On Continued Operation of the BEVALAC Facility: Letter Report

Committee on Space Biology and Medicine, National Research Council

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On August 20, 1992, Committee on Space Biology and Medicine Chair Fred W. Turek and Space Studies Board Chair Louis J. Lanzerotti sent the following letter to the Honorable James D. Watkins, U.S. Secretary of Energy, and NASA Administrator Daniel S. Goldin.

On May 14, 1992, the Committee on Space Biology and Medicine (CSBM) of the Space Studies Board (SSB) was briefed by the acting director of NASA's Life Sciences Division, Mr. Joseph K. Alexander, concerning various issues and activities in which the division is engaged. Among the issues raised was the impending decommissioning of the BEVALAC at the Lawrence Berkeley Laboratory as outlined in correspondence from Dr. David Hendrie, director of the Department of Energy's Division of Nuclear Physics. Subsequently, the CSBM discussed this issue with the Board at its meeting in Huntsville, Alabama, in June.

The Board and the CSBM are in agreement with a host of advisory committees' recommendations concerning the importance of gaining a better understanding of the biological effects of high Z element (HZE high-energy) particles.[1] Critical to planning for extended human sojourns in deep space is quantitative knowledge about the dose rates and types of radiation that will be encountered and the related biological effects.

The SSB and CSBM are concerned about the closing of the BEVALAC given that there is no alternative facility at which to continue the radiobiological research conducted as part of this country's goal of expanding the human presence in space. This facility is the only accelerator in the United States capable of producing the spectrum of energies required for research concerning the physical and biological effects of the heavy ions that will be encountered during deep-space missions. Providing adequate shielding against radiation and taking other measures to protect astronauts during deep-space travel are directly dependent on information derived from research concerning the biological effects of protons and HZE particles.

It is our understanding that even if funding for an alternative facility were provided today, there would be at least a five-year hiatus before suitable beams could become available. An interruption of the radiobiological research currently under way at the BEVALAC would have a number of deleterious effects on this well-established program that is a critical component of the national goal of human space exploration. Research teams that have been assembled to conduct this work would disperse and transfer to other areas of research. The flow of valuable long-term data derived from the BEVALAC studies would cease. Thus it would be necessary to start all over with new research animals, when another accelerator became available, in order to obtain data from repeated, increasingly longer periods of exposure—a condition absolutely crucial to this type of research. Finally, losing this capability would seriously damage the research program of the recently established NASA Specialized Center for Research and Training (NSCORT) in Space Radiation Health at Lawrence Berkeley Laboratory and contribute to the loss of expertise in basic radiobiological research—an outcome that would be contrary to the conclusion reached in NASA's Space Radiation Health Program Plan.[2]

> There is an acute need for additional well-trained and well-qualified researchers in space radiation physics and biology. A continuous supply of trained space researchers needs to be developed and adequate numbers of trained personnel need to be available to enable program expansion. (p. 30)

Various heavy-ion facilities exist worldwide that could, theoretically, support the type of space-related research under way at Berkeley. However, the SSB and CSBM have no evidence that any of these facilities could be made available to support NASA's HZE radiation research program. The BNL Booster at Brookhaven National Laboratory has limited capability, and no beam time will be available until a new irradiation facility is built. The Darmstadt accelerator has provisions for cell research but not for animal research, and beam time at the facility is currently oversubscribed by a factor of two. The JINR at Dubna has obsolete equipment, low beam intensity, and beam contamination—significant limiting factors. The Synchrophasotron at Saclay has no provisions for conducting animal or cell research, and at least a year would be required to prepare the facility to provide iron beams. Beams generated at the facility at Geneva are beyond the energy range required by NASA researchers. Finally, the accelerator at Chiba is not yet in operation and will not produce iron ion particles.

Understanding that the NASA-sponsored research at the BEVALAC may be relatively minor in the context of the Department of Energy's (DOE) overall mission, the SSB and CSBM believe that the decision to decommission this facility should be considered in the context of the importance of the BEVALAC to the U.S. space program—one in which DOE plays an increasing role.[3] *Until a suitable alternative can be provided that supports research related to long-term plans for human space exploration, the SSB and CSBM urge that the BEVALAC remain available to NASA researchers. Given the importance of the radiobiological research conducted at the BEVALAC and its fundamental role in realizing the national goal of human space exploration, the SSB and CSBM strongly recommend that DOE and NASA agree on a means for continuing without interruption the capability now provided by the BEVALAC.*

[1]Attachments citing 14 supporting statements drawn from internal NASA and

advisory documents and NRC reports accompanied the original correspondence; they are appended to the letter.

