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Office of Biological and Physical Research
Washington, DC 20546**

Research Opportunities in Space Radiation Biology

NASA Specialized Center of Research (NSCOR) for the Estimation of Solid Tumor Cancer Risks from Space Radiation

**New
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**Research Opportunities in Space Radiation Biology: NASA Specialized Centers of
Research for the Estimation of Solid Tumor Cancer Risks from Space Radiation**

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Research Announcement for NASA Specialized Centers of Research in Space Radiation Biology

I. Funding Opportunity Description

A. Summary and Background Information

The National Aeronautics and Space Administration (NASA) Vision is:

*To improve life here,
To extend life to there,
To find life beyond.*

January 14, 2004, the President of the United States announced a new vision for NASA to

- implement a sustained and affordable human and robotic program to explore the solar system and beyond;
- extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;
- develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and
- promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

The vision affirms the nation's commitment to space exploration and provides a clear direction for the civil space program. The activities carried out to implement this vision will be paced by experience, technology readiness, and affordability. Implementation involves key missions, including Moon and Mars exploration.

The Office of Biological and Physical Research (OBPR) contributes to this vision through its support of research that addresses the following questions:

- How can we assure the survival of humans traveling far from Earth?
- How does life respond to gravity and space environments?
- What new opportunities can research bring to expand understanding of the laws of nature and enrich lives on Earth?
- What technology must we create to enable the next explorers to go beyond where we have been?
- How can we educate and inspire the next generations to take the journey?

OBPR has developed a strategy that provides a description of the direction that the Enterprise will take to answer these questions and fulfill its mission. The OBPR Strategy can be accessed at:

http://spaceresearch.nasa.gov/general_info/strat.html

OBPR studies the biological and medical effects of space flight on human systems with the goals of managing medical risks, increased efficiency, and return benefits to earth. Four of the most important biomedical risks for long duration human space flight are: radiation health effects (increased risk of cancer and central nervous system damage), loss of bone density and muscle strength, behavioral health, and the ability to diagnose and treat illness and injury. In order to address the first of these risks, OBPR sponsors a vigorous radiation research program intended to enable NASA to eventually assure that humans can safely live and work in the space radiation environment anywhere and at any time.

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals for a NASA Specialized Center of Research (NSCOR) on Estimation of Solid Tumor Cancer Risks from Space Radiation sponsored by the Office of Biological and Physical Research (OBPR). An NSCOR consists of a team of investigators who have complementary skills and who work together to solve a closely focused set of research questions. The home laboratories of NSCOR team members may be geographically contiguous or dispersed, as long as the NSCOR team members have a mechanism for working together. In the past 10 years, NASA has funded NASA Specialized Centers of Research and Training (NSCORTs) in several areas. The center described in this solicitation will not have an explicit training component and, hence, the abbreviated acronym.

Radiation exposures required to conduct the research will use ground-based irradiation facilities at the NASA Space Radiation Laboratory (NSRL) at Brookhaven National Laboratory (BNL) in Upton, New York. NASA will not fund beam time or related expenses at accelerator facilities other than BNL.

Proposals outside the stated area of emphasis will be considered non-responsive and will be returned without review. However, NASA reserves the right to act in the best interests of the Federal Government in the matter of acceptance and evaluation of all proposals.

The mission of the OBPR includes strategic research as its highest priority. Within OBPR, the strategic research includes flight-based and ground-based research that enables NASA's mission to explore the Universe and search for life. The focus of radiation research in OBPR is to generate knowledge and information that is directly applicable to protecting humans from radiation during space travel, and Earth applications. Proposers are strongly encouraged to submit multidisciplinary research proposals consistent with the goals of the OBPR.

The Office of Science of the Department of Energy (DOE) may support additional research by a meritorious NSCOR that falls within the DOE mission in accordance with existing agreements with NASA regarding research of joint interest. The mission of the DOE Office of Science is **to deliver the remarkable discoveries and scientific tools that transform our understanding of energy and matter and advance the national, economic, and energy security of the United**

States. Within the DOE Office of Science, the office of Biological and Environmental Research (BER) and its Low Dose Radiation Research Program has the challenge of conducting research that can be used to inform the development of future national radiation risk policy for the public and the workplace. For this solicitation, DOE/BER is interested in funding research that would extend work to be done specifically for NASA to very low doses of low Linear Energy Transfer (LET) radiation (electrons, x- and gamma rays). The DOE/BER component would measure endpoints at doses that are at or near current workplace exposure limits, generally less than or equal to 0.1 Gray (10 rads). The low dose experiments will, as appropriate, leverage on the data from exposures to higher doses of radiation. Ideally, the combined research will help to determine the validity of extrapolation methods previously used to estimate the effects of low doses of radiation from observations made at high doses.

B. Introduction

The research solicited here is intended to further the following NASA objectives:

1. Enable the design of space exploration missions to the Moon and Mars that limit the risk of exposure to space radiation.
2. Reduce the uncertainty (understood as the 95% Confidence Level interval in the associated probability distribution) in the prediction of human cancer risk from exposure to space radiation to be no more than $\pm 50\%$.
3. Develop methods to assess variation in human susceptibility to cancer risk, that can be used to better inform astronauts and their health care providers about the risks incurred by consenting to occupational exposure to space radiation.
4. Develop methods to mitigate health risks of space radiation to humans by, e.g.,:
 - a. providing information to designers about the biological consequences of the utilization of various spacecraft, habitat and radiation shielding materials, to ensure maximally effective shielding.;
 - b. better design of mission parameters (orbits, EVA, etc.) to minimize biologically significant exposure;
 - c. discovery of biomarkers enabling early medical intervention, when required, for improved recovery; and
 - d. adaptation of biotechnological advances to treat and prevent radiation injury.

