REPORT

Of the

UNIVERSITY RESEARCH REACTOR TASK FORCE

To the

DEPARTMENT OF ENERGY

NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE

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REPORT SUMMARY

Introduction

In mid-February, 2001 The University Research Reactor (URR) Task Force (TF), a sub-group of the Department of Energy (DOE) Nuclear Energy Research Advisory Committee (NERAC), was asked to:

- Analyze information collected by DOE, the NERAC "Blue Ribbon Panel," universities, and other sources pertaining to university reactors including their research and training capabilities, costs to operate, and operating data, and

- Provide DOE with clear, near-term recommendations as to actions that should be taken by the Federal Government and a long-term strategy to assure the continued operation of vital university reactor facilities in the United States.

The Task Force was asked to provide their report to the NERAC at their next meeting on April 30, 2001. The members of NERAC appointed to the Task Force were:

Robert L. Long, Ph.D., Retired nuclear utility executive (Chair)
Jose Luis M. Cortez, Ph.D., Energy and Materials Research & Technology consultant
Allen L. Sessoms, Ph.D., Professor, JFK School of Government, Harvard Univ.

Near Term Closings Of University Research Reactors

Based on information provided by the reactor staffs and the Task Force visits to the three universities considering very near-term closing of their research reactors, the Task Force has made the following recommendation:

> DOE should immediately allocate $250,000 each (total $750,000) for the current year, FY01, to ensure continued operation of the Cornell University, Massachusetts Institute of Technology and University of Michigan Research Reactors.

Long Term Strategies For Continued University Reactor Operation

A number of reports over the past 15 years have documented concerns regarding the long-term viability of continued university reactor operation. The most detailed, a 1988 Report of the National Research Council, "University Research Reactors in the United States – their Role and Value", is as valid in 2001 as it was in 1988. The concerns may be summarized as follows.

University research and training reactors are underutilized and, as a result are being decommissioned. The reason for the lack of utilization is shown to be a chronic inability to generate sufficient funds to procure and maintain state-of-the-art instrumentation for prospective users. These reactors support an amazing array of nuclear science/engineering education and research. The base financial support for both reactor operations and the technical support staff needed to interface with users is necessary if these facilities are not to be irretrievably lost from the educational infrastructure of the United States.

Thus, in very abbreviated form, the Task Force has recommended the following:

- The DOE and OMB should adjust their FY02 budget request to the U.S. Congress to include the funding recommended by the NERAC Blue Ribbon Panel and authorized by Senate Bill S.242.
- The DOE Office of Nuclear Energy, Science and Technology University Support Programs should be continued and enhanced as recommended in other NERAC reports.
- The DOE should provide funding beginning in FY02 to initiate establishment of five geographically distributed regional URR user facilities.
- The DOE should provide funding beginning in FY02 to initiate establishment of up to four geographically distributed regional university training and education reactor user facilities.
- The user facility concepts described in the preceding two recommendations should themselves be subject to peer-review by the university reactors operations and user communities. Thus, before the end of FY01, DOE should convene and sponsor participation in a 2-3 day Workshop on Long-Term Strategies for Continued University Reactor Operations.

Conclusion

The need for federal government support for a nuclear engineering, science and technology infrastructure in U.S. educational institutions has been well documented over the past decade or two. The URR Task Force believes it is vital for DOE to act now on the recommendations of (1) the NERAC Blue Ribbon Panel on the Future of University Nuclear Engineering Programs and University Research & Training Reactors, (2) the National Organization of Test, Research and Training Reactors, (3) the Nuclear Engineering Department Heads Organization and (4) this Task Force. Only determined and committed leadership at the highest levels of DOE and the U.S. Congress will assure the continued operation of vital university reactors in the United States.

REPORT OF THE UNIVERSITY RESEARCH REACTOR TASK FORCE

INTRODUCTION

The University Research Reactor (URR) Task Force (TF), a sub-group of the Department of Energy Nuclear Energy Research Advisory Committee (NERAC), was asked to:

- Analyze information collected by DOE, the NERAC "Blue Ribbon Panel," universities, and other sources pertaining to university reactors including their research and training capabilities, costs to operate, and operating data, and

- Provide DOE with clear, near-term recommendations as to actions that should be taken by the Federal Government and a long-term strategy to assure the continued operation of vital university reactor facilities in the United States.

Appendix A describes the process used by the Task Force to gather and review information. The documents referenced in Appendix A, particularly the 1988 Report of the National Research Council, "University Research Reactors In The United States – their Role And Value", clearly establish the importance of university research reactors to maintain a national capability in nuclear engineering and nuclear and neutron science and technology.

Taking this importance as a given, this URR TF Report presents the Task Force findings and recommendations.

