nuclei. When they do, they glance off at an angle, exiting the material in a different direction from the angle at which they entered. This is neutron scattering, and it is vital to understanding how a material is assembled at the atomic level.

By examining the angles and speeds at which neutrons are scattered, scientists can learn how the atoms that make up the material are arranged and how they move around. This allows scientists to work with the material, even rearranging its structure, to make quality and performance improvements on which both science and industry can capitalize.

In a scattering experiment, neutrons that enter a material at one angle are likely to exit at another, revealing the material's atomic structure.

Where Scattering Matters

Neutron scattering is essential for studying materials such as the liquid crystals used in portable computer displays, metals and semiconductors used in electronics, and high-temperature superconductors. In fact, virtually everything known about the magnetism in materials that are strong candidates for superconductivity comes from neutron scattering studies. These materials may someday revolutionize transportation and telecommunications.

But it is the class of materials known as polymers that may reap the most research benefits from the ANS. Polymers are the focus of study for many disciplines including, materials science, physics, and chemistry. High-tech polymers, generally known as plastics, are everywhere. They are used in making commercial and military aircraft, automobiles, spacecraft, medical prostheses, and manufacturing equipment. Besides plastics, they make up paints, adhesives, engine lubricants, and an abundance of recycled material, to name a few.

Polymers are formed from long, thread-like molecules that weave in and around one another like spaghetti on a plate. Hardness, wear resistance, flexibility, and other important

properties depend on how the molecules pack together. Determining this in ever greater detail requires the small-angle neutron scattering that the ANS permits.

The unmatched capabilities for neutron scattering at the ANS will reveal to science and industry not only how existing polymers are put

together, but will also lead to entirely new polymers that could greatly impact the nation's economy through commerce and industry.

Biologists, too, have a keen interest here because DNA, which contains all of a person's genetic code, is actually a biological polymer, a long chain of molecules linked together to form a bigger, complex molecule. The ANS will increase at least tenfold the productivity of

IF WE DO NOT HAVE A NEW REACTOR FOR THE NEXT CENTURY, NEUTRON STRUCTURAL BIOLOGY WILL PROBABLY NO LONGER BE POSSIBLE IN THE UNITED STATES.

DR. STEPHEN H. WHITE, DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS, UNIVERSITY OF CALIFORNIA, IRVINE

neutron structural biologists. Using neutrons, scientists can further understand how this genetic material is arranged in even more complicated structures, such as viruses. Furthermore, the much higher intensity of the ANS will make possible experiments that scientists know how to do but are frustrated because of the comparatively weak neutron beams available at today's facilities.

Neutron Activation Analysis

The fast neutrons used for materials irradiation are also ideal for a procedure called neutron activation analysis, an extremely sensitive technique for chemical analysis. In activation analysis, samples of a material are placed in containers known as "rabbits," and sent through a pneumatic tube to a spot near the core of the reactor.

There, the samples are bombarded with neutrons, causing materials in the samples to become radioactive. Radioisotopes in the sample then emit energy in the form of gamma rays. These gamma energies can be analyzed using a detector to determine what materials are present, and in what quantities.

Jack Ruge National Laboratory researchers used neutron activation analysis in 1991 to determine that Zachary Cator, the 12th President of the United States, did not die from arsenic poisoning.

Isotope Production

As noted earlier, the HFIR facility at ORNL is the only significant source in the Western Hemisphere for certain radioisotopes.

Such as californium used in treating cancer. Californium is also a key isotope for explosives detection aerospace radiography, and it has applications for other national security needs. In addition to californium, many other isotopes produced at ANS

will have medical, pharmaceutical, and industrial uses. Many isotopes decay rather quickly, so they cannot be stockpiled. If construction of the ANS is not complete when the time comes to shut down our older reactors, there will be a costly gap in isotope production and availability in the United States. Of course, if the ANS is not built, the United States will simply have no capable source for producing specialized isotopes, and will have to turn to Russia and other states of the former Soviet Union — the only other sources — to fill its needs.

