

Report of the
Basic Energy Sciences Advisory Committee

Subpanel on Neutron Scattering

February 2000

U.S. Department of Energy
Office of Science

UNIVERSITY OF OREGON



10 March 2000

Dr. James Decker
Acting Director
Office of Science
U.S. Department of Energy
19901 Germantown Road
Germantown, Maryland 20874-1290

Dear Dr. Decker,

I would like to express my appreciation for your attendance and presentation at our Basic Energy Science Advisory Committee (BESAC) meeting last week. It is encouraging to see the proposed budget increases for the Office of Science and Basic Energy Sciences (BES). As a Committee we are committed to helping to make the proposed budget a reality.

At our meeting three Subpanel reports were presented addressing the recent charges given to us by former Director of Science, Martha Krebs. The three reports submitted by the Subpanels pertained to Neutron Scattering in light of the recent shutdown of the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL), a review of the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory (LBNL), and a review of the Electron Beam Microcharacterization Centers at Oak Ridge National Laboratory (ORNL), University of Illinois, Argonne National Laboratory (ANL), and LBNL. The purpose of this letter is to forward to you the reports of these Subpanels and the response of BESAC to these reports. Overall, the BESAC members are supportive of the recommendations of the Subpanels. We are appreciative of the tremendous amount of work that Panelists and BES staff contributed to these important planning and review exercises.

Neutron Scattering Research Capabilities

The purpose of this Subpanel, chaired by Dr. Martin Blume, was to recommend steps to provide the best possible neutron scattering research capabilities in the United States in the near term. Subpanel deliberations took into account the shutdown of the High Flux Beam Reactor at BNL and assumed that the Spallation Neutron Source at ORNL would be operational in a timely manner. The Subpanel was also asked to provide advice on how to properly accommodate the neutron scattering groups at BNL, conditional on their submitting satisfactory long-term plans for programs to be funded by BES.

Neutron scattering is a critical tool in the arsenal of experimental techniques for studying condensed matter systems. It will be particularly valuable for studies in nanotechnology and nanoscience. BESAC is committed to assuring that neutron scattering science in this country retains its world-class standing and to supporting facilities that allow scientists to conduct first-rate science in this area. BESAC commends the Subpanel for the high quality of the submitted report, recognizing the short time constraints imposed by the need to assure continuity in the field in light of the HFBR shutdown. BESAC supports the general recommendations of the report that is provided with this letter. However, with respect to the funding recommendations, first BESAC regards these numbers as estimates requiring detailed review. Several factors need to be considered before funding decisions are made, including determination of what costs are currently in the FY 2001 budget, the shutdown costs of HFBR, and the anticipated growth in the number of users over the next few years as the other neutron scattering facilities increase their operations. BESAC however felt strongly that any increase for the existing facilities should not come at the expense of core BES programs. The funding for research and instrumentation should be competitive with the core program.

Review of the Electron Beam Microcharacterization Centers

BESAC's charge was to help assess the scientific impact of the nation's need for the Electron Beam Microcharacterization Centers operated by BES. To this end a Subpanel of experts was assembled and chaired by Dr. John Stringer. The four centers considered were the Shared Research Equipment Program at ORNL, the Center for Microanalysis of Materials Research Laboratory at the University of Illinois Frederick Seitz Materials Research Laboratory, the Electron Microscopy Center for Materials Research at ANL, and the National Center for Electron Microscopy at Lawrence Berkeley National Laboratory. The Subpanel visited each of the four centers and met with members of their management, staff and user communities. The recommendations of this group are summarized in the enclosed report. The Subpanel's review was a monumental effort and BESAC expresses its appreciation for the efforts of the committee, the chair and the BES staff.

In general these facilities were found to operate well and produce excellent science. BESAC is supportive of the recommendations found in the report. The recommendations have been carefully derived and attention has been paid to the unique nature of different facilities. BESAC accepted the recommendations provided that any additional funds allocated to these centers as a result of the review be competitive with the core BES program.

Review of the Advanced Light Source

BESAC was charged in August 1999 with reviewing the Advanced Light Source (ALS) at LBNL. The purpose of the review was to examine those issues that were raised by the BESAC report on "DOE Synchrotron Radiation Sources and Science," known as the Birgeneau Report. In particular, BESAC was asked to explore ALS's vision for the future, the quality and diversity of the science program at the facility, the user demand, and the interaction and relationship with the user committee. The Subpanel charged with this study was chaired by Dr. Yves Petroff and consisted of expert scientists from a broad spectrum of scientific areas.