NEAR TERM CLOSINGS OF UNIVERSITY RESEARCH REACTORS

Summary Of Findings and Supporting Information

As documented in the recent NERAC Blue Ribbon Panel Report and letters from the Chairs of the National Organization of Test, Research and Training Reactors (TRTR) and the Nuclear Engineering Department Heads Organization (NEDHO) to NERAC Chair J. Duderstadt, the university nuclear engineering and training and test reactor communities are greatly concerned about the possible closings of the Cornell University, Massachusetts Institute of Technology and University of Michigan Research Reactors. From the Task Force on-site visits and documents provided by the staffs of these three university reactors the Task Force findings, along with supporting information, are as follows.

Cornell University

Summary. The Task Force found that the TRIGA Reactor and associated facilities of the Cornell University Ward Laboratory were in excellent condition and were being used by a diverse set of faculty and students for research and education. There are a number of long-time industrial paying customers making use of the Center. There are a small number of other universities using the Center and a growing list of collaborative research efforts with national laboratories. The Director of the Ward Center is seeking to expand the use of the Cornell Reactor by other educational institutions.

While the current activities and plans appear to be very consistent with the 1996 Plan for the Ward Center, there is still some uncertainty about whether the Cornell Administration will support continued operation of the Reactor.

Supporting Information. The "Ward Center for Nuclear Sciences Report", dated September 2000, was prepared by the Ward Center Director, who reports to the Vice Provost for Research. The TRIGA Mark II Research Reactor (500 KWt) and the Cobalt-60 Gamma Cell that are the primary research tools at the Ward Center are described. Details of the research programs carried out at the Center and a 3-year expense and income history are given. Over the 3-years, the Center's operating budget has remained around $500,000 per year with the University appropriation at $200,000 per year. The remainder has come from external users fees ($240,000 in 2000-2001) and other non-university funds.

The Ward Center provides semester long laboratory experiments for graduate and undergraduate students in engineering, physics, art, archeology and geology. Students from area high schools and universities visit and use the Center facilities.

The Ward Center was used for research activities in FY 99/00 by 17 Cornell faculty members from 12 different departments and 4 different colleges. About a dozen corporations from across the United States use the Center for a variety of research, testing and development activities. The primary users are corporations based in upstate New York.

The Center's federal funding has grown from $3,000 in 97/98 to $623,000 in 00/01 with three proposals outstanding that could bring the 00/01 total funding to $971,000.

To quote from the Ward Center Report:

“The Cornell TRIGA reactor is the only operating university research reactor in the State of New York. The Cornell TRIGA is used as a source of radiation for numerous nuclear analytical and testing facilities. These facilities include: Neutron Activation Analysis, Fast Neutron Irradiation, Neutron Radiography, Neutron Induced Auto-Radiography, Cold Neutron Source, Prompt Gamma Activation Analysis (near completion), and Neutron Depth Profiling (near completion). In addition the development of a Boron Neutron Capture Therapy facility and a Neutron Powder Diffractometer facility are planned. Recently we completed a new neutron activation analysis laboratory with NSF funds for the analysis of dendrochronologically dated tree rings for the identification of volcanically-influenced periods of environmental change.”

The development of activities and programs at the Ward Center are consistent with “A Plan for the Future Operations of Ward Laboratory, Cornell University”, dated February 20, 1996, and prepared by the Ward Laboratory Advisory Board. The Task Force found that the facility and associated instrumentation were in excellent condition. The faculty and students interviewed were enthusiastic about the support provided to their research activities by the Ward Center staff.

As part of the on going evaluation by the Cornell Administration, the Cornell University Faculty Senate voted on March 14, 2001, 36 to 19 in favor of continued operation of the Cornell Research Reactor. However, the Task Force found the Vice Provost for Research adamantly opposed to the continued operation of the Reactor. The belief was that, unless the Reactor was contributing to the advancement of nuclear (fission and/or fusion) power, its continued operation could not be justified. Further, the Vice Provost stated that Cornell had eliminated their Nuclear Engineering Department and had no plans to hire new faculty with nuclear power interests and expertise. There appeared to be very little recognition of value-added by the multi-disciplinary neutron science based research activities and the variety of industrial services being provided by the Ward Center to these users.

Subsequent to the Task Force visit, correspondence from Cornell indicates that the Provost and President may be receptive to recommendations from over 100 Cornell faculty members (as well as many alumni) to delay any decision on closing of the Ward Center Reactor for at least 3 years.

Massachusetts Institute of Technology

Summary. The Task Force found the MITR-II and associated facilities in good condition, but significantly underutilized. If the NRL reactor staff was augmented to provide strong technical support to potential users, and capital funds were made available to bring research capabilities up to "state-of-the art", there exists a great potential for the Reactor to support a broad range of new nuclear and neutron science applications.