It is NASA's intention that the NSCOR team includes biologists who will use advanced ("cutting edge") scientific tools and methods to answer critical research questions regarding the consequences of space radiation to biological systems. Scientists working in rapidly developing areas of life sciences not necessarily associated with the study of radiation are particularly encouraged to consider the contributions that their field of study can make, and to propose relevant investigations. However, investigators new to radiation research are encouraged to

consult or collaborate with radiation experts in order to develop realistic experimental plans. The background information in this announcement and the list of references are intended to provide a useful starting point for such scientists as well as for expert radiation researchers not necessarily familiar with the idiosyncrasies of space radiation. Furthermore, NASA scientists are available to assist investigators wishing to enter this field of research.

The purpose of this document is to describe the rationale and objectives of the NSCOR program, the type of award to be made, and the research focus of this solicitation. **This NRA does not request proposals for flight research.** It is important that prospective investigators read the relevant section(s) carefully, as some of the programmatic emphases are different from those appearing in previous OBPR Announcements. In addition, this NRA includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and investigators.

C. NSCOR Goals and Objectives

The NSCOR program was established to advance knowledge in biological and biomedical sciences and technology, with the ultimate application of this knowledge to enable human space flight and long-term planetary missions. The NSCOR program is expected to enhance NASA's base of scholarship, skills, and performance in the space biological and biomedical sciences and related technological areas, and also expand the pool of research scientists and engineers trained to meet the challenges ahead as we prepare for future human space exploration missions.

An NSCOR differs from a set of independent projects in that suitable mechanisms are defined to engage the contributing projects in a synergistic manner, so that the total output of the NSCOR is greater than the sum of the parts: each project needs to contribute to all other projects, and each project needs to benefit in demonstrable ways from the contributions of all other projects. The team approach is also expected to lead to experimental protocols that achieve efficient beam utilization and sharing of experimental resources.

General goals of the NSCOR program are:

- to expand our understanding of specific scientific and technical challenges associated with biological and biomedical sciences;
- to provide substantial long-term funding to the research community in a manner that encourages the development of a stable base upon which problem-solving strategies can be built for the benefit of NASA and the public;
- to involve a broad spectrum of research scientists, engineers, and high caliber students in the activities of the NSCOR; and
- to facilitate the rapid transfer of knowledge gained and technology developed that is consistent with NASA missions.

The management structure must be the minimum that is consistent with financial and programmatic accountability and should not impose onerous costs or procedures on the investigators. Procedures to allocate resources and adjudicate differences of opinion need to be clearly defined and agreed upon by all participants.

D. Radiation Sources

All components of space radiation can be simulated using beams of high-energy charged nuclei. Such beams are available at the DOE Brookhaven National Laboratory (BNL), where NASA has recently commissioned the \$34M NASA Space Research Laboratory (NSRL). **Research proposals are expected to utilize beams of charged particles available at the NSRL or at BNL's Alternating Gradient Synchrotron (AGS) and to address experimental data obtained with such beams in ways leading to significant predictions that can be tested in future experiments.** Detailed information about the NSRL may be found in Section VIIIA of this document. Currently, the emphasis is on utilization of NSRL beams; AGS beams will continue to be available, but scientific justification for the use of their higher energies will need to be provided. NASA intends to operate these facilities for 600 hours or more per year if funds are available; selection of beam species and beam energies for experimental periods will be made by program managers in consultation with scientists proposing experiments for these beams. Investigators selected for funding will need to meet BNL requirements for experiment scheduling in order to gain access to beams and irradiation facilities.

NASA negotiates beam delivery directly with BNL and investigators proposing to use these irradiation facilities should not include the cost of beam time in their budgets. However, investigators should include the cost of carrying out the experiments, including travel to BNL, and provide an estimate of the hours of beam time required to conduct their experiments.

Investigations proposing the use of radiation sources in addition to NSRL and the AGS will be considered to the extent that this use is essential and complementary to research with HZE beams and does not involve additional costs. Neutron studies are not considered to be a valid model for HZE and proposals for neutron irradiation of model systems will not be supported.

E. Research Elements and Emphases

1. Description of Research Elements

To be responsive to this research solicitation, proposed studies should be hypothesis-driven and lead to new knowledge within accepted scientific standards. Purely phenomenological approaches with no significant mechanistic basis or likely gain in scientific knowledge are not acceptable. Experimental studies not directly using the irradiation facilities at BNL or not directly relevant to improved interpretation of experiments already conducted with such radiation will not be funded.

Each proposal should identify a coordinating Principal Investigator (Director) who will be responsible for ensuring that the NSCOR includes investigators with appropriate expertise in

radiation biology. Experimental protocols should reflect careful consideration of irradiation requirements, including justified estimates of dose, dose rates, and beam time for selected examples. Proposals should take into account the impact of gender, age, nutrition, stress, genetic predisposition, or sensitivity to other factors of importance in managing space radiation risks.

Proposals must identify questions and priorities enumerated in the Bioastronautics Critical Path Roadmap (BCPR) that will be addressed by or answered by their proposed research. Information about the CPR can be found online at <http://criticalpath.jsc.nasa.gov/main.asp>.

The focus and intended outcome of radiation biology research results is the development of accurate risk projections and countermeasures based on a thorough understanding of fundamental radiobiology.