The Subpanel gave an enthusiastic review of the ALS. The response of the management of the ALS to criticism in the Birgeneau Report has led to a restructuring of LBNL .to.raise the ALS to the divisional level. The user hours have dramatically increased, and the user participation in the ALS decision making process has been welcomed-by the users. Most important is the high quality of the science being generated at the ALS. LBNL. Director Chuck Shank and ALS Director Daniel Chemla are commended for this impressive turn around. BESAC accepted the recommendations of the subpanel provided that any increase in funding to the ALS as a result of this positive review not come at the expense of the BES core program. Increases in funding for beamlines should be competitive with the core program.

Thank you again for attending our BESAC meeting and giving us your insights into the FY 2001 budget process.

Enclosures

Sincerely,

/s/ by

Geraldine L. Richmond
Chair
Basic Energy Sciences Advisory Committee

cc. Iran Thomas, Acting Director of Basic Energy Sciences
Patricia Dehmer, Acting Deputy Director of the Office of Science
Sharon Long, Basic Energy Sciences

Report of the
Basic Energy Sciences Advisory Committee
Subpanel on Neutron Scattering

Martin Blume (APS) (Chair)
Michael Rowe (NIST) (Vice-Chair)
Shenda Baker (Harvey Mudd College, on leave at U. Mass. Amherst)
Bruce Brown (IPNS, ANL)
Jack Crow (BESAC, FSU)
Yasuhiko Fujii (Tokyo University)
John Larese (BNL)
Charles Majkrzak (NIST)
Thomas Mason (SNS, ORNL)
Anne Mayes (BESAC; MIT; Treasurer, NSSA)
Cherry Murray (LUCENT)
Stephen Nagler (HFIR, ORNL)
Roger Pynn (Lujan Center, LANL)
James Rhyne (President NSSA; U Missouri)
James Roberto (ORNL)
John Tranquada (BNL)

February 28th 2000

Submitted on Behalf of the Subpanel:

/s/ by

Martin Blume, Chair

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1.0 Executive Summary

This subpanel was established by the Department of Energy's Basic Energy Sciences Advisory Committee (BESAC) in the aftermath of the announcement of the permanent closure of the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL), to recommend steps to provide as strong as possible a neutron scattering capability for United States (U. S.) researchers in the near term, i. e. in the next five years. The Spallation Neutron Source (SNS), now under construction at Oak Ridge National Laboratory (ORNL), will at that time be approaching operation, and a clearer view of the neutron scattering scene in the U. S. will be available. At some point in the near future it will be desirable to undertake a more detailed review of the longer term aspects of the U. S. neutron scattering effort and to make further recommendations to assure the best possible future for this vital experimental technique for U. S. researchers.

Several specific questions were asked of this subpanel, and the full charge containing these questions is shown in Appendix I. The membership of the subpanel, chosen to provide a broad knowledge of the capabilities, needs, and possibilities for the various facilities and for the scientific disciplines that utilize neutron scattering techniques, is listed in Appendix II. The timescale for this review and for the formulation of the recommendations was quite short. The first conference call of the subpanel took place on December 27, 1999, and this report was discussed at the full BESAC meeting on February 28-29, 2000. Two one-and-one-half day meetings were held in Gaithersburg, Maryland during the interval, and many emails were exchanged as well. A list of the meetings is shown in Appendix III.

The subpanel recommendations, found in section 5.0, constitute a program highlighted by a new Initiative for Neutron Science User Support designed to bring the neutron scattering effort in the U. S. through a difficult period with a significant financial investment that will pay significant dividends. It is important that a vigorous effort be made to regularize U. S. access to foreign sources, especially for the near term. However, when this program is fully in place, there will be important new capabilities available in the U. S., and establishment of strong user programs will enable those capabilities to be exploited properly. The ability to serve users effectively at Department of Energy (DOE) facilities will be more than doubled, even though we cannot replace the triple axis spectrometers lost with the shutdown of the HFBR.

Our recommendations require an increase in the annual neutron budget of \$19M once all proposals have been fully implemented, and onetime costs of \$3M. These estimates and the impact on the user capacity are based on benchmarking against staffing levels and user community size, and against other U. S. (NIST) and international neutron facilities. In addition there are several recommendations, including one for foreign participation by U. S. scientists, for which we cannot provide proper estimates at this time. We do expect that these additions will not be a large fraction of what has been proposed.

The subpanel believes that these proposals will lead to a much stronger situation in this critical area, and that a subsequent review several years from now will be able to address a much brighter future.