While clearly believing the focus at MITR-II should be on the advancement of fission and fusion nuclear power, the MIT Administration would be supportive of establishing MITR-II as a DOE sponsored regional user facility.

Supporting Information. The MIT Research Reactor (MITR-II) is a 5 MWt tank-type reactor designed by MIT. An MIT published pamphlet provides details about the design and research capabilities, including a total of more than 40 ports (horizontal and vertical) and vertical thimbles into the reactor core that can be used for neutron exposures and beam experiments.

Data provided to the Task Force show a 2000-2001 operating budget of about $2.9M with about $1.7M offset by income from research and industrial services. Thus the net cost to MIT appears to be about $1.2M per year.

During the Task Force visit to MIT, the Nuclear Engineering Department (NED) Chair and the Director of the Nuclear Reactor Laboratory (NRL) made presentations and provided various documents describing the research and teaching activities conducted at MITR-II. The NED Strategic Plan prepared about 3.5 years ago noted that NED use of the Reactor was greatly reduced. However, in 2000-2001 there are significant changes, including:

- Fission research has established a comeback through NERI and NEER type research grants
- There are now new fission related reactor projects on the drawing board
- A new faculty member has been hired in the Nuclear Engineering Department-Radiation Science & Technology (RST) program. He is a potentially large user of the Reactor
- Three other RST members have new projects on the Reactor
- NED is developing a proposal for a new fusion research project focusing on radiation in materials

- NED is revamping the undergraduate and graduate curriculum with a much stronger emphasis on hands-on learning, for which the Reactor is crucial.

The Director of NRL, who reports to the MIT VP for Research, described to the Task Force the present status of MITR-II. He also shared a copy of the MIT NRL Strategic Plan, dated March 2001. In July 1999 NRL submitted to the Nuclear Regulatory Commission an application for a twenty-year license extension that included a request for a power upgrade from 5 MWt to 6 MWt. This application is still under review. Many upgrades have been made to reactor support systems and the reactor is in excellent material condition.

MITR-II has unique capabilities that include neutron capture therapy (NCT) for brain and skin cancer, in-core loops that replicate PWR-BWR conditions, and R&D of digital control of nuclear reactors. Other existing, but under used capabilities, include neutron activation analysis, prompt gamma facility, neutron chopper, isotope production and NTD silicon. A significant one-time capital outlay is needed to bring these capabilities up to state-of-the art.

The Reactor is used in laboratory exercises for MIT classes, training of students as reactor operators and for facility tours by the general public. The DOE Reactor Sharing Program is used by a significant number of high schools, some elementary schools and about a dozen other universities.

The NRL Director and NED Chair believe that use of the Reactor by other MIT departments and other university researchers has been limited by the lack of operating funds for support staff, e.g. to assist with neutron activation analysis data acquisition and interpretation. Boron neutron capture therapy is viewed by NED faculty and NRL staff as a major capability having continuing research support from DOE and NIH.

Similar to Cornell, there appears to be conflict between the views of the MIT Administration and NED/NRL. The Administration very strongly supports nuclear engineering, particularly at the graduate level, and believes the NED/NRL focus should be on the advancement of nuclear (fission and fusion) power. The MIT Administration appears uninterested in support of multi-disciplinary neutron science and are not in favor of MITR-II becoming a medical science and research facility.

The MIT Administrators emphasized that no decision has been made to shutdown MITR-II. They have commissioned a study of the costs

for decommissioning to have adequate dollars included in the MIT balance sheet as a contingent liability. Nothing precipitous is going to happen at MIT before FY03 (July, 2002). The administration is not very hopeful that DOE "…will provide the support needed to provide a facility where great science can be done."

University of Michigan

Summary. The Task Force found that the FNR and associated facilities are used by a diverse population of researchers from U of M and across the nation. The facilities are in need of substantial renovation and upgrade, and the U of M Administration is very concerned that about 75% of the users are external and these external users provide only about 15-20% of the reactor operating costs. Assuming financial support was provided for base operating costs, the U of M Administration would be supportive of establishing FNR as a DOE sponsored regional (and national) user facility.

Supporting Information. The Chair of the Department of Nuclear Engineering and Radiological Sciences (NERS) provided (1) a 2-page summary of the Ford Nuclear Reactor (FNR) use by the NERS Department and (2) an 11-page summary of the overall FNR utilization. The Director of the FNR reports to the University of Michigan (U of M) Vice President for Research.