2. Solicitation Focus

The central focus of this solicitation is research that will provide the basis for estimation of solid tumor cancer risks from space radiation. Analysis of epidemiological data on human and animal populations exposed to ionizing radiation is not expected to lead to the desired levels of accuracy, and cannot provide the understanding of biological processes intervening between radiation exposure and manifest disease. However, it is also recognized that molecular biology mechanisms, by themselves, are necessary but not sufficient as a basis for human risk estimates. This solicitation assumes that the required advances will evolve from studies with animal models and tissues, elucidating mechanisms hypothesized on the basis of cellular and molecular studies, and extrapolating the knowledge acquired to different species; in particular, to humans. **This solicitation does not solicit large-population animal studies and proposals for life-span studies or similar investigations.**

All applicants are required to discuss how their research may lead to risk estimates for protons and HZE particles, using animal models, including transgenic models of human cancers and how the proposed results can be extrapolated to estimate *human* solid tumor cancer risk from space radiation. In this context, cross-species comparisons using intermediate biological models representative of complex human models (e.g., skin, rat trachea, lung, etc.) may be of interest. In some cases, such extrapolations may not be obtainable directly from the research proposed; in those cases, investigators are required to make a compelling case for the argument that their research will result in major advances that are required for future extrapolation.

An assessment of the statistical power of analysis associated with the research is required, keeping in mind the NASA objective of attaining $\pm 50\%$ as the error in the predicted probability of excess solid tumor cancer fatality. It is likely that other consequences of space radiation exposure will become incorporated in future radiation risk assessments and need to be considered by investigators where appropriate. While attainment of the eventually desired error margin may not be possible for current investigations, it is nevertheless a requirement that investigators attempt to provide a realistic, quantitative assessment of the extent to which their proposed research is likely to contribute to this objective.

The primary criterion for an award will be scientific merit. Proposers are encouraged to establish interdisciplinary teams that address the objectives outlined below. However, proposers are not required to cover all of the topics below, but only those that best match the NSCOR criteria with the investigators' expertise.

The NSCOR team should focus their research on one or more topics and questions, of which the following are considered to be of high priority:

- a. Development of new understanding and models of the role of genetic susceptibility and sensitivity in the risk of solid cancers from space radiation. Models of carcinogenesis should allow comparison with existing low LET, low dose data on lung, GI, breast, thyroid, and skin. These are currently the tissues of greatest interest; studies of other tissues may be supported but applicants are required to provide a compelling rationale for their contribution to the field. Model systems that relate whole animal tissue effects to cellular mechanisms are preferred. Pilot studies of model systems designed to address issues of relevance to space radiation are encouraged as part of the larger investigation. Similarly, investigators are encouraged to consider model systems likely to enable a better understanding of the role of susceptibility gene expression in the course of sporadic carcinogenesis.
- b. Studies that improve the understanding of the dose response and radiation quality dependence of solid cancer risks.
- c. The role of space radiation in tumor promotion and progression. Degree of malignancy – e.g., number of metastasis, multiplicity of tissues involved, etc., is a related variable that may characterize high LET radiation carcinogenesis and proposals to additionally investigate this parameter are encouraged. Investigations into tumor progression along different pathways affected by different subsets of susceptibility genes is also a topic of interest.
- d. Studies of the biological factors that contribute to latency as a function of cancer type, age, radiation quality, and individual sensitivity, and how they can be used to improve risk assessment models. The latency period following high-LET radiation is observed to be shorter than that of low-LET radiation in animal studies of leukemias, mammary, lung, and other cancers, and is a concern for risk assessment. The average time to tumor appearance is also shortened in animal models that show increased radiation sensitivity due to inactivation of genes involved in repair of DNA damage, cell cycle checkpoints, and other genes.
- e. How can the age and gender dependence of solid cancer risk be determined and does the age and gender dependence of cancer risk found with low LET radiation hold for high LET? In particular, studies with middle age animals representative of the age distribution of astronauts (35-50 yrs) are of interest. Investigators need to be aware of the fact that intrinsic mortality may be a factor in the interpretation of the proposed research and need to explain how they intend to account for this factor where appropriate. Similarly, shifts in pathology need to be considered to the extent that they contribute to the mortality risk in some animal cancer data.

The following topics are considered to be of medium priority:

- a. Are there unique phenotypes in the risk of solid cancer from HZE particles?
- b. Studies leading to the development of molecular biomarkers of individual risk of cancer initiation (chromosomal changes leading to fusion genes (transcription factors), genomic instability, hyper-methylation, etc.), or other cellular and molecular changes caused by protons and HZEs and how such markers can be applied across species are of interest.

The following topics are considered to be of low priority:

- a. Studies of synergistic risks of cancer from radiation and space flight environmental toxicological factors are of interest.
- b. Studies that investigate possible relationships between solid cancer risk to bystander effects, adaptive responses, genomic instability, etc., are of interest (LOW Because NRA researchers already funded are doing this).
- c. Studies that improve the understanding of the mechanisms or biological countermeasures of solid cancer risk induced by space radiation.

NASA/DOE Collaboration

Proposed research, of relevance to common interests of NASA and DOE, may be funded by DOE/BER in addition to those portions of the NSCOR that are focused on the above NASA requirements relevant to space radiation. For the present solicitation, DOE/BER is interested in funding research that would extend work to be done specifically for NASA to very low doses of low Linear Energy Transfer (LET) radiation (electrons, x- and gamma rays). The DOE/BER component would measure endpoints at doses that are at or near current workplace exposure limits, generally less than or equal to 0.1 Gray (10 rads). The low dose experiments will leverage data from exposures to higher doses of radiation. Ideally, the combined research will help to determine the validity of extrapolation methods previously used to estimate the effects of low doses of radiation from observations made at high doses. This component of the research program will be a success if the science it generates is useful to policy makers, standard setters, and the public. Research projects utilizing the systems biology or discovery science approach, including the tools of comparative genomics and proteomics, are especially sought. Research projects that use experimental protocols or cell microenvironments that will lead to an understanding of radiobiological responses in intact human tissue are also strongly encouraged.