The recommendations are directed to DOE, as that is the organization to which BESAC provides advice. There are, however, several areas in which the Department of Commerce, which provides for operation of and research at the NIST reactor, and the National Science Foundation (NSF), which supports some of the user facilities at the National Institute of Standards and Technology (NIST), supports the research of many users, and is considering support for a second target station at the SNS, can contribute strongly to the effort to fill the gap left by the closure of the HFBR. In particular we call attention of those agencies to the recommendations in section 5.0 on user support at existing sources, on scientific research program support, and on the HFBR user program.

2.0 Introduction

As stated by an earlier BESAC review panel~ "Over the past 40 years, research-based neutron sources have been crucial to advances in fundamental science, technology, and medicine. Neutrons provide critical information that is impossible to acquire by any other means. For many purposes they provide a necessary complement to x-rays and the parallel development of both neutron sources and x-ray synchrotron sources is essential." It is this estimate of the importance of neutron scattering to science and technology that motivates us to propose a dramatic initiative for user support at the facilities available to us.

The state of neutron scattering facilities and operations in the U. S. is at present dismal compared to that in Europe and Japan. Indeed, the situation has worsened beyond that envisioned by the Birgeneau panel in 1996. The result is a serious shortfall in neutron scattering capability that is particularly acute for steady-state (reactor) facilities. Steady state sources are complementary to pulsed sources (e.g., SNS) for many applications, and both are essential for a competitive neutron science program.

The closure of the HFBR has produced a serious loss of capabilities for the U. S. neutron scattering community. This report makes a series of recommendations that will in part fill the gap and increase the availability and flexibility of user support at existing sources. We emphasize, however, that there is no completely satisfactory solution to the problems created by the loss of the HFBR capabilities. Our recommendations must strike a balance between and set priorities for otherwise desirable efforts that will not compromise our ability to finish what has already been undertaken. We have also to keep in mind that we are looking at short-term solutions in making our proposals.

The direct benefits that will accrue from implementation of the recommendations in this report include:

- A mechanism for continuing the outstanding science program in place among the HFBR user community, albeit not at full efficiency.

A solution to provide continued support for the U. S. - Japan agreement including moving of the spectrometer built under this agreement to the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL).

Increased support for the timely completion of the ongoing upgrades at HFIR.

- A pathway to increase by about a factor of two the number of users that can be accommodated at HFIR, the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory, and the Lujan Center at Los Alamos National Laboratory, by implementation of the Initiative for Neutron Science User Support.

The Spallation Neutron Source will, when operational, be a world leader in neutron science, and a focal point of neutron scattering in the U. S. More than an order of magnitude gain in intensity over existing pulsed neutron sources, combined with an innovative and robust initial instrument suite, will provide entirely new possibilities for forefront research, and will re-establish this country as a leader in neutron scattering. It is the highest priority for the neutron community, and our recommendations will help to assure a vibrant scientific effort in neutron scattering when it goes into operation. The recommendations will also help to ensure that the community has access to the highest quality steady state (reactor) sources and instrumentation in the United States and, if possible, abroad. This is essential to provide for a balanced program for the future. In order to meet the schedule that calls for operation of the SNS in 2006 that project requires active participation of neutron scattering experts in the U. S. and abroad. Our recommendations take this requirement into account.

The preamble to the charge to the subpanel asks that its recommendations "should also provide a proper arrangement for the neutron scattering groups at Brookhaven to pursue forefront research programs". The subpanel observed that the research programs in neutron science at Brookhaven are of the highest quality and have made important contributions to science. The recommendations give strong support to the continuation of these programs, with emphasis not only on the Brookhaven research but also on the research of university and laboratory scientists who had programs at the HFBR.

The U. S.-Japan Cooperative Research program on neutron scattering between DOE and MONBUSHO (the Japanese Ministry of Education) has been based at the HFBR and HFIR. Begun in 1981, this collaboration has produced very high quality research in condensed matter science. In 1997, an International Review Committee examined this program, which was viewed to be mutually beneficial to both countries, and strongly recommended its continuation. The loss of HFBR necessitates a new plan for its continuation, as the DOE has a contractual obligation to provide acceptable facilities to replace the capabilities which were established at the HFBR. We make a recommendation below for the continuation of this program.

3.0 Background

There are now four significant neutron scattering facilities in the U. S. and a fifth, the Spallation Neutron Source, is being designed and built. These are listed below, with some remarks on their plans and prospects for the next few years.