The FNR is a 2 MWt MTR-type open pool reactor. In 1999/2000 the cost of operating FNR was about $1.7M with $250K offset by income of $100K from Nuclear Regulatory Commission (NRC) materials irradiations and $150K from other research and industrial services. Thus the net reactor operating cost to the U of M appears to be about $1.5M per year.

The FNR supports three semester long laboratory courses in reactor experiments, radiation measurements and applications of radiation. In addition, U of M students and students from four other academic institutions come to the FNR for lectures and labs. Instructional areas include introductory nuclear engineering, nuclear physics and analytical chemistry.

The FNR and the U of M Phoenix Memorial Laboratory facilities provide irradiation and analytical services to other universities and to government and industrial users. A major research effort is an NRC sponsored project, performed in collaboration with Oak Ridge National Laboratory and University of California at Santa Barbara, focused on irradiation damage studies of steel pressure vessel materials. The NRC sent a Division Director to U of M to

brief the Task Force on the importance of this research. He pointed out that NRC has invested ~$2M in research equipment and estimates ~$1M in costs to move the equipment to another reactor, probably outside the United States, if the U of M Reactor is closed. For the present, the NRC has agreed to increase their payments to FNR from $100K to $200K per year to help offset increasing operating costs.

The FNR is used extensively for Instrumental Neutron Activation Analysis (INAA) by many researchers from U of M and, over the past 3 years, 17 other universities and 8 industrial users. INAA supports research in such disciplines as art history, archeology, chemical engineering, environmental science, geology, medicine and zoology.

The use of Ar-Ar geochronology has more than doubled at FNR in the past decade. The FNR has a full-time archeologist staff member who assists users with applications of INAA and Ar-Ar geochronology. She pointed out the FNR is the “facility of choice” for Ar-Ar geochronology for many researchers because FNR can perform “wet” irradiations and keep the samples cool.

Other FNR research programs and services include neutron radiography and radioscopy, neutron irradiation services, ion chamber lifetime testing and radioisotope production. Researchers from across the nation conduct research at the Ford Nuclear Reactor, or send samples for irradiation and/or analysis at the nuclear reactor laboratory. FNR is the only one of the three URRs visited that has both a regional and national user base.

The U of M Administration, while uncertain about a resurgence of nuclear power, recognizes that the FNR 24/7 operations and capabilities make it attractive to many institutions and U of M researchers. The Administrators acknowledge that there is still a strong NE program at U of M. However, their concern is that 75% of FNR use is by outsiders — industry, universities and government - but only 25% is by U of M faculty and students who generally do not pay for services. The Administrators are also concerned about potential cost of license renewal, due in 3-4 years. They have also been provided estimates of $5-10M to renovate and upgrade the building and reactor associated systems and instrumentation, if the reactor license is renewed for another 20 years. The Task Force tour of FNR confirmed the need for this renovation and upgrade work (although, not the dollar cost estimates).

The U of M Administration has serious reservations regarding DOE’s interest in and commitment to maintaining URR infrastructures in general. Unless circumstances improve, U of M is planning to

decommission the FNR in the near future. A decommissioning study underway should be completed by the end of 2001. It is estimated that another year will be needed to apply for and get NRC approval of a decommissioning plan. The administration would continue to support operation of FNR up to the start of decommissioning. It is clear to the Task Force, however, that reactor users, including NRC, will begin to look for other facilities if it seems probable FNR will be shutdown.

Recommendation

The Task Force was informed by DOE that $700,000-$1,000,000 might be made available in FY01 to provide some financial incentives for continuing operation of the URRs in question for at least one year. DOE also assured the Task Force that this money would not be taken from funds that support the facilities and users of the entire community of university research and training reactors.

Given the importance of the Cornell University, Massachusetts Institute of Technology, and University of Michigan reactors to the total remaining URR research and training capabilities, the Task Force recommends the following near-term action:

> DOE should immediately allocate $250,000 each (total $750,000) for the current year, FY01, to ensure continued operation of the Cornell University, Massachusetts Institute of Technology and University of Michigan Research Reactors. To receive these grants, each institution should be asked to submit by May 31, 2001 a letter proposal describing the use of these funds including, e.g., such items as meeting operation and maintenance expenses, support of researchers from other departments and institutions, reactor and experimental facility instrumentation upgrades and additions, support of education and training, and support of community outreach activities. The letter proposal must contain an attached letter from the institution’s senior administrators committing the institution to continued operation of the reactor at least through December 31, 2002.
>
> Providing the proposals are acceptable, the grants should be awarded on or about July 31, 2001 for use through December 31, 2002. This should allow time for the reactor administrators and university-wide research faculty members to apply for on going DOE and other government funding.

