CORNELL
UNIVERSITY

Office of the Vice Provost for Research

529A Clark Hall
Ithaca, NY 14853-2501

Telephone: 607 255-6423
Facsimile: 607 255-6428
e-mail: rcr2@cornell.edu

April 16, 2001

President Hunter R. Rawlings III
300 Day Hall
Cornell University
Ithaca, NY 14853

Dear President Rawlings,

This letter concerns the pending decision regarding the re-licensing of the nuclear fission reactor in Ward Laboratory. I discuss considerations important to the university, and then recommend that we cease the operation of the reactor.

The reactor at the Ward Center for Nuclear Sciences has served the Cornell community, the State of New York, and national industry for 40 years. My conclusion that it should be closed is particularly poignant because the staff of the Center, under the leadership of Dr. Kenan Ünlü, continue to provide excellent service to users. The Office of Nuclear Science and Technology of the Department of Energy is especially anxious that Cornell keep the facility active. The Director of that office as well as members of his advisory committee have visited Cornell to urge the continuation of reactor operation. We have received a very large number of thoughtful supporting letters from Cornell alumni, industrial users, and Cornell faculty. In addition, the University Faculty Senate has recently passed a resolution reaffirming its 1996 recommendation that Cornell University operate the nuclear reactor, gamma cell, and associated analytical facilities as the Ward Center for Nuclear Sciences. The vote on the resolution was 36 in favor, 19 opposed, and 9 abstentions.

During the Fall Semester of 2000 a committee of the University Faculty Senate, the Local Advisory Committee (LAC), undertook a thorough review of the Ward Center at my request. Briefly, my central charge to the LAC was to answer the question of whether it is in the best interest of Cornell University to keep Ward Center as an active university facility. In the interval between mid-September and mid-January the ten members of the LAC invested an average of more than 30 hours each in the task. In considering the value of the current and potential future research and training at the Center, the LAC interviewed a large number of Cornell faculty and staff. Their report is attached. (http://www.cornell.edu/UniversityFaculty/forums/WardCenter/Ward_LAC_finalRept) Quality of the research was discussed at length in the private meetings of the LAC. They unanimously recommended "..that Cornell move to decommission the TRIGA reactor and phase out the Ward Center activities." There were many faculty members who disagreed with the LAC report. Many of their letters are stored on the Faculty Senate Web page. (http://www.cornell.edu/UniversityFaculty/OnLineForum/main.html)

A second major Faculty Senate Committee, CAPP (Committee on Academic Programs and Policies) sponsored a Senate meeting on the Ward Center. The public presentation of

the activities of the faculty who have been using the Ward Center was quite informative. However, there was no attempt to present an objective and impartial assessment of the quality of that work, nor would that public venue have been an appropriate setting. CAPP recommended that the LAC report should stand and concluded that the proper role of the Senate is to provide a venue for all concerns to be heard. Charles Walcott's minutes of the public meeting (http://UniversityFaculty.cornell.edu/FSminutes/2000-01/Feb21minutes.html) are a very important record of the discussion. Walcott's record is particularly meaningful because it contains copies of the transparencies presented during the forum discussion.

TRIGA stands for Teaching, Research, Isotope, General Atomics. The Cornell TRIGA reactor was manufactured by General Atomics and 'went critical' (got turned on) in January 1962. Much of the theory underlying the design of the TRIGA reactor was due to a Cornellian, Mark Nelkin, later a professor in our Department of Applied and Engineering Physics. The design is particularly brilliant because of its inherent safety. The fuel is alloyed in a matrix containing Zirconium hydride. This fuel design has the important property that its prompt temperature coefficient of reactivity is negative and large. This means that the neutron multiplication rate decreases instantly as the fuel temperature rises and that this decrease is very sensitive to any increase of temperature. Since an increase of reactor power increases the fuel temperature, power excursions are limited by the special nature of the fuel. Thus, human, electronic, or mechanical operations are not required to guarantee the reactor safety during operation.