The NIST Reactor at the National Institute of Standards and Technology:

This reactor, operated by the Department of Commerce, has a full complement of instruments, either existing or under active development, with little possibility for additional expansion. This reactor has operated reliably over the past several years, and has been the workhorse of the U. S. neutron scattering program during that time. The present user program is of high quality, although more staff is needed for optimal service to users as more instruments are added to the program. The reactor has a cold source and guide hall. In all there are 16 neutron scattering instruments at the NIST reactor, along with a large number of other facilities. Several of these instruments would benefit from upgrades, and most of these upgrades are now under way. The NIST reactor is well maintained and operates at high efficiency. There will be a several month shutdown in about one year to upgrade the cold source, effectively doubling the available flux, but limiting for a time the availability of sources here in the U. S.

The High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL):

HFIR was, as its name implies, designed primarily to produce neutron rich isotopes, such as those of the transuranic elements. Four large beam ports were, however, included in its design to provide neutron scattering capabilities. In the past five years HFIR has operated at 80% of its scheduled time, with two years during which it operated for about two-thirds of the scheduled time. Most recently, it has operated with high reliability. HFIR is the nation's highest flux reactor, and there is a program of upgrades to improve and assure reliability for the future. Also underway is a needed replacement of the reactor's beryllium reflector (required about every ten years), and installation of a high quality cold source, with a guide hall and attendant instrumentation. The reactor and experimental program will, in order to complete these projects, be shut down for about one year beginning in September 2000, thus limiting still further the available time for users in the U. S. When these upgrades are completed HFIR will join the NIST reactor as a major facility on the world scene, and become an essential component of the U. S. neutron scattering capability. In order to properly utilize this new capacity, it is important for more resources to be dedicated to operation as a full user facility.

The Manuel Lujan Jr. Neutron Scattering Center (Lujan Center) at the Los Alamos Neutron Scattering Center (LANSCE):

In its most recent years of operation (1996 and 1997), the Lujan Center saw more predictable beam delivery as a result of a reliability upgrade funded by the Department of Defense. Two currently funded upgrades to the accelerator (funded by DOE's Office of Defense Programs) and the neutron scattering instruments (funded by the DOE's Office of Science) are underway. The Lujan Center has not operated for the past 12 months, however, because it has been correcting safety and operational deficiencies. It is expected to begin operation again in the next month, but it lacks the operating funds to include more than 4 of its 7 neutron scattering instruments in a user program. Three new spectrometers are expected to begin their commissioning towards the end of the currently planned run cycle (which will terminate in October 2000). An additional 2 spectrometers will begin construction this summer but are not expected to be available to users for at

least two years. The facility will require additional operating funds to ensure that these instruments can be made available to the national user community. The facility has the potential to rival the British ISIS spallation source, currently the best in the world. A major effort on the part of Los Alamos National Laboratory will be necessary to have the Lujan Center reach its potential. While the Lujan Center has several unoccupied beamlines, none provides a reasonable "home" for HFBR spectrometers.

The Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory:

IPNS is a relatively small spallation source which has an admirable record for operational reliability, instrument development, and scientific achievement. The IPNS staff are leading the instrument development program for the SNS, and have recently taken on major responsibilities for the second target station, in the event this is funded by the NSF. The facility has supported the largest number of users of any DOE neutron source for the past several years, and has produced a constant stream of high quality publications. While it cannot replace the lost capabilities of the HFBR in inelastic scattering, it can provide substantial additional capabilities for the community with modest investments in source and instrument improvements. In the area of structural studies it is capable of supporting scientific research that is competitive on the world scene. It has not been adequately funded for operating time, facility maintenance, or user support in the past, and increased funding can quickly provide increased capabilities for neutron scattering.

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL):

The SNS now under construction at ORNL will be, as noted in the Introduction, the world leader in spallation neutron science, and the focal point of neutron scattering in the U. S. It will provide entirely new possibilities for forefront research, and will re-establish this country as the leader in neutron scattering. It is, and must remain, the highest U. S. priority for funding in neutron science. In order to meet the aggressive schedule, which calls for operation in 2006, the project will have to recruit heavily among the neutron scattering experts in the country, putting serious pressure on available manpower. Since this is the highest national priority, it is essential that other projects do not detract from this effort.