THE 1988 REPORT OF THE NATIONAL RESEARCH COUNCIL, "UNIVERSITY RESEARCH REACTORS IN THE UNITED STATES – THEIR ROLE AND VALUE"

Introduction

Most of the 1988 Report of the National Research Council, "University Research Reactors in the United States – their Role and Value", is as valid in 2001 as it was in 1988.

The 1988 Report findings have more recently been confirmed in a technical note on "University Research Reactors: Issues And Challenges" by John A. Bernard and Lin-Wen Hu of MIT, which was published in **Nuclear Technology**, Vol.131, Sept. 2000. Drs. Bernard and Hu's summary statement captures the present state of affairs as indicated and predicted in the 1988 National Research Council Report and reads as follows:

"University research reactors are underutilized and, as a result are being decommissioned. The reason for the lack of utilization is shown to be a chronic inability to generate sufficient funds to procure and maintain state-of-the-art instrumentation for prospective researchers. The role of these reactors in nuclear science/engineering education is explored and the rationale for their continued operation is presented. It is argued that base financial support for both reactor operations and the technical support staff needed to interface with experimenters is necessary if these research facilities are not to be irretrievably lost from the educational infrastructure of the United States."

This **Nuclear Technology** paper mentions Section IV, "Solutions", of the 1988 National Research Council Report, and the fact that the 1988 recommendations for federal government to provide base financial support for university reactors were not forthcoming then or in 2000.

Following are the principal findings and recommendations from the 1988 Report of the National Research Council. These will serve as an introduction to the URR Task Force Recommendations for a long-term strategy to assure the continuation of vital university reactor facilities in the United States.

Principal Findings (1988 Report, pp.2-4)

"Pursuant to the National Interest

The national interests served by university research reactors include:

- Development of high-technology applications in fields such as materials sciences, fluid dynamics, and biomedical sciences, using reactors as sources of neutrons;
- Research contributing to the future of nuclear power reactors, including the scientific basis for new concepts, for safeguards, and safety; and,
- Education of personnel needed to operate, maintain and improve reactors and other facilities associated with national defense and nuclear power activities.

The Committee [1988] finds that the existing population of university research reactors, as a whole, does not adequately fulfill these national interests, particularly with respect to the use of neutrons in the development of high technology. Moreover, in several important research areas the U.S. is not currently on a par with Europe and Japan. Deficiencies at U.S. university research reactors, stemming in part from inadequate financial support, include inadequate peripheral research equipment such as spectrometers, cold sources, and radiographic equipment. The effects of these deficiencies would be reduced by better access for university-based researchers to major national facilities, which are better equipped. But opportunities for such access are now inadequate.

The Committee is concerned that a failure to correct these deficiencies, coupled with a continuation of the trend in reactor closures, will serve to widen an existing gap of U.S. neutron science capabilities.

The Committee is also concerned that future national needs for nuclear engineers and scientists trained in the neutron sciences may not be met if the current negative trends continue.

However, selective reduction in the number of university research reactors will not of itself damage the national interest, provided that a healthy core of on-campus and off-campus research and educational reactor facilities is retained.

Pursuant to Academic Values

The Committee [1988] finds that on-campus research reactors contribute to academic values through research and education at the university, and through service to off-campus user constituencies:

Research: University research reactors are the focus of multi-disciplinary research with contributions to physics, chemistry, biology, medicine, epidemiology, environmental sciences, material sciences, fluid mechanics, geology, archaeology, paleontology, forensic sciences, and other fields in addition to nuclear engineering research and reactor physics. The three principal reactor research techniques are neutron activation analysis, neutron scattering, and neutron radiography. The latter two are largely confined to reactors of one megawatt and higher power. Research reactors in the United States constitute unique and essential research tools in several aspects: structural determinations of materials including superconductors and biologicals, ultra sensitive analysis for traces of elements, radiological display of physical phenomena, and introduction of radioisotopes for medical diagnostics and research.

Education: On-campus reactors have been a traditional focus of educational programs for nuclear engineers. In addition, students in the non-nuclear fields listed above increasingly use on-campus reactors as laboratories. Educational uses are made of even the smallest fractional watt on-campus reactors. Beneficiaries include graduate and undergraduate students, as well as nuclear power plant operators, secondary schools and the general public through outreach programs.

Service: University reactors, particularly those of one megawatt and larger, serve a range of off-campus constituencies: the medical community, industrial organizations, and government agencies. These clients use irradiated materials, materials analysis, trace element detection, and radiographic analysis of objects and processes. By providing such services, managers of university research reactors establish beneficial links to off-campus users, expose faculty and students to commercial applications of the nuclear sciences, and earn revenues to help support reactor programs.