[2]Space Radiation Health Program Plan, Life Support Branch, Life Sciences Division, NASA, Washington, D.C., November 1991.

[3]National Space Policy Directive for Space Exploration Initiative Strategy, Section III, paragraphs *c* and *d*, March 13, 1992.

ATTACHMENT 1—Letter from DOE

ATTACHMENT 2—Excerpts and Recommendations Concerning Biological Effects of Radiation Exposure

ATTACHMENT 3—Selected Reports Concerning Radiation Research and Humans in Space

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Attachment 1

Department of Energy
Washington, DC 20585

MAY 5 1992

Dr. Frank Sulzman
Chief
Life Support Branch
SBM
National Aeronautics
and Space Administration
Washington, D.C. 20546

Dear Dr. Sulzman:

For many years, the Bevalac has hosted a wide variety of world class research activities, including those in nuclear physics, biomedical research, space physics, and other areas. For many years, financial support for operation of the Bevalac for all programs has been provided by the Division of Nuclear Physics within the Office of Energy Research of the Department of Energy. The Nuclear Physics program used about one half of the beam time available for research, programs of the National Cancer Institute (NCI) used about one third, and the remainder was used by other programs including National Aeronautics and Space Administration (NASA) based research.

Within nuclear physics, advisory committees have noted that the requirements of relativistic heavy ion science is moving to higher energies. In accord with the scientific priorities, it was recommended that nuclear physics support for the Bevalac should phase out in the mid 1990's. Our previous plans were that nuclear physics would continue facility support through 1994. However, fiscal stringencies and scientific priorities require us to phase out the facility earlier than projected. The Nuclear Physics program was unable to obtain the funding needed to operate the Bevalac through FY 1993, and attempts to obtain sufficient additional funding through other interested programs have not succeeded.

Therefore, the intent of the Nuclear Physics program is to remove the Bevalac from operating status in FY 1993, and to start the activities necessary to prepare for decommissioning. Beyond FY 1992, those programs that had used the Bevalac beams for their research must develop other plans to continue their activities. Although this notification of termination of availability may seem abrupt, the managers of the NASA and NCI programs have been aware of the situation since the President released the budget in January, and have been fully consulted in the attempt to devise alternative funding strategies.

fully consulted in the attempt to devise alternative funding strategies.

I write this letter with the twinge of nostalgia of one who has performed research at the Bevalac, but also of gratification when I review the many pioneering accomplishments of the scientific programs at the facility over the years. I anticipate with pleasure the further achievements to be made in the many scientific areas first developed at the Bevalac.

Sincerely,

David L. Hendrie
Director
Division of Nuclear Physics

Letter

Attachment 2—Excerpts and Recommendations Concerning Biological Effects of Radiation Exposure

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Attachment 2

Excerpts and Recommendations Concerning Biological Effects of Radiation Exposure

It is critical for NASA to formalize agreements to utilize one or more of the federal accelerator facilities, and to assure that those facilities remain in operation until necessary ground-based research is completed.

> —Aerospace Medicine Advisory Committee/NASA Advisory Council, *Strategic Considerations for Support of Humans in Space and Moon-Mars Exploration Missions, Life Sciences Research and Technology Programs*. 1992

In order to protect crews, to the extent possible, from the various harmful effects of radiation, it is necessary to thoroughly characterize the radiation environment, understand the biological effects of HZE radiation and protons (leading to the establishment of appropriate risk levels and limits for radiation exposure), and accurately predict and provide warning of any increased levels of radiation.

> —Discipline Working Group on Radiation Health and Environmental Health, NASA, *Space Radiation Health Program Plan*. 1991

Determining the long-term medical consequences of exposure to high Z element (HZE) particles present as a component of galactic cosmic radiation (GCR) is critical. The biological hazards associated with HZE particles, i.e., the "late effects," are not adequately known and may pose unacceptable long-term cancer risks. Exposure can result in life-threatening and life-shortening effects, such as cancer, and other detrimental consequences including cataract formation, mutagenesis, and other tissue damage.

> —Aerospace Medicine Advisory Committee/NASA Advisory Council, *Strategic Considerations for Support of Humans in Space and Moon-Mars Exploration Missions, Life Sciences Research*

and Technology Programs. 1992

NASA should make a commitment to support fundamental research on the biological effects of radiation. This support and commitment should take the form of expanding NASA's role in and funding for basic research and of contributing to the necessary facilities, such as the BEVALAC accelerator.