It is important too to put on the record the plight of the user community in the past several years. In the absence of the capabilities of the HFBR users moved their research efforts to the facilities listed above, and in addition made as heavy use of international facilities as was permitted by those laboratories. The international facilities used included the reactor at the Institute Laue-Langevin in Grenoble, France; the ISIS spallation source at the Rutherford-Appleton Laboratory in Chilton, England, the reactor at the Riso National Laboratory in Denmark, the reactor at the Hahn-Meitner Institute in Berlin, the JRR-3M reactor at Tokai, Japan, and the SINQ spallation source near Zurich, Switzerland. There are limitations on use of some of these facilities by non-contributors to their operating costs, in particular by U. S. researchers, but U. S. users were in fact accommodated to some degree at all of them. There have been other problems besides the unavailability of operating time and user support in the U. S., Because the facilities are being upgraded the budgets for neutron scattering went increasingly to the facilities and

less and less to support user programs. This is unfortunate, but is a fact of life - the needs of the facilities of necessity have taken precedence over any other requirements. In setting priorities for the next few years it is necessary to take this into account and to redress it to some degree if we are to deliver, at the time of operation of the SNS, a strong user community ready to take advantage of the facilities put before them.

4.0 Discussion

It is clear to the subpanel that it will not be possible to replace in the short term the lost capacity of the HFBR by moving instruments to existing sources. The two high performance reactor sources, HFIR at ORNL and the NCNR at NIST do not have suitable unassigned ports available. Other research reactors in the U. S., including university research reactors, are also not suitable for our purposes for a variety of reasons, including low source thermal flux and lack of infrastructure, which preclude their use for a worldclass neutron scattering effort. It would not be possible to use any of these sources by upgrading them to have them ready for use on the time scale of our charge. Thus, the Committee has no recommendations relating to moving the instrumentation at the HFBR, with the exception of the instrument that is part of the U. S.-Japan collaboration. For this instrument only, we do give a recommendation below. Brookhaven should, however, make efforts to ensure the continuation of a strong neutron scattering program, for the benefit of the entire scientific community.

We have also examined other options for recovering the lost capacity of the HFBR, including construction of a new thermal neutron guide hall at the HFIR. We have concluded that it would not be possible to have this facility ready on a time scale adequate to be effective for U. S. users in the near future. Especially, given the importance of our other recommendations and the resources necessary to carry them out, we do not recommend proceeding with this project at this time. A thermal guide hall could provide important additional thermal neutron capability in the long term, and it should be reconsidered in the future in the context of other ongoing projects, including the SNS. In the interim Oak Ridge should assure that the current upgrades preserve the option of the thermal guide hall for the future.

We have concluded that much of the capacity lost by the HFBR shutdown is in fact truly lost - it cannot be replaced in the short term by any feasible actions. Of course when the SNS comes on line powerful new capability will be available for neutron based research, but this will not completely substitute for the lost reactor based capabilities. In the meantime the past users of the HFBR will have to compete for available resources, and we have recommendations to improve efficiency of utilization. We also conclude that the existing research programs at Brookhaven National Laboratory are critically important, and should be sustained. This will require arrangements for access at other sources, including those abroad.

It is apparent that existing facilities are not being exploited in an optimal fashion. All~ facilities studied have reported inadequate user support, as have all users of the facilities. The new cold neutron capabilities being built at the HFIR will not achieve their full potential unless adequate operating funds are available to fully staff the user operations.

Similarly IPNS has had continuing problems in finding full operation, including accelerator spares, user support, and facility maintenance. The Lujan Center is now developing new instruments, but has inadequate support to operate all present instruments in full user mode. NIST operates a full user program on some of its instruments, but will not be able to properly operate the rest of the instruments now being commissioned at anything like full efficiency without additional operating funds. This subpanel believes that there is no more important or cost-effective way to improve service to U. S. users in the short term than to properly fund ongoing operation of the existing, upgraded sources.

5.0 Recommendations

The basis for these recommendations, then, is the observation that what is most needed for the U. S. neutron scattering program at present is reliable and well supported access for users to the available facilities, and increased support for the research programs of those users. There are many new instruments and capabilities under construction at present, and we have noted above that there will be shutdowns of NIST and HFIR in the near future that will make still less access possible. We have therefore focused our recommendations on prompt completion of these upgrades, with only minimal additions to them that will have a quick and low-cost payoff. We also recognize the shortage of expert manpower, given requirements for SNS, and have crafted the recommendations accordingly. We recognize that we cannot replace the HFBR capabilities in the short term, and, in response to the needs of the user community, have recommended seeking access to facilities abroad during this period.

We provide in the recommendations below a key to the questions asked in the Charge to the subpanel to which the recommendations are responding. Given the short time allowed to the subpanel for this report to be completed the cost estimates for the individual recommendations are of necessity crude, and will need to be reexamined in more detail later.