The Committee finds that U.S. university research reactor facilities must be upgraded and provided with modern equipment if they are to meet their intended objectives and become world-class research and educational facilities. Needs include modern instrumentation, low temperature irradiation facilities, cold

neutron capabilities, modern spectrometers, radiographic equipment, increased power and neutron flux, and other enhancements.

University administrators, in weighing the future of on-campus reactor programs take into account the following factors:

- academic benefits in terms of research, education, and service;
- costs of achieving these benefits including the costs of safety and safeguards, as well as dealing with legal actions and protests;
- the availability of resources from federal and other sources to defray these costs; and
- competition from other on-campus research facilities for limited financial and other resources.

On-site reactors, clearly, enhance the educational and research missions of a university. Properly equipped and managed on-campus reactors offer unique advantages in terms of hands-on education and research experience in running small scale experiments which would not be practical at larger off-campus reactors. However, it cannot be concluded that every on-campus research reactor is essential to these missions. This depends on the particulars of the educational program, and on the nature of access to off-campus research reactors."

Principal Recommendations (1988 Report, pp. 4-5)

"The federal government, in partnership with the universities and the national laboratories, should develop and implement a national research reactor strategy, the elements of which should include:

- development of university and national laboratory centers of excellence in specific areas of the neutron sciences and reactor technology for world-class research as well as for education;
- anticipation that as some university reactors are upgraded and a user's network is created, others are likely to close;
- mechanisms to assure that such closures do not go so far as to damage the national interest related to research and educational capabilities in the nuclear sciences and engineering; and
- development and support of a reactor network to provide enhanced utilization and productivity of U.S. research reactors involving researchers from universities with and

without on-campus reactors, and from the national laboratories.

To implement the above strategy:

- a single federal agency should be designated to administer programs in support of the national research reactor programs; and,
- the federal government should create a standing advisory structure to advise on a continuing basis on all aspects of this program.

In pursuit of this strategy the Federal government should:

- adopt the goals of meeting U.S. research reactor needs, and regaining a position competitive with Europe and Japan in the neutron-based sciences;
- study, in detail, the approaches of other advanced countries to operating research reactor networks such as that of linking the major facility at Grenoble with small reactor research centers in Europe;
- establish and support such a network, adapted to U.S. needs;
- make up to $20 million available annually (as a preliminary estimate to be modified as improved data becomes available) to universities through the designated federal agency, specifically for operational support and facility upgrades of university research and educational reactors; and,
- create a peer review mechanism to assist the designated agency in making grants to universities.”

LONG TERM STRATEGIES FOR CONTINUED UNIVERSITY REACTOR OPERATION

Summary Of Findings

Failure to implement the recommendations of the 1988 National Research Council Report and Secretary O'Leary's 1994 "Report to the Congress on the Condition and Status of University Research and Training Reactors" has had the predicted consequences. In 1988 there were 40 reactors located at 36 university campuses. In 1994 there were 36 reactors at 33 university campuses. In 2001 there are 28 reactors at 27 campuses. Of the 28, the three already discussed are actively considering closing and one other is in cold shut down with the fuel in an on-campus storage pool. Many of the research reactors operating in 1988 at government owned and industrial laboratories have also ceased operations.
The NERAC Blue Ribbon Panel Report and Supplement (2000) have specific recommendations for actions to stem the decline in research, training and education capabilities in nuclear engineering, science and technology. Many of the recommendations could be implemented if the DOE and the U.S. Congress provide the significant budget increases for the support of university research reactors specified in Senate Bill, S.242, "Department of Energy University Nuclear Science and Engineering Act".

Recommendations

In addition to the Blue Ribbon Panel recommendations, the URR Task Force recommends the following actions to be initiated as soon as possible:

DOE FY02 Budget Request

The DOE and OMB should adjust their FY02 budget request to the U.S. Congress to include the funding recommended by the Blue Ribbon Panel and authorized by Senate Bill S.242.

University Reactor Fuel Assistance and Support

The DOE Office of Nuclear Energy, Science and Technology University Support Programs should be continued and enhanced as recommended in other NERAC reports. These Programs include: Reactor Fuel Assistance, Reactor Sharing, Reactor Upgrades, Nuclear Engineering Education Research (NEER) Grants, Nuclear Engineering/Health Physics Fellowships and Scholarships, Minority Fellowships and Scholarships, Radiochemistry, Nuclear Engineering and Science Education Recruitment Program, and the jointly funded with industry programs, Nuclear Energy Research Initiative (NERI) and Nuclear Energy Plant Optimization (NEPO).