In the present context, the research considered to be most useful will focus on biological responses that are known to be induced at low doses of radiation, have the potential to directly impact (i.e., increase or decrease) subsequent development of cancer or other harmful health impacts, are quantifiable, could potentially be linked to the development of a biologically based model for radiation risk, and could potentially lead to the development of biological predictors (biomarkers) of individual risk.

Alternatively, a biological response of interest could meet all of the above criteria only at high doses but may actually be absent (as opposed to simply undetectable) at low doses of radiation. Since evidence is accumulating that the mechanisms of action are different after high versus low doses of radiation, such studies would help define these mechanisms. Defining the doses where these mechanisms shift is of critical importance.

DOE/BER will act as observers to the peer review and selection process and will advise NASA if any of the NSCOR proposals qualify for DOE additional support. DOE and NASA will determine the most appropriate funding mechanism for jointly supported research.

3. Structure of the NSCOR

Interactions among Investigators, University Partners and NASA

Teaming arrangements among investigators and research groups at the same institution and between different institutions is required and must be clearly explained. Evidence of appropriate institutional approval from each institution must be included in the proposal. The sharing of resources and responsibilities between member institution(s) must be explicitly stated in the proposal.

Key Personnel

Each proposing team must have a coordinating Principal Investigator with demonstrated scientific and administrative leadership qualities who will serve as NSCOR Director. The proposal should contain a detailed and coherent management structure that is conducive to accomplishing the goals of the NSCOR and is consistent with the research goals of the space radiation research program. The positions of NSCOR Director, Associate Director(s) (if any), and Research Leads (Principal Investigators) are considered Key Personnel. Their qualifications, roles, and responsibilities must be clearly defined in the proposal and they may not be substituted or removed without NASA's approval. The expertise of the key personnel should match the areas of emphasis. The Director of the NSCOR will be considered as the primary point of contact between the NSCOR and NASA. A written agreement with the proposal and a commitment to carry out their responsibilities in the event that the NSCOR is selected and funded must be signed by each participating Principal Investigator.

Scientific Advisory Committee

Each NSCOR proposal must identify a plan to establish an NSCOR Scientific Advisory Committee to assist and support the Director to ensure that

- the internal activities and external interactions of the NSCOR are coordinated;
- funds are allocated and used to properly fulfill the objectives of the NSCOR;
- fair procedures are in place to adjudicate differences of opinion among the participants;

- advice on productivity and effectiveness of the NSCOR is provided to the Director; and
- appropriate interactions take place to assure information exchange and technology transfer among scientists, engineers, and administrators, and those in other public and private institutions deemed important to the effort.

The NSCOR Scientific Advisory Committee should include members with appropriate scientific and management expertise. The composition of this committee is at the discretion of the Director, but it must meet formally at least once a year to evaluate the NSCOR's progress and issue a written report on its findings. This report shall be a part of the annual report required of the NSCOR.

Expertise of Universities

Academic Departments

The different academic departments at the participating institutions must have committed personnel and facilities to accommodate the research needs of this NSCOR. There should be a plan for coordination of research activities and resource sharing.

Personnel

The participating institutions must have faculty with the expertise to undertake this multidisciplinary NSCOR project. The proposal should outline how the complementary expertise of the faculty will result in a teaming effort that will adequately address the research needs of the NSCOR.

Roles and Responsibilities

In order to achieve the research goals of the NSCOR, the roles and responsibilities of the individual investigators, Research Leads, Associate Director(s), and the Director must be clearly defined. The proposal must also include a description of these roles and responsibilities and interactions between partnering institutions. A description of the process for the transfer of resources and other partnering agreements between the participating institutions must be included in the proposal.

F. Education and Public Outreach

OBPR programs represent an opportunity for NASA to enhance and broaden public knowledge, understanding, and appreciation of biological and biomedical research, and the value of this research in the space environment. Individuals participating in NASA's OBPR programs have a responsibility to foster the development of a scientifically informed public. Therefore, all participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of biological and biomedical sciences, the space environment, and OBPR programs through formal and informal education opportunities.

OBPR envisions that the selected proposals will be structured and operated in a manner that supports the nation's educational initiatives and goals (including support of historically black colleges and universities and other minority universities), and in particular the need to promote scientific and technical education at all levels. OBPR envisions that the selected proposals will support the goals for public awareness and outreach to the general public. The selected principal investigators are invited to participate in OBPR-funded educational programs.

The proposal represents an opportunity for NASA to enhance and broaden the public's understanding and appreciation of the value of OBPR research in the context of NASA's mission. Therefore, all investigators are strongly encouraged to promote general scientific literacy and public understanding of OBPR research through formal and/or informal education opportunities. If appropriate, proposals should include a clear and concise description of the education and outreach activities proposed. Examples include such items as involvement of students in the research activities, technology transfer plans, public information programs that will inform the general public of the benefits being gained from the research, and/or plans for incorporation of scientific results obtained into educational curricula consistent with educational standards.

Where appropriate, the supported institution will be required to produce, in collaboration with NASA, a plan for communicating to the public the value and importance of their work. Once NRA selections are made, the selected PIs will have an opportunity to request additional funding through an OBPR-sponsored pilot program to implement an education outreach program at the grades 6-12 level, at an amount not to exceed \$10,000 per year for the term of the grant. A request for proposal will accompany the selection notification letter. Proposals will be due within 60 days of selection notification and shall be limited to 4 pages. A review of these proposals by educational specialists will determine which proposals will be funded.

G. NASA Safety Policy

Safety is NASA's highest priority. Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including employees working under NASA instruments), and (4) high-value equipment and property. All research conducted under NASA auspices shall conform to this philosophy.