• **The HFBR User Community** (*1. What assets of the HFBR should be moved to other neutron scattering facilities in the U. S. .?)*

The HFBR user community faces special challenges, as there are no immediate opportunities to relocate instruments from the HFBR to comparable facilities within the U. S. The Solid State Physics and Materials Chemistry neutron scattering programs at Brookhaven National Laboratory are of the highest quality, and have made important contributions to U. S. science. The best opportunity within the U. S. for maintaining the health of these activities and exploiting expertise at BNL is for HFBR scientists and interested users to participate in Participating Research Teams (PRTs) for already planned instruments or potential upgrades. In particular, BNL scientists have active interests in several PRTs: HERMES (a crystal backscattering spectrometer) at the Lujan Center, the cold-neutron triple-axis spectrometer at HFIR, and a potential instrument upgrade at NCNR. Opportunities for PRT-type access to world-class facilities outside of the U. S. should also be explored. With adequate support, Brookhaven can provide scientific, design, and engineering talent, as well as instrument scientists and technical support for users. Equipment from the HFBR, including sample environments such as cryostats, furnaces and magnets, will be used to support these efforts to the greatest

extent possible. Beyond these needs, BNL should seek the best opportunities for relocating equipment (especially complete spectrometers) for maximum benefit to U. S. programs. A complete catalog of available excess equipment should be prepared by the Brookhaven staff.

We recommend that BNL be funded to allow active participation in Participating Research Teams at the Lujan Center, HFIR, and NCNR, as well as at sources outside of the U. S. (Estimated cost \$3M/year above existing support; International costs to be determined).

We further recommend that the excess equipment at the HFBR should be made available to other U. S. programs, wherever located, in the following order: first, complete instruments where possible; second major assemblies not part of usable complete instruments; third, individual components. (Estimated cost to be determined.)

· The U. S./Japan Cooperative Program (2. *What should be the future of the Japanese collaboration with HFBR.?*)

The DOE has an obligation under the U. S. - Japan cooperative agreement to consult with the Japanese side and to make a strong effort to relocate the H4 main spectrometer at the HFBR. The Japanese representative on the subpanel (Y. Fujii) has agreed that a cold neutron triple axis spectrometer at HFIR, based upon the relocated components of the H4 main instrument at BNL, is acceptable to Japan.

We recommend that the proposal for a second cold neutron triple axis spectrometer at the HFIR cold guide hall be accommodated as agreed upon. This spectrometer would meet U. S. obligations to the U. S./Japan Cooperative Project, and would provide important new capabilities for neutron scattering. (Estimated one-time cost \$1M).

· User Support at Existing Sources and Scientific Research Program Support

(4. Should new instruments and upgrades be considered? If so, what kind and where? If more beam time could be made available, which is more important to the community- more instruments or more time.?)

In the next 2-5 years, current instrument design and construction with existing upgrades to facilities will bring on-line about 10 new instruments, 5 at the Lujan Center and 4-7 at HFIR. In addition, more than 10 new instruments are being designed for SNS. These projects require a large effort of sophisticated manpower. The addition of new instruments, beyond those already planned, is not a short-term solution to the problems caused by the HFBR closure as there are no places to install them. Completion of the suite of already planned instruments and associated upgrades is of primary importance and will provide much needed capacity for the national user community.

Consequently, at this time increasing the beam time available to users and support for their research programs are the more important considerations. This can be achieved both by operating facilities longer if possible and also by assuring that the user programs at the facilities are adequately staffed. It is very important for the neutron community that the user program at each facility provide scientists, technicians and instrument maintenance to assure effective use of instruments and beam time.

In particular, IPNS has source capability to operate a user program for 30 weeks per year, but is currently limited solely by staffing considerations to a 26 week user program. The Lujan Center currently has 7 operable instruments that could contribute to their user program. However, lack of adequate staff has kept 3 of these 7 instruments unavailable to the greater community of scientists performing neutron research. HFIR will see a dramatic change in its mode of operation from a facility in which experiments involving scientists outside of ORNL were performed predominantly in a collaborative mode, to an open proposal-based user program. Current plans already call for enhanced staffing to develop a strong user program to match instrument and source upgrades at HFIR. To ensure that HFIR evolves to a world-class user facility, these staffing increases must take high priority.

The subpanel recommends that added financial and technical support for the IPNS user program be provided to allow for thirty weeks of user operations. At the Lujan Center and HFIR current levels of staffing should be raised to provide adequate user support for current instruments, and increased staff support must go hand-in-hand with the coming on line of new instruments to ensure maximum benefit from all instruments to the broader user community.