Regional University Research Reactor User Facilities

The DOE should provide funding beginning in FY02 to initiate establishment of five geographically distributed regional URR user facilities. These facilities should be selected from peer-reviewed proposals submitted by universities having the following qualifications:

- An acceptable operational and safety record for the URR over the past five years
- Core faculty using the URR for research and training and education
- An operating steady-state power level of at least 500 Kwt
- Capability (with staff augmentation, as needed) to perform extended 24/7 operations as required for experiments
- Established or indications of willingness to establish collaboration/service agreements with educational institutions, national laboratories and industrial users
- Many or all of the following
  - -multiple beam ports
  - -in-core irradiation access
  - -ex-core irradiation access
  - -beam port filters/instrumentation for
    - -neutron activation analysis
    - -neutron scattering
    - -radiography
    - -medical applications
  - -isotope production with receiving, handling and shipping capabilities
- Capability (with staff augmentation, if needed) to provide assistance and support to facility users
- Desirable (but not necessary) to have gamma irradiation and hot cell facilities.

DOE should provide a 5-year commitment of support to each of the selected regional URR user facilities. The host universities must be committed to operation of the URR through the 5-year program support period, and must demonstrate that substantial institutional support comes from the university and will continue through the program support period. This university support can be in the form of faculty and staff salaries, student scholarships and fellowships, and research dollars obtained from other than DOE to pay for URR services.

The URR proposals to become a regional user facility should request and DOE should fund:

- Capital outlay spread over the 5-years to bring the URR and its research instrumentation capabilities up to state-of-the-art in selected areas of specialty
- Base support for a technical staff to construct, operate and maintain the equipment that is needed by prospective reactor users
- Base support for reactor operations and maintenance.

Each regional URR facility should:

- Provide regional and national, as appropriate, universities, hospitals, other non-profit entities and industrial users with state-of-the-art neutron sources for nuclear engineering research and research applications of nuclear science and technology
- Provide training and educational experiences for undergraduate and graduate students in nuclear engineering and in applications of nuclear science and technology
- Provide reactor users with all equipment and staff support needed to perform their research
- Actively seek enhanced linkups with other URRs and reactor and neutron source facilities at national laboratories
- Provide public outreach education for non-collegiate groups and professional organizations.

The regional URR user facilities would be expected to work with staff and researchers from other URRs to identify research and educational opportunities that could begin at the lower power URRs and feed into regional user facilities and/or national laboratory reactors.

Regional University Training & Education Reactor User Facilities

The DOE should provide funding beginning in FY02 to initiate establishment of up to four geographically distributed regional university training and education (T&E) reactor user facilities. By virtue of their lower power levels and 8-hr/5-day operating schedules, the T&E reactors are somewhat less expensive to operate. The support funds needed for three facilities should be about the same as for one regional URR research facility.

These facilities should be selected from peer-reviewed proposals submitted by universities having the following qualifications:

- An acceptable operational and safety record for the reactor over the past five years
- Core multi-disciplinary faculty using the reactor for training and education activities in reactor physics and operations and nuclear science and technology (e.g. NAA, radiation measurements)
- Established or indications of willingness to establish collaborative/service agreements with educational institutions, nuclear utilities and industrial users
- Access to staff with skills in development and testing of learning methodologies
- Capability (with staff augmentation, as needed) to provide assistance and support to T&E reactor facility users.

DOE should provide a 5-year commitment of support to the selected T&E reactor user facilities. The host universities must be committed to operation of the reactors through the 5-year support period, and must demonstrate that substantial institutional support comes from the university and will continue through the program period. This university support can be in the form of faculty and staff salaries, student scholarships and fellowships and T&E development dollars obtained from other than DOE.

The proposals to become regional T&E reactor user facilities should request and DOE should fund:

- Capital outlay spread over the five years to keep the reactor instrumentation and T&E equipment up-to-date
- Base support for a technical staff to construct, operate and maintain the equipment needed to advance the T&E experiences
- Base support for reactor operations and maintenance.

The regional T&E reactor user facilities should:

- Develop and provide learning experiences for elementary, middle and high school students; undergraduate and graduate students in nuclear engineering and nuclear science and technology; nuclear utility operations and support staffs; and members of the public
- Provide reactor users with equipment and staff needed to support their T&E experiences

- Actively seek enhanced linkups with educational institutions at all levels and professional organizations engaged in the applications of nuclear engineering, science and technology.

The regional T&E reactor user facilities would be expected to work with staff and educators from other university reactors and nuclear utilities to identify T&E opportunities that could begin at the very low power reactors and culminate with short-term (e.g. 1-week) experiences at the regional URR or T&E reactor user facilities, a utility control room replica simulator or national laboratory reactors. Once these facilities are operational, they will be available to government institutions and organizations, including the military, to train their staff at a very reasonable cost.