"MORE THAN 10 MILLION MEDICAL DIAGNOSTIC PROCEDURES ARE PERFORMED IN THE UNITED STATES EACH YEAR BY USING RADIOISOTOPES. . . . NUCLEAR MEDICINE PRACTICE, RADIOPHARMACEUTICALS, AND INSTRUMENTATION HAVE A MARKET GREATER THAN \$10 BILLION PER YEAR IN THE UNITED STATES."

NEUTRON SOURCES FOR AMERICA'S FUTURE.
REPORT OF THE BASIC ENERGY SCIENCES ADVISORY COMMITTEE PANEL ON NEUTRON SOURCES, JANUARY 1993

Neutron Radiography

Undiscovered, the tiniest flaw in an airplane wing, or in materials used in the aerospace or construction industry, could mean disaster. Often, the best way to find such flaws is through a process known as neutron radiography. Neutrons pass smoothly through metals to show types of corrosion that are not detected by X-rays. The technique is also used for quality control of aerospace components and to test weld seams on products such as submarines, water storage facilities, pipelines, and offshore drilling platforms. Industrial neutron radiography is a \$500 million industry (with a far greater economic impact).

Environmental, Safety, and Health Considerations

Throughout the design phase of the ANS, building safety into the plan has been priority-one. Design features of the reactor are based on safety implications. Risk assessments and evaluations were rigorously performed as early as the initial design stage (unprecedented for such a project). State-of-the-art analyses were also performed to support and define how the reactor core would be cooled. Designers and engineers set up hypothetical severe accident conditions to ensure that the reactor containment is more than adequate. Furthermore, the defense-in-depth principle is applied throughout, meaning that successive, independent barriers are in place to stop any release of radioactive products into the environment.

PRIMARY ES & H CONSIDERATIONS

This attention to detail has produced a design concept with many inherent or passive safety features. The primary cooling system enhances natural circulation-cooling of the reactor core and guards against loss of coolant throughout the system in the unlikely event of a major leak or break in pipes, valves or pumps. Two independent systems can shut down the reactor in case of an emergency. Either can safely do the job on its own, even if one of its control rods (which stop the nuclear chain reaction by absorbing neutrons) fails to operate. A concrete and steel reactor-containment building, with walls 6 feet thick, houses the entire primary coolant system. The containment building is double-walled, further protecting against leaks to the environment. Further, the entire reactor system is designed to withstand earthquakes or tornados.	<ul style="list-style-type: none"> • <i>Risk assessments & evaluations</i> • <i>Environmental Impact Statement</i> • <i>Redundant safety systems ("defense-in-depth")</i> • <i>Inherent/passive safety features</i> • <i>Double-walled containment building</i> • <i>Designed to withstand natural disasters</i>
---	--

The project's environmental effects are also of utmost concern. Environmental studies were rigorously documented during the conceptual design phase. Just as ANS engineers used safety analyses as a basis for design, they also used the results of environmental reports in planning for the plant's waste systems, ventilation systems (in terms of airborne releases), instrumentation (monitoring) systems, and required land improvements, which may affect site drainage and the local environment. Before the final site selection is made, the public will be invited to comment on the environmental impact assessment required by the National Environmental Policy Act. To ensure that environmental concerns are adequately examined, that assessment will not be carried out by the ANS project staff or their subcontractors, but rather by an independent expert group contracted directly to the Department of Energy.

Education

Students are attracted to fields where they see an opportunity to do world-class research. This is exemplified by the X-ray community, where the promise of advanced facilities has attracted thousands of new people into the field. The new U.S. Department of Commerce Cold Neutron Research Facility at the NIST in Maryland is attracting new students — and experienced scientists — into neutron scattering in numbers not seen in the United States for many years.

The preeminence of the ANS as a research facility will keep the best and brightest students with interests in

neutron research here, in America. If the U.S. role in such research dwindles, so does the base of top-notch students; they will either go into some other field, or go to another country, taking their skills and research contributions with them.