In the academic year 2002-03 the reactor must either be re-licensed with the Nuclear Regulatory Commission (NRC) or be decommissioned, also under NRC approval. The formal preparation for either decision is complex with numerous reports required. The NRC requires a detailed inspection of the effects of aging on the facility. Any degradation of the surrounding structure must be repaired. The electronic equipment for reactor operation and control will be inspected. Some of the older portions of the control circuitry will have to be replaced in the near future. Safety records, procedures, and equipment will be examined. An Environmental Impact Statement is required, including public review.

If we decide to continue the operation of the reactor, the details of the annual renewal assurances must be updated and revised with special care. We need to assure the NRC that we reserve sufficient funds to pay for the decommissioning of the reactor, estimated in FY99 as $4.01 million including 25% contingency. The decommissioning expense is a delayed obligation of the university and will need to be faced eventually, either via closure of the reactor to build a more modern facility (an unlikely situation) or to cease all reactor activity.

If we choose to keep the reactor open there is an additional commitment. The fissionable materials and fission products that accumulate in the fuel elements must be securely protected with extraordinary care to prevent loss by theft or by release into the environment. Were we to decide to cease operation and no longer keep the Ward staff we would still have to maintain a continuous high level security of the installation until all irradiated fuel is removed. Such removal is likely to take at least the same several years

required today. If federal funds are not available at that time Cornell will have to pay for the removal of the irradiated fuel. Today the DOE has funds to assist universities in disposing of the spent fuel and waste. The DOE has a disposal site in Idaho that still accepts the material. Even this year the Idaho congressional delegation has questioned the Secretary of Energy about when the State of Idaho might expect to be able to move the stored nuclear waste to the proposed national facility in Nevada.

There are three main reasons why Cornell might want to operate a nuclear fission reactor: 1) training of students; 2) research of the university faculty and staff; and 3) public service to industrial and governmental users. The LAC has analyzed all three. Much of my discussion is taken directly from their report.

With regard to training, the economic need for the United States to revitalize nuclear engineering training and to build new power reactors has been widely discussed in the last year. I agree with the arguments. New power reactors should (and probably will) be built in the coming decade and there will be an attendant demand for students trained in the field. However, Cornell no longer has substantial academic or research activities in nuclear science and engineering and has not since the mid 1970s. In the mid 1990s, the College of Engineering disbanded the Nuclear Science and Engineering Program that had been in existence as a separate academic unit since 1977. The program termination was in response to Cornell's sub-critical and noncompetitive position in the nuclear engineering area, particularly in terms of student enrollments and sponsored research activities. The graduate program was also put on probation by New York State in 1994 because the number of students and faculty was too small. The program is even smaller now. Of the five full time faculty directly associated with the program in 1993, only three remain on the Cornell faculty and only one still lists fission reactors as a main activity. The graduate field currently lists six faculty members of whom only three are actively involved in any aspect of nuclear engineering. There are fewer than six graduate students (including three Ph. D. students). The facility offers orientation tours in several introductory courses; but only a very small number of students take courses that make extensive use of the reactor. At the present time no department has any plan to make an appointment in the field. There is negligible chance that any department will choose to do so in the next decade regardless of whether or not Cornell's reactor remains open. It is important to note that the TRIGA reactor is of a completely different design from power reactors used for the production of electricity.

The logged usage by Cornell faculty of only 226 hours for an entire year (FY 2000) represents a serious under utilization of this facility. The use is highly subsidized with no fees charged to Cornell users in most cases. The main application is neutron activation analysis (NAA). The technique is used for analysis of the elemental composition of matter, especially for the detection of trace quantities of elements. Specimens are irradiated in the reactor producing radioactive nuclei as neutrons are captured. Thereafter, the energy of the photons emitted in the decay of the radioactive nuclei provides a unique signature of each element. The current NAA work done by Suzanne and Bob Kay on rocks Suzanne has obtained in the Andes and that by Peter Kuniholm studying ancient tree rings has been especially interesting. Both projects have received a great deal of recognition. Both projects have also involved many students and

collaborators working in the Ward Center. For the most part, Cornell faculty perform NAA studies at Ward Center because it is free and readily accessible. The significance of the Kay and Kuniholm projects is an exception. Citing the LAC report, "Little competitively reviewed, externally funded research has been done with the reactor for years. Much of the work, especially that for outside industry, is routine. Since the inauguration of Ward Center in 1996, its research base has grown somewhat across campus, and signs for the future are generally positive. Many people across campus have good impressions about the facility. On the other hand, very few if any young faculty are enthusiastic about the science, about devoting their own careers to building or improving the facility, or about utilizing the reactor heavily."