H. Availability of Funds for Awards

Funds are not currently available for awards under this announcement. The Government's obligation to make award(s) is contingent upon the availability of the appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this announcement.

II. Award Information

It is anticipated that there will be one new award to a focused NSCOR research team dealing with the risk of solid tumor carcinogenesis incurred by exposure to space radiation; an NSCOR engaged in a similar study related to leukemogenesis is already supported by NASA. The selected proposal will be funded as a research grant in one-year increments for activities lasting up to **five** years. The funding duration will depend on proposal requirements, review panel recommendations, and continuing progress of the activity.

NASA may consider funding more than one proposal in the event that more than one outstanding project is found to be of superior scientific merit and programmatic relevance. Conversely, NASA may not fund any project if the scientific merit and programmatic relevance of all proposals fail to meet the high standard required. If separate projects in a grant application are of outstanding merit, but the group as a whole fails to provide a satisfactory case for funding as a team, one or more individual projects may be selected for funding, if NASA determines that this is in the best interests of the program.

The total annual cost to NASA shall not exceed **\$2,000,000** per year. NASA reserves the right to return proposals, without review, that exceed the described award amounts. NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget. It is estimated that the initial selection will be announced by **September 2004** and the grant awarded in a reasonable time frame. However, selection and start of funding may be delayed to the start of the next fiscal year.

The mechanism for funding the NSCOR will be a single grant, with funding allocations to participating investigators based on the submitted budget. The NSCOR Director, with the advice and consent of the internal advisory committee, may make changes in this budget. NASA will fund the NSCOR one year at a time. The funding is to last up to a maximum of five years. Elements of the proposed work that address DOE concerns should be clearly identified and the proposal shall provide a clear explanation of the extent to which the research overlaps the interests of both agencies and the extent to which the research oriented toward DOE concerns is additional. The NSCOR Director is expected to work closely with the appropriate technical representatives from NASA in order to assure continued success and programmatic relevance. NASA, together with DOE as appropriate, will conduct a yearly review of NSCOR progress.

III. Eligibility Information

A. Eligibility of Applicants

All categories of U.S. institutions are eligible to submit proposals in response to this NRA. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in

science and technology, or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior NASA support of research or training in any institution or for any investigator is not a prerequisite to submission of a proposal or a competing factor in the selection process.

B. Cost Sharing or Matching

If an institution of higher education, hospital, or other non-profit organization wants to receive a grant or cooperative agreement from NASA, cost sharing is not required. However, NASA can accept cost sharing if it is voluntarily offered (See the Handbook, Section B, Provision 1260.123, “Cost Sharing or Matching,” which describes the acceptable forms of cost sharing). If a commercial organization wants to receive a grant or cooperative agreement cost sharing is required, unless the commercial organization can demonstrate that they are unlikely to receive substantial compensating benefits for performance of the work. If no substantial compensating benefits are likely to be received, then cost sharing is not required but can be accepted (See the Handbook, Section D, Provision 1274.204, “Costs and Payments”).

C. Guidelines for International Participation

Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation. Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective investigator to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at <http://www.pmdtc.org> and <http://www.bis.doc.gov/>. Investigators are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered “Defense Articles” on the United States Munitions List and are subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

IV. Proposal and Submission Information

A. Source of Application Materials

All information needed to apply to this solicitation is contained in this announcement and in the companion document entitled “Guidebook for Proposers Responding to NASA Research Announcements” (hereafter referred to as the Guidebook for Proposers) that is located at <http://www.hq.nasa.gov/office/procurement/nraguidebook/>. This solicitation and any modifications or updates to this solicitation are available at:

http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU002N/index.html.

Except where specifically stated otherwise in this NRA, applicants must prepare proposals in accordance with the Guidebook for Proposers. Proposals that do not conform to the standards outlined in this NRA and included in the Guidebook for Proposers may be declared noncompliant and returned without review. Note that the NASA policy for proposals involving non-U.S. participants is given in Section (I) of Appendix B of this Guidebook. Comments and suggestions of any nature about the Guidebook for Proposers are encouraged and welcomed and may be directed at any time to Mr. Tom Sauret, Office of Procurement, Code HK, NASA Headquarters, 300 E Street SW, Washington, DC 20546-0001; E-mail: Tsauret@mail.hq.nasa.gov.

B. Content and Form of Proposal Submission

The following information is specific to this NRA and **supersedes** the information contained in the Guidebook for Proposers.

1. SYS-EYFUS Registration

SYS-EYFUS is an electronic system used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, etc.).

The SYS-EYFUS Help Desk is available at (202) 479-9376. Help desk hours are from 8 a.m. to 6 p.m. Eastern time.

All investigators planning to submit a proposal to this solicitation are required to register online with SYS-EYFUS. Comprehensive help, instructions, and contact information are provided online. SYS-EYFUS can be accessed at the following Web address:

<http://proposals.hq.nasa.gov/proposal.cfm>

If you have previously registered with SYS-EYFUS, you are asked to verify and update your user information. If you have forgotten your user ID or password, select the “Forgot Your Password” option and type in your first and last name to search our database. The system will send an automatic e-mail message with your username and password to the e-mail address listed in our database.