As a base of comparison, the NIST reactor facility is currently viewed by the neutron user community as the domestic facility that offers the most adequate support for the instruments currently in its user program. While needed instrument technical support will clearly vary from instrument to instrument, the average level of manpower required for sufficient user support for a single instrument, according to this metric, is at least 3.5 individuals, including technicians, engineers, software support staff and instrument scientists.

Finally support for user research, as noted in the introduction, has decreased both for programs at National Laboratories and at Universities, in order to take care of the needs of the facilities. It is essential to move towards redressing this imbalance.

We recommend that DOE begin an Initiative for Neutron Science User Support to increase the funding to existing and future sources to adequately operate neutron scattering facilities for the national user community. Staffing should be supported at a realistic level based upon national and international practice. (Estimated cost at DOE facilities \$10M/year.)

We recommend as part of the Initiative that annual DOE funding for university and laboratory user research programs be increased. (Estimated annual cost \$2-4M.)

We recommend that IPNS submit a proposal for increased operating time. DOE should consider this proposal in terms of its contribution to former HFBR users and to future SNS users. (Estimated cost \$2M/yr, in addition to staffing increases included above.)

APPENDIX 1 - Charge to BESAC

**Department of Energy
Washington, DC 20585**

November 17, 1999

Dr. Geraldine L. Richmond, Chair
Department of Chemistry
University of Oregon
Eugene, Oregon 97403-1253

Dear Geri:

As you know, on November 16th, Secretary Richardson announced his decision to permanently close the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory. The Basic Energy Sciences Advisory Committee (BESAC) under your leadership and that of your predecessors has provided sound technical advice and thoughtful analysis to the Department on the HFBR for many years and particularly during the past three years when the HFBR has been in standby mode. I want to express my gratitude for these efforts. I especially want to thank you for your personal commitment to this effort and for the role that you played in providing a balanced perspective to the Secretary on HFBR as part of the Basic Energy Sciences portfolio.

Following the Secretary's decision, I have reviewed all of the BESAC reports on the HFBR produced since 1996, and I was reminded of the fifth recommendation made by BESAC following its meeting on July 30-August 1, 1997 -- a meeting that was devoted solely to the role that the HFBR played in the Nation's neutron scattering enterprise. That recommendation reads, in part, "... we [BESAC] request that, should a decision be taken not to restart HFBR under the conditions outlined above, we have the opportunity to review the implications for the whole field of neutron-based research in the United States once again." I agreed to this recommendation, which I believed to be both necessary and prudent.

Therefore, I am now requesting that BESAC assess the consequences of the shutdown of the HFBR. I would like BESAC to advise the Office of Science on how best to use the neutron scattering resources available to the Nation's researchers and what, if any, changes should be made in the BES plans for the facilities that it stewards -- IPNS, the Lujan Center at LANSCE, HFIR, and SNS. I would like this report to be presented to BESAC and acted on at the time of your February 2000 meeting.

With Very Best Regards,

/s/ by

Martha A. Krebs
Director
Office of Science

APPENDIX 2 - Charge to the Subpanel

UNIVERSITY OF OREGON

December 1, 1999

Dr. Martin Blume
Editor-in-Chief
American Physical Society
Editorial Office
One Research Road
Box 1000
RidgeNY 11961

Dear Dr. Blume:

The Basic Energy Sciences Advisory Committee (BESAC) has been asked by Dr. Martha Krebs, Director, Office of Science, to assess the consequences of the shutdown of the High Flux Beam Reactor. She would like BESAC to advise the Office of Science on how best to use the neutron scattering resources available to the Nation's researchers and what, if any, changes should be made in the BES plans for the neutron facilities that it stewards. I am very grateful that you have agreed to chair this panel.

The purpose of this panel is to recommend steps to provide the best possible neutron scattering research capabilities in the United States in the near term. Panel deliberations should take into account the shutdown of the High Flux Beam Reactor at Brookhaven, and should assume that the Spallation Neutron Source at Oak Ridge will be completed and operational in a timely fashion. These steps should also provide a proper arrangement for the neutron scattering groups at Brookhaven to pursue forefront research programs, conditioned on their submitting a satisfactory long-term plan for these programs to the Department of Energy.