What the ANS Means for Local Communities

The University of Tennessee and ORNL will draw from a pool of world-class scientists for lectures, seminars and research collaborations. The reputation of the university and the national laboratory will be greatly enhanced, and the ANS will attract the best students, staff, and faculty in science and engineering to the region.

More than 1000 scientists annually will visit the region for one to two weeks to do experiments at the ANS. These users will have a direct impact on revenues of shops, restaurants, and hotels.

The presence of major ORNL user facilities already has helped attract industry to the region, and with the addition of the ANS facility, even more industry will be recruited to the Knoxville-Oak Ridge High Technology Corridor. For example, Coors Ceramics located in Oak Ridge specifically to take advantage of ORNL's High Temperature Materials Laboratory. The ANS will enhance the attractiveness of the area to other high technology companies interested in using neutron-scattering research facilities. In turn, the ANS will benefit directly from the strong regional research infrastructure.

What Will the ANS Cost?

The total construction cost including all contingency money is about \$2 billion (spread over nine years). This cost estimate is supported in the ANS Conceptual Design Report issued in June 1992 and is believed to be conservative. The total project cost (including other expenses) is \$2.7 billion.

Total Payroll Generated

Construction:	\$512 M
Annual Operations:	\$51.44 M

Total Sales Tax Revenue

	Local	State	Total
Construction	\$29.39 M	\$78.36 M	\$107.75 M
Annual Operations	\$1.65 M	\$4.53 M	\$6.23 M

Total Jobs Created

	Primary	Secondary	Total
Construction	800	3,076	3,876
Annual Operations	290	1,904	2,194

"IN THE ANS WE HAVE A PROJECT THAT CAN BE JUSTIFIED ENTIRELY ON CLEAR, DELIVERABLE GOALS THAT ARE INEXTRICABLY COUPLED TO THE NATION'S TECHNOLOGY BASE AND INTERNATIONAL COMPETITIVENESS. AND AT THE SAME TIME, IT PROMISES TO KEEP THE UNITED STATES AT THE VERY FOREFRONT OF SCIENTIFIC AND ENGINEERING INNOVATION."

FRANK BATES, PROFESSOR OF CHEMICAL ENGINEERING AND MATERIALS SCIENCE AT THE UNIVERSITY OF MINNESOTA

APPENDICES:

- *Recent Applied Research Using Neutron Facilities*

- *ANS Steering Committee (April, 1993)*

- *Technical Specifications*

Recent Applied Research Using Neutron Facilities

3M Company	Polymers	European Space Agency	Rocket fuel quality control	Lockheed Missile and Space	Solid fuel blends
Allied Chemical	Polymer blends	EXXON	Radiography of rocket and satellite components	Monsanto	Plasticized polymers
Allied Signal	High-Tc superconductors Melt-spun metallic glasses		Micelles, microemulsions Polymer blends	Mound Laboratories	Polymers
American Dental Association	Alloys	Firestone Tire and Rubber	Aggregates in heavy oils Residual stress in materials Polyelectrolytes	National Institutes of Health	Vesicles
AMOCO	Catalysis			Naval Research Laboratory	Crystalline materials Lipids
AT&T Bell Laboratories	Magnetic materials Fluid mixtures High-Tc superconductors Porous materials	Food and Drug Administration		Nuclear Metals	Residual stress in materials
Bell Communications	High-Tc superconductors	Ford Motor Company		Philips	Magnetic recording media
BP	<i>In situ</i> catalyst temperatures	General Electric	Residual stress in materials jet engine turbine blades	Raychem Corporation	Polymers
Chevron Oil	Polymers	GTE Laboratories		Rolls Royce	Jet engine lubrication Jet turbine blade temperatures
Dow Chemical	Polymer processing	Goodyear Tire and Rubber		Schlumberger-Doll	Catalysis
E I duPont de Nemours	Catalysis Polymer fabrication High-Tc superconductors	Hercules, Inc.	Polymer latexes	Sid Richardson Oil Company	Carbon black
Eastman Kodak	Activation analysis Polymer latexes Polymer blends	IBM	Polymer intertaces, films, and melts Polymer blends Plasticized polymers	Smithsonian Institute	Ancient bronze sculptures Paintings
EG&G	Residual stress in materials	Imperial Chemical Industries	Catalysis	Standard Oil	Ceramic composites
				Unilever	Complex fluids under shear
				Union Carbide	Synthetic materials
				U.S. Army	Residual stress in materials Kinetic energy penetrators Artillery shells
				Xerox Corporation	Polymer blends