2. Instructions for Preparing and Electronically Submitting a Notice of Intent

All investigators planning to submit a proposal in response to this solicitation are requested to submit a **non-binding** notice of intent (NOI) to propose by the due date identified in the Submission Dates and Times Section of this NRA via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above and select “New Notice of Intent.”
- 2) The Division Specific Opportunities screen will appear. In the selection window, highlight “**UU-OBPR**” and click on “Continue.”
- 3) The List of Existing Opportunities screen will appear. In the selection window, highlight “**NNH04ZUU002N - NSCOR for Estimation of Solid Tumor Cancer Risks from Space Radiation**” and then click on “Continue.”
- 4) This will bring you to the Notice of Intent Submission Form. **All fields are required.**
 - a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.
 - b. Please select from **only** the following three options: For the proposal type field on this form, new/no prior support means that the investigator has not received NASA funding from 2001 through 2003, new/prior support means that the investigator has received NASA funding between 2001 through 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.
 - c. Indicate the status of IRB/IACUC for your proposal. If IRB or IACUC review is unavoidably delayed beyond the submission of the application, enter “Pending” on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.
 - d. Provide your DUNS and CAGE numbers. If you do not know your DUNS and CAGE numbers, contact your Office of Sponsored Research or equivalent office. All applicants must provide the Dun and Bradstreet (D&B) Data Universal Numbering System (DUNS) number for their organization in the Cover Page of their proposal. This requirement applies to renewals of awards as well as to prospective new awards. The DUNS number is a unique nine-character identification number provided by the commercial company Dun & Bradstreet (D&B). Organizations will use the same DUNS number with every proposal submitted for a Federal grant and cooperative agreement. Note that the DUNS number is site-specific. Applicants may call D&B at 1-866-705-5711 to register and obtain a DUNS number, or access the D&B website at: <http://www.dnb.com/us/>.

NASA also requires the applicant's organization to be registered in the Central Contractor Registration (CCR) database and obtain a Commercial And Government Entity (CAGE) code prior to submitting a proposal. The purpose of this requirement is to help centralize information about grant recipients and provide a central location for grant recipients to change organizational information. Information for registering in the CCR and online documents can be found at <http://www.ccr.gov/>. Before registering applicants and recipients should review the Central Contractor Registration Handbook, which is also located at <http://www.ccr.gov/>. The process for obtaining a CAGE code is incorporated into the CCR registration.

- 5) Click on "Submit NOI Page."
- 6) The Team Member Page screen will appear, where you can add or remove team members. Select continue if there are no other team members. To add a team member, highlight the role option on the selection list, type in first and last name and click on search. When the resulting set appears, choose the appropriate radio button and click on ADD to add the person to the NOI. After you are done, click on "Continue." **IMPORTANT:** If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.
- 7) After continuing from the Team Members Page, your NOI will be displayed. Click on "Resubmit NOI Page" to complete your NOI submission.
- 8) You may edit and resubmit your NOI at any time before the submission deadline. Once you submit an NOI, it cannot be deleted, only edited. For title, team member, or any other changes, please edit your existing NOI and resubmit changes to avoid duplicate records.

3. Instructions for Preparing and Electronically Submitting a Proposal Cover Page

All investigators planning to submit a proposal in response to this solicitation must electronically submit proposal cover page information online and provide a hardcopy of the cover page attached to each proposal copy by the due date indicated in the Submission Dates and Times Section of this NRA. The proposal cover page can be submitted and printed via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above.
- 2) To submit a New Proposal Cover Page, click the "New Proposal Cover Page" option on the SYS-EYFUS Options screen, and the New Proposals Cover Page screen will appear.

- 3) If you previously submitted an NOI in response to this solicitation, choose to carry over the existing NOI. This option will populate the cover page fields with the NOI information. Edit the information as necessary, click “Continue,” and proceed to #8 below.
- 4) If you did not previously submit an NOI, click on New Proposal Cover Page option, and the Division Specific Opportunities screen will appear.
- 5) In the selection window, highlight “**UU-OBPR**” and click on “Continue.”
- 6) The List of Existing Opportunities screen will appear. In the selection window, highlight “**NNH04ZUU002N - NSCOR for Estimation of Solid Tumor Cancer Risks from Space Radiation**” and then click on “Continue.”
- 7) This will bring you to the Proposal Cover Page Submission Form. Fill in all the fields. All fields are required.
 - a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.
 - b. Please select from **only** the following three options: For the proposal type field on this form, new/no prior support means that the investigator has not received NASA funding from 2001 through 2003, new/prior support means that the investigator has received NASA funding between 2001 through 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.
 - c. Indicate the status of IRB/IACUC for your proposal. If IRB or IACUC review is unavoidably delayed beyond the submission of the application, enter “Pending” on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.
 - d. Provide your DUNS and CAGE numbers. If you do not know your DUNS and CAGE numbers, contact your Office of Sponsored Research or equivalent office. All applicants must provide the Dun and Bradstreet (D&B) Data Universal Numbering System (DUNS) number for their organization in the Cover Page of their proposal. This requirement applies to renewals of awards as well as to prospective new awards. The DUNS number is a unique nine-character identification number provided by the commercial company Dun & Bradstreet (D&B). Organizations will use the same DUNS number with every proposal

submitted for a Federal grant and cooperative agreement. Note that the DUNS number is site-specific. Applicants may call D&B at 1-866-705-5711 to register and obtain a DUNS number, or access the D&B website at: <http://www.dnb.com/us/>.

NASA also requires the applicant's organization to be registered in the Central Contractor Registration (CCR) database and obtain a Commercial And Government Entity (CAGE) code prior to submitting a proposal. The purpose of this requirement is to help centralize information about grant recipients and provide a central location for grant recipients to change organizational information. Information for registering in the CCR and online documents can be found at <http://www.ccr.gov/>. Before registering applicants and recipients should review the Central Contractor Registration Handbook, which is also located at <http://www.ccr.gov/>. The process for obtaining a CAGE code is incorporated into the CCR registration.

Click on "Continue."

- 8) The Team Member Page screen will appear, where you can add or remove team members. Every proposal must specify the critically important personnel who are expected to play a significant role in the execution of the proposed effort and their institution of employment. Categories of personnel to be included as Team Members are described in Guidebook for Proposers.