The NAA technique is not unique to the Ward Center. It is readily available, for a price, at other university or private facilities. The NAA method is being displaced by other more modern analytical techniques such as Inductively-Coupled Plasma Atomic Emission Spectroscopy (ICP) and X-ray Fluorescence Spectroscopy (XFS). The latter two typically cover a wider range of elements and are frequently more sensitive. Similarly, other uses of neutrons at the Ward Center such as radiography, instrument calibration and radiation induced defects are available at other facilities.

Proponents of the Ward Center argue that new techniques and new research activities are likely to be important in the future. Again, I quote the LAC report, "...With respect to the potential of expanded neutron beam capabilities of the reactor, most of which have been in consideration or under development for quite some time, in some cases for decades, there is not an engaged and energetic group of faculty who are willing to champion and support their development. Nor can a compelling case be developed from the LAC interviews that more substantial use of the reactor will develop if these capabilities are indeed eventually established, nor that they would have a major, enabling impact on Cornell research programs." The two new uses most frequently cited are Boron Neutron Capture Therapy (BNCT) and neutron diffraction studies of structures. Both are highly implausible as important programs at the Ward Center.

In BNCT, boron is attached to enzymes which are released into the brain or other organs affected with a tumor. Subsequently the patient is placed in a neutron beam. The boron captures neutrons and the cancerous growth is destroyed by radioactive decay in the resulting nuclear reaction. The method works but is cumbersome. Clinical facilities, even for animal research, are very expensive. The scheme is not new. Clinical trials of BNCT were conducted at Brookhaven National Laboratory (BNL) and the Massachusetts Institute of Technology (MIT) during the 1950s and 1960s. Those trials were unsuccessful and had unacceptable clinical toxicities. Through the following decades research was directed toward more careful measurement of radiation dosage and more careful control of the drug distributing the boron in the brain. Work was conducted in numerous facilities worldwide. Despite a great deal of publicity about the benefits of the method in the early 1990s, the amount of supported research has declined. In 1999 DOE's Biological and Environmental Research Advisory Committee (BERAC) reviewed the BNCT research supported by the agency. BERAC recommended that DOE cease the support of clinical trials of BNCT. (http://www.er.doe.gov/production/ober/berac/bnctfnl1199.html)

Subsequently, the BNCT clinical facility at Brookhaven was shut down. The National Cancer Institute of the NIH now has only two active grants in this field.

With regard to diffraction measurements, the neutron beam intensity at Ward Center is not large enough to make such measurements competitive with other facilities. The Ward TRIGA is a 500 kW reactor. Ward's power level is only 5% of that at the weakest reactor in the United States being used for diffraction measurements. Major facilities at NIST and Oak Ridge have powers of 20 MW and 85 MW respectively. It is highly unlikely that Cornell users will choose Ward for structure studies. It is also unlikely that DOE would award a competitive grant for the expensive modifications and new equipment required for diffraction spectroscopy.

Industrial concerns used the TRIGA reactor for the largest amount of time in 2000. They paid for 311 hours of use. Our rate is quite competitive and our staff is user friendly. The fees paid by external users are an important source of income for the Center. The principal applications have been NAA, controlled production of defects, radiography, and instrument calibration. The external users have written very enthusiastic letters of support for the Ward Center. The service we provide is both valuable and important to them. However, the activity is routine and the services are available elsewhere. External user service is also subsidized by the university in the sense that it does not reflect the true cost of operation of the facility. The value of the assistance we give to industry must be balanced against the long term needs of Cornell.