National Steering Committee for the Advanced Neutron Source

April 1993

CONDENSED MATTER PHYSICS

G. Aepli AT&T Bell Laboratories
R. J. Birgeneau Massachusetts Institute of Technology
C. S. Cargill IBM
H. A. Mook Oak Ridge National Laboratory
J. J. Rhyne Exxon

CHEMISTRY

R. L. Harlow DuPont
J. D. Jorgensen Argonne National Laboratory
E. W. Kaler University of Delaware
J. J. Rush NIST

BIOLOGY

S. H. White University of California (Irvine)
A. Wlodawer NCI

MATERIALS SCIENCE

A. N. Goland Brookhaven National Laboratory
R. A. Page SW Research Institute
R. Pynn Los Alamos National Laboratory

POLYMERS

T. P. Russell IBM
R. S. Stein University of Massachusetts

FUNDAMENTAL PHYSICS

G. L. Greene NIST
A Steyerl University of Rhode Island
R. Wilson Harvard University

NUCLEAR AND CHEMICAL ANALYSIS

R. F. Fleming University of Michigan
R. Lindstrom NIST

ISOTOPES

J. E. Bigelow Oak Ridge National Laboratory
G. J. Earhardt University of Missouri

MATERIALS IRRADIATION

L. K. Mansur Oak Ridge National Laboratory
G. R. Odette University of California (San Bernardino)

NEUTRON SOURCES

J. M. Carpenter Argonne National Laboratory
J. A. Lake Idaho National Engineering Laboratory
W. L. Whittemore General Atomics

MEMBERS AT LARGE

J. D. Axe Brookhaven National Laboratory
F. S. Bates University of Minnesota
R. M. Moon Oak Ridge National Laboratory

OFFICERS

Past Chairman J. J. Rush
Chairman F. S. Bates
Secretary R. M. Moon

Technical Specifications

Scientific and Production Capabilities

Reactor

Maximum thermal neutron flux	$7.5 \times 10^{19} \text{ m}^{-2} \cdot \text{s}^{-1}$	Type	Heavy-water cooled and reflected
Number of neutron beams		Fission power	330 MW
Hot	2	^{235}U uranium loading	17 kg
Thermal	9	Fuel form	U_3Si_2
Cold	16	Fuel enrichment, %	93
Very Cold	2	Fuel plates	Annular involute plates, aluminum clad
Number of neutron scattering stations	48	Coolant temperature	45°C (inlet)/85°C (outlet)
Number of irradiation facilities		Coolant pressure	3.2 MPa (inlet)/1.7 MPa (outlet)
Transuranium isotope production	30		
Other isotopes	8		

Research Support

Materials testing	11	Beam experiments will have two associated local areas (each about 10 square meters) for experiment setup space and a control station. There will be corresponding space in the office building for an average of five scientists and technicians per instrument.	
Number of materials analysis facilities	10	Approximately 6,000 square meters of laboratory and workshop space will be provided for experiment support in a building adjacent to the neutron guide hall.	
Gamma irradiation facilities	1		
Positron production facility	1		

A Joint Institute for Neutron Studies building (in association with the University of Tennessee) will provide classroom space, small conference rooms, and some on-site accommodations.

**DATE
FILMED**

10/29/93

END