You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

IMPORTANT: If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

- 9) After continuing from the Team Member Page, the Proposal Options Page appears.
- 10) Please fill out the budget form by clicking on the "Budget" button, filling in project costs, and clicking "Continue." This will bring you to the Proposal Budget Review Page. Click "Continue" if the information is correct.
- 11) After verifying your budget information, you will be returned to the Proposal Options Page. Click the "Show/Print" button.
- 12) For detailed budget information, you must use the budget forms provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU002N/index.html. Sample copies of these forms are also available as attachments to this NRA and must be filled out for each year of grant support requested. These forms cannot be electronically

submitted. Fill out the forms and attach them to your proposal.

- 13) At the page entitled Proposal Information Item List, click “Continue” to preview your Proposal Cover Page. Print the cover page from your Internet browser once you have reviewed the information. The cover page must be signed by both the Principal Investigator and the authorizing official and attached to the front of your proposal before submission of hard copies to NASA.

By signing and submitting the proposal identified on the cover sheet, the authorizing official of the proposing institution (or the individual investigator if there is no proposing institution) 1) certifies that the statements made in the proposal are true and complete to the best of his/her knowledge; 2) agrees to accept the obligations to comply with NASA Award terms and conditions if an award of a grant or cooperative agreement is made as a result of this proposal (does not apply to contract awards); and 3) provides certification to the following that are reproduced in their entirety in Appendix G of this NRA: (i) Certification Regarding Debarment, Suspension, and Other Responsibility Matters, (ii) Certification Regarding Lobbying, and (iii) Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

Once you print your cover page, the electronic portion of your NASA proposal submission is complete.

- 14) You may edit and resubmit your proposal cover page at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA. Please note that once you submit a proposal cover page, it can only be edited, not deleted. For title, team member, budget or any other changes, please edit your existing proposal cover page and resubmit changes to avoid duplicate records. After you print your edited cover page, your changes are automatically submitted to NASA.

4. Instructions for Preparation and Delivery of Proposals

All proposals submitted must include the completed cover page form as described above. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the cover page form, where fields are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to the maximum duration identified in this announcement but should be suitable for the project proposed.

The proposal must include the following material, in this order:

- (1) Proposal Cover Page: Solicited Proposal Application, including certification of compliance with U.S. code (if applicable). One signed original required. Please see “Instructions for Preparing and Electronically Submitting a Proposal Cover Page” in Section IV.B.3 above for instructions on how to complete the proposal cover page

information.

- (2) Transmittal Letter or Prefatory Material, if any (see Guidebook for Proposers).
- (3) Proposal Title Page, with Notice of Restriction on Use and Disclosure of Proposal Information, if any (see Guidebook for Proposers).
- (4) Project Description: The length of the Project Description section of the proposal cannot exceed 40 pages using regular (12 point) type. Text must be printed on one side only and should have the following margins: left = 1.5"; Right, top, bottom = 1.0". Referenced figures must be included in the 40 pages of the Project Description. The Bibliography, Management Approach, and all following sections are not considered part of the 40-page project description. Proposals that exceed the 40-page limit for the project description will not be reviewed. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with current resources and the resources requested. In addition, the proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement. Reviewers are not required to consider information presented as appendices or to view and/or consider Web links in their evaluation of the proposal.
- (5) Management Approach: Each proposal must specify a single Principal Investigator (Director) who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. The roles and responsibilities of the Associate Directors, Research Leads and other Key Personnel in the NSCOR and the proportion of each individual's time to be devoted to the proposed research activity must be clearly defined. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

Investigators are strongly encouraged to identify only the most critically important personnel to aid in the execution of their proposals. Should such positions be necessary, Co-Investigators (co-Is) may be identified who are critical for the successful completion of research through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, regardless of whether or not they receive compensation under the award. Most NRAs require a co-I to have a well-defined role in the research that is defined in the Management section of the proposal. Evidence of a co-I's commitment to participate is often requested through a brief letter to be included with the proposal.

There are three subcategories of co-Is that a proposal may identify, as appropriate:

- A co-I may be designated as the Science PI for those cases where the proposing institution does not permit that individual to formally serve as the PI as defined above. In such a case, the Science PI will be understood by NASA to be in charge of the scientific direction of the proposed work, although the formally designated PI is still held responsible for the overall direction of the effort and

use of funds.

- A co-I may be designated as an *Institutional PI* when their institution is making a major contribution to a proposal submitted by a PI from another institution.
- A co-I from a non-U.S. institution may be designated as a *co-Principal Investigator* (co-PI) should such a designation serve required administrative purposes in that co-I's institution and/or for the procurement of funding by that co-I from their sponsoring funding authority.

Additional category positions are often included in proposals as defined as follows:

- A *Postdoctoral Associate* holds a Ph.D. or equivalent degree and is identified as a major participant in the execution of the proposed research. Such personnel may be identified by name or only by function in those cases where their recruitment depends on the successful selection of the proposal.
- *Other Professional* is a description appropriate for personnel who support a proposal in a critical albeit intermittent manner, such as a consulting staff scientist or a key Project Engineer and/or Manager, who is not identified as a co-I or Postdoctoral Associate.
- A *Graduate Student* included in a proposal is working for a post-graduate degree and will support the proposed research under direction of the PI. Such a student may be identified by name or only by function in case their recruitment depends on the successful selection of the proposal.
- A *Collaborator* is an unfunded position included in a proposal, whose participation is less critical than a co-I, but who is committed to provide a specific contribution to the proposal.