—Life Sciences Strategic Planning Committee, NASA, *Exploring the Living Universe—A Strategy for Space Life Sciences*. 1988

In summary, the highest priorities are for improved dosimetry and for studies of the effects of HZE particles so that the risks of both stochastic effects, such as carcinogenesis, and nonstochastic effects such as CNS damage, can be estimated with confidence.

National Council on Radiation Protection and Measurements, *Guidance on Radiation Received in Space Activities*. 1989

One concern requiring further study in this area is the high-energy high-charge component of the cosmic ray flux, which can damage non-dividing cells, including those of the central nervous system.

National Commission on Space, *Pioneering the Space Frontier*. 1986

The Space Exploration Initiative requires understanding and management of space radiation hazards. Uncertainties in these radiation effects on cells, tissue and small organisms could be reduced by simulations using the Bevalac at the Berkeley Radiation Laboratory.

Synthesis Group, NASA, *America at the Threshold*. 1991

REPORTS FROM THE NATIONAL RESEARCH COUNCIL

The availability of HZE particles for experimental radiation biology is extremely limited. The only feasible approach to obtaining the required information is to carry out controlled studies in adequate ground-based facilities.

Radiobiological Advisory Panel/Space Science Board, *Radiobiological Factors in Manned Space Flight*. 1967

The availability of a ground-based accelerator capable of producing HZE particles now permits the design of precisely ordered experiments. Such experiments should be supported.

Committee on Space Biology and Medicine/Space Science Board, *A Strategy for Space Biology and Medical Science for the 1980's and 1990's*. 1987

It is important to learn more about the relative biological effects of radiation influences, particularly high-Z galactic cosmic rays and solar flare electrons and their relationship to cancer and cataract induction in order to set meaningful guidelines for radiation protection. The question of appropriate shielding in flight is complex and requires further study.

Committee on Human Exploration of Space/National Research Council, *Human Exploration of Space—A Review of NASA's 90-Day Study and Alternatives*. 1990

Terrestrial studies of the biological effects of low-level, high LET irradiation on cell cultures and animals (using particle accelerators) should be expanded, with particular attention paid to the space radiation problem.

Life Sciences Task Group, Space Studies Board, *Space Science in the Twenty-First Century—Imperatives for the Decades 1995 to 2015—Overview and Life Sciences*. 1988

Planning for extended human sojourns in space mandates that we have quantitative knowledge about the dose rates and the types of radiation that will be encountered. Similarly, the effects of the different types of radiation encountered in space, especially deep space, must be defined quantitatively. Much of the necessary radiobiology research can be carried out on Earth with defined radiation sources.

Committee on Space Biology and Medicine/Space Studies Board, *Assessment of Programs in Space Biology and Medicine—1991*. 1991

One way to maximize the return on investment in research is through various modes of cooperative research, with foreign partners, private concerns, and between federal agencies. . . . [An] example for . . . collaboration between federal agencies are facilities supported by the Department of Energy such as the BEVALAC, which has the capability of providing for study of very high-Z particles and their biological effects.

Space Studies Board, *Priorities in Space Life Sciences Research*, testimony by Space Studies Board Member Robert H. Moser to the House Budget Committee Task Force on Defense, Foreign Policy and Space, April 28, 1992

Improved measurements of cross-sections and better modeling of heavy-ion interactions, particularly for the yield and spectra of neutrons and other secondary particles generated in the shielding material, are also required. NASA currently helps support the BEVALAC heavy-ion accelerator and some cross-section studies. However, the BEVALAC has been threatened with closure, thus endangering some of the enabling research on both cross-section measurements and the long-term biological effects of ionizing radiation.

Committee on Human Exploration/Space Studies Board, *Scientific Prerequisites for the Human Exploration of Space*. 1993, in press

Letter

Attachment 1—Letter from DOE

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Attachment 3

NATIONAL RESEARCH COUNCIL

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Report of the 90-Day Study on Human Exploration of the Moon and Mars. 1989. NASA, Washington, D.C., November.

Strategic Considerations for Support of Humans in Space and Moon-Mars Exploration Missions, Life Sciences Research and Technology Programs. 1992. Volumes 1 and 2. Aerospace Medicine Advisory Committee, NASA Advisory Council. NASA, Washington, D.C., February.

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