If we ignore, for the moment, the operation and maintenance (O&M) costs for running the Ward Center and the more important opportunity costs associated with other uses of the space, the Center has an annual operating budget of $500,000 (AY'00-'01). The University pays $200,000 of the budget. The Center anticipates an income of $240,000 from external users. (It received $215,000 in AY '99-'00.) The remainder of the income is derived from external grants paying for equipment and safety upgrades, from endowment income ($21,000) and internal user fees ($7,000). The historical average for external funding for research at the laboratory has been roughly $250,000 per year (in year 2000 dollars). (A misleading graph was presented at the University Faculty Meeting implying an almost exponential increase in the growth rate of funding. The graph showed $623,000 in federal funding received in the current year. The funds were not the annual income but income for three years. Most of the funding is not competitive. That is, most or all of the applicants to this particular program received awards.) To summarize, it currently costs the central administration $200,000 per year in direct funding to support the center. The additional costs for O&M, reported to DOE by the Ward Center are $270,000 per year, though that number might be too high by a factor of two. The indirect costs returned to the university for research conducted at the Ward Center are less than $80,000.

Dr. Ünlü has pointed out that there are two authorization bills before the Senate, S.242 and S.472, which are intended to provide financial relief to universities with research reactors and programs in nuclear science and engineering. Neither bill is an appropriation bill. The money is not available until both houses of congress have passed the appropriation bills. S.474 is evidently the authorization bill for the long standing

programs of the Department of Energy in nuclear science and engineering. S.242 is a program earmark that would authorize the Department of Energy to set aside $30M to support nuclear engineering training at universities. The bill directs the Secretary of energy to fund graduate fellowships and assist young faculty in programs of reactor science and engineering. It is not clear how S.242 would affect Cornell with our absence of such programs.

The national trend in research reactor operation has been a downward spiral since the peak in funding in the 1960s. There has been a steady decline in the number of active research reactors from a peak of 60 down to 25 today. Even if the pending authorization bill, S.242, fails to be supported the funding for university reactors is unlikely to decline further. The country has a great deal of interest in maintaining at least the present minimum level of training. For Cornell, the funding relief, if any, is likely to be temporary and in the form of further assistance in operating equipment and for the expenses involved with re-licensing. We do not have the programs in nuclear science and engineering for which the bulk of the legislation is intended.

The most important consideration for Cornell is the long term use of the facilities and space occupied by Ward Center. The immediate questions of financial support of the Center should be set aside. Do we want to have the TRIGA reactor and the associated responsibilities at the site of Ward Laboratory for the next 20 years? My answer is "no." There is no path for significant improvement of the current facility. The reactor power could be doubled at large expense but the progress stops there. The reactor would be destined to be an increasingly out of date research tool. At the same time, the building has a gross space of 33,000 square feet. Ignoring staircases, toilets, and rooms for building support there are more than 16,000 square feet of space that can be used for offices and research laboratories after the reactor is decommissioned and the irradiated fuel is removed. The land upon which the Center sits is very valuable to Cornell because of its close proximity to the Engineering Quadrangle. Eventually the space can be used for the next major building of the Engineering College. In the meantime the building can be used as 'surge space' for engineering faculty when much needed renovations are made to other buildings on the Engineering Quadrangle. We will never be able to use the site for planning another building unless we begin the lengthy decommissioning process well in advance.

I repeat here the summary recommendation of the LAC: "The LAC unanimously recommends that Cornell move to decommission the TRIGA reactor and phase out the Ward Center activities. We recommend that the administration be proactive in addressing the transitional inconvenience of current users as they transfer their research to other facilities, and in helping the staff whose jobs will be affected. The LAC recommends that Cornell maintain the Co^{60} source at an appropriate local facility. These recommendations are independent of any proposed schedule for fuel removal from the reactor." I concur with the recommendation. It is especially important that we be proactive in helping the staff who will be affected and in assisting in the transition for those who must transfer research to other facilities.

My succinct summary is that we can no longer warrant spending DOE and Cornell funds to subsidize the TRIGA reactor. The reactor has far too little use. There is small chance that the demand will increase significantly in the next decade. Possession of the nuclear fuel is a liability to the university. The space occupied by the Ward Center is too valuable to justify the current use. I urge that we decommission the reactor and shut down the Ward Center.

Respectfully submitted,

Robert C. Richardson
Vice Provost for Research