(6) Personnel/Biographical Sketches: The NSCOR Director is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the Director that includes his or her current position title and educational background, a list of principal publications, and a description of any exceptional qualifications must be included. The research and professional experience of the Associate Director, Research Leads and other Key Personnel must be described. Concluding with present position, chronologically list previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications (see Guidebook for Proposers). A sample biographical sketch form can be downloaded at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU002N/index.html. A sample copy of the form is available as an attachment to this NRA. These forms cannot be electronically submitted. Do not exceed two pages. Omit social security numbers and

other personal items that do not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described. Fill out the forms and attach them to your proposal.

- (7) Facilities and Equipment: Describe the available facilities and major items of equipment specially adapted or suited to the proposed research activities, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use in the research activities. The research plan must provide evidence that such facilities or equipment will be made available if the proposal is accepted. Before requesting a major item of capital equipment, the proposer should determine the availability of equipment already within the organization as an alternative to purchase. Where such arrangements cannot be made, the proposal should state this explicitly. The need for items that can be typically used for research and non-research purposes should be explained.
- (8) Special Matters (specific information on animal or human subjects protocol approval required, if applicable)

For proposals employing human subjects and/or animals, assurance of compliance with human subjects and/or animal care and use provisions is required on the Proposal Cover Page. In addition, the application must include a statement from the applicant institution certifying that the proposed work will meet all Federal and local human subjects requirements and/or animal care and use requirements.

Policies for the protection of human subjects in NASA sponsored research projects are described in NASA Management Instruction (NMI) 7100.8B (*Protection of Human Research Subjects*). Animal use and care requirements are described in the NASA Code of Federal Regulations (CFR) 1232 (*Care and Use of Animals in the Conduct of NASA Activities*). Both documents are available from the Office of Biological and Physical Research, Code UB, NASA Headquarters, Washington, DC 20546.

Additional Requirements for Research Employing Human Subjects

A letter signed by the Chair of the Institutional Review Board (IRB) identifying the proposal submitted to NASA by title and certifying approval of proposed human subjects protocols and procedures should be included with each copy of the proposal. IRB certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IRB certification is pending on the proposal due date, select “pending” from the

IRB/IACUC section menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IRB Chair identifying the proposal by title and indicating the status of the IRB review process at the time of submission. IRB certification must be received no later than 90 days after the proposal due date. An application lacking the required IRB certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

With regard to research involving human subjects, NASA and the NSBRI have adopted the National Institutes of Health (NIH) policy. Women and members of minority groups and their subpopulations must be included in NASA-supported biomedical and behavioral research projects involving human subjects, unless a clear and compelling rationale and justification is provided showing that inclusion of these groups is inappropriate with respect to the health of the subjects or the purpose of the research.

NASA will require current IRB certification prior to each year's award.

Additional Requirements for Research Employing Animals

Specific information describing and justifying the use of animal subjects must be included in the proposal.

A letter signed by the Chair of the Institutional Animal Care and Use Committee (IACUC) identifying the proposal submitted to NASA by title and certifying approval of the proposed animal research protocols and procedures should be included with each copy of the proposal. The institution's Public Health Service Animal Welfare Assurance Number must be included on the IACUC certification and entered in the IRB/IACUC section of the Proposal Cover Page. IACUC certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IACUC certification is pending on the proposal due date, select "pending" from the IRB/IACUC selection menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IACUC Chair identifying the proposal by title and indicating the status of the IACUC review process at the time of submission. IACUC certification must be received no later than 90 days after the proposal due date. An application lacking the required IACUC certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review. NASA will require current IACUC certification prior to each year's award.

(9) Detailed Budget and Supporting Budgetary Information

For detailed budget information, you must use the forms provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU002N/index.html. Sample copies of these forms are also available as attachments to this NRA. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

NASA is expected to be operating on the basis of full cost accounting as soon as possible, including all Civil Service salaries with overhead. In the interim period, proposals should use the accounting method authorized at their institutions at the time proposals are due and for the entire proposed period of performance. Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are to be budgeted within the NASA intramural Principal Investigator budget.

If travel is planned, the proposal budget should include appropriate travel funds for visits to NASA field centers (as appropriate) and presentation of findings at professional society meetings.

In this solicitation, the terms “cost” and “budget” are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: \$1,000, or Labor: \$6,000) may cause delays in evaluation and award. Generally, costs will be evaluated for realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate, such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

- Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- Consultants: Identify consultants to be used, why they are necessary, the time

they will spend on the project, and the rates of pay.

- Equipment: List separately. Explain the need for items costing more than \$5,000. Describe basis for estimated cost. General-purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant, and provide the basis of estimate, including information on destination and number of travelers (if known).
- Other: Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts.

All awards made as a result of this NRA may be funded as grants or contracts. However, while proposals submitted by “for profit” organizations are allowed, they cannot include a “fee.”

- (10) Other Support: You must provide information on other support for specific sources of other support for the principal investigator and each Co-Investigator (not consultants). A sample form is provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU002N/index.html. A sample copy of the form is also available as attachment to this NRA
- (11) Appendices, if any. (**Reviewers are not required to consider information presented in appendices**).

5. Submission Dates and Times

One (1) signed original cover page and proposal and fifteen (15) copies of the proposal cover page and proposal **must be received by 4:30 p.m. Eastern Time, August 13, 2004**. Proposals shall not be submitted electronically, except for parts specified in this NRA. Proposals mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA Peer Review Services
SUBJECT: **Radiation NSCOR**
500 E Street SW
Suite 200
Washington, DC 20024

Proposals that are hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between 8:00 a.m. and 4:30 p.m. Proposals must be received by 4:30 p.m. Eastern time on the proposal due date. The telephone number (202) 479-9030 may be used when required for reference by delivery services. NASA Peer Review Services (NPRS) cannot receive deliveries on Saturdays, Sundays, or federal