Workshop on Long-Term Strategies for Continued University Reactor Operations

The user facility concepts described in the preceding two recommendations should themselves be subject to peer-review by the university reactor operations and user communities. Thus the URR Task Force recommends that before the end of FY01, DOE convene and sponsor participation in a 2-3 day Workshop on Long-Term Strategies for Continued University Reactor Operations. The purpose would be to assemble representatives from the university reactor operations and university user communities, national laboratories, nuclear utilities, and industrial users to thoroughly explore the development of the Regional URR User Facilities and the Regional T&E Reactor User Facilities.

DOE representatives should present R&D needs for their national laboratory neutron source facilities and identify potential projects that could be done at university reactors and other university research laboratories, to then be brought to the DOE facilities for application or further R&D that could be accomplished only at the higher neutron flux or fluence available at those facilities.

DOE, the Nuclear Regulatory Commission, and other government agency representatives should present their training and education needs that could be accomplished at the Regional T&E Reactor User Facilities.

Panels should be assembled to review and discuss with participants the regional user facility concepts. Reporters should be assigned to capture the concerns and consensus views to be incorporated into the DOE requests for proposals.

Breakouts into Working Groups could be used to discuss the great variety of nuclear engineering, neutron and nuclear science and technology areas of interest needing support by regional URR and national laboratory facilities. These might be organized as updates to the 1988 National Research Council Report.

This Workshop should not be another series of conversations with no results. It must be hard hitting, heavily results and action oriented, with much preparation up front and an effective facilitator in charge. Proceedings of the Workshop should be published and should then form the basis for the detailed request for proposal and peer-review process to be implemented by DOE.

CONCLUSION

The need for federal government support for a nuclear engineering, science and technology infrastructure in U.S. educational institutions has been well documented over the past decade or two. The URR Task Force believes it is vital for DOE to act now on the recommendations of the Blue Ribbon Panel, TRTR and NEDHO, and this Task Force. Only determined and committed leadership at the highest levels of DOE and the U.S. Congress will assure the continued operation of vital university reactors in the United States.

APPENDIX A

Information Gathering Process

The Task Force used six documents as basic reference material:

1. **University Research Reactors in the United States – their Role and Value,** Committee on University Research Reactors, National Research Council, National Academy Press, 1988.

2. **Report to the Congress on the Condition and Status of University Research and Training Reactors,** submitted by Secretary of Energy, Hazel R. O'Leary, May 19, 1994.

3. **Nuclear Engineering in Transitions: A Vision for the 21st Century,** J. Freidberg, et al, a publication by the Nuclear Engineering Department Heads Organization, December 1, 1998.

4. **Report of the Blue Ribbon Panel on the Future of University Nuclear Engineering Programs and University Research & Training Reactors,** submitted to NERAC, May 10, 2000.

5. **DOE Program for University Research & Training Rectors,** submitted to NERAC by Blue Ribbon Panel, December 21, 2000.

6. J. A. Bernard and L. Hu, "University Research Reactors: Issues and Challenges", **Nuclear Technology**, Vol. 131, (379-384), Sep. 2000.

The Task Force also reviewed many other documents provided by the University Research and Training Reactor community.

On March 7, 2000, the Task Force met at Ohio State University (OSU) where we toured the OSU Research Reactor and heard presentations by the Blue Ribbon Panel Chair, representatives from Pennsylvania State and Texas A&M Universities, and an ORNL staff member who described the organization of research reactors in Western Europe.

At OSU the Task Force also heard from representatives of the nuclear power industry. Participants in the OSU Meeting are listed in Appendix B.

March 21, 22, and 23, 2001 the Task Force visited, on successive days, Cornell University, Massachusetts Institute of Technology, and the University of Michigan. We had tours of the reactors and associated research facilities, met with university senior

administrators and heard presentations by faculty, research staff and some students. All three URRs provided extensive materials describing their activities and associated sources of income and costs.

In early April, one of our members visited the University of Texas reactor and talked to University of Maryland reactor personnel. The staffs of these facilities also expressed their concerns regarding funding of operations and needs for equipment and support staff.

APPENDIX B

PARTICIPANTS – OSU MEETING OF URR TASK FORCE

NAME	ORGANIZATION
Robert Long	Nuclear Stewardship, LLC
W. F. Naughton	Exelon Nuclear
Ed Klevans	Penn State University (Retired)
Colin D. West	Oak Ridge National Laboratory (Retired)
David M. Slaughter	University of Utah
John Gutteridge	U. S. DOE
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M. Corrodini	Univ. of Wisconsin
Brian Hajek	Ohio State University
Frank Pisarsky	American Electric Power
Jose Luis M. Cortez	Research and Technology Consultant
Kenneth Quinn	Westinghouse Electric
Norton Haberman	DOE
Allen Sessoms	Harvard University (by telephone)
Don Miller	Ohio State University