The following questions should be addressed:

1. What assets of the HFBR should be moved to other neutron scattering facilities in the U.S.? Include instruments, shielding, neutron guides, and other assets associated with HFBR that might be valuable to other neutron facilities. Which instruments would be most appropriate to be under the purview of and operated by BNL staff?
2. What should be the future of the Japanese collaboration with HFBR?
3. How does the permanent shutdown of HFBR affect the planned upgrades at HFIR?
4. Should new instruments and other upgrades be considered? If so, what kind and where? If more beam time can be made available, which is more important to the community -- more instruments or more time?

I anticipate that you will want to assemble a panel, which will help in your deliberations. Dr. Patricia Dehmer, Dr. Iran Thomas and I each will provide you with names of suggested panel members. You should make the final selection, and you should feel free to add other names to the list of suggested names.

I am hopeful that the review can take place within the next few months and that your panel is able to present a final report to BESAC at its next meeting, which is scheduled for February 2000. You are invited to the February meeting to make the presentation of the panel's findings and recommendations. Alternatively, if you cannot attend the meeting, I ask that you designate a member of the panel to make the presentation.

Logistics for the meeting will be handled by Sharon Long of DOE's Office of Basic Energy Sciences. She can be reached at (301) 903-5565 or sharon.long@science.doe.gov. Travel expenses for you and non-Federal panel members will be reimbursed by [3OE. Reimbursement for Federally employed panel members, including DOE laboratory staff, will be handled through their respective offices.

Sincerely,

/s/

Geraldine L. Richmond
Chair, Basic Energy Sciences Advisory Committee

cc. Patricia Dehmer, Associate Director, BES
Iran Thomas, Deputy Associate Director, BES

APPENDIX 3 - Subpanel Membership

Martin Blume (Chair) American Physical Society Editorial Office One Research Road Box 1000 Ridge, NY 11961 (631) 591 -4036

Shenda M. Baker Polymer Science and Engineering Conte Polymer Research Center 120 Governors Drive University of Massachusetts Amherst, MA 01003 (413) 577-1535 (413) 577-1510 (Fax)

Bruce Brown Argonne National Laboratory Intense Pulsed Neutron Source 9700 South Cass Avenue Argonne, IL 60439-4814 (630) 252-4999

Jack E. Crow Director, National High Magnetic Field Laboratory Florida State University 1800 E. Paul Dirac Drive Tallahassee, FL 32306-4005 (850) 644-0851

Yasuhiko Fujii Chair of Neutron Scattering Laboratory Institute for Solid State Physics The University of Tokyo 106-1 Shirakata, Tokai Ibaraki 319-1106, Japan +81-29-287-8901 (Tokai Headquarters)
+81-29-283-3922 (Fax)

John Larese Brookhaven National Laboratory Building 555A P. O. Box 5000 Upton, NY 11973-5000 (631) 344-4349

Charles Majkrzak NIST - Center for Neutron Research (856) Reactor Building 235, Room E128 100 Bureau Drive, Stop 8562 Gaithersburg, MD 20899-8562 (301) 975-5251

Thomas Mason Oak Ridge National Laboratory P. O. Box 2008 Oak Ridge, TN 37831 (423) 241-1499

Anne M. Mayes Associate Professor of Polymer Physics Massachusetts Institute of Technology MS13-5066 Cambridge, MA 02139 (617) 253-3318

Cherry Murray Bell Labs/Lucent Technologies 700 Mountain Avenue, Room 1 D269 Murray Hill, NJ 07974 (908) 582-5849

Stephen Nagler Oak Ridge National Laboratory P. O. Box 2008 Oak Ridge, TN 37831 (865) 574-5240

Roger Pynn Los Alamos Neutron Science Center (LANSCE) Los Alamos National Laboratory P. O. Box 1663 Los Alamos, NM 87545 (505) 667-5051

James Rhyne University of Missouri Physics Department Building 223 Columbia, MO 65211 (573) 882-6506

James Roberto Oak Ridge National Laboratory P. O. Box 2008 Oak Ridge, TN 37831 (423) 576-0227

Michael Rowe NIST Center for Neutron Research (856) Reactor Building (235) Room A104 100 Bureau Drive, Stop 8560 Gaithersburg, MD 20899-8560 (301) 975-6229

John Tranquada Brookhaven National Laboratory Building 510B p. O. Box 5000 Upton, NY 11973-5000 (631) 344-7547

APPENDIX 4 - Activities of the Subpanel

Conference Call - December 22, 1999

Subpanel Meeting, Gaithersburg, MD - January 5-6, 2000

Subpanel Meeting, Gaithersburg, MD - February 14-15, 2000

Subpanel Report to BESAC, Gaithersburg, MD - February 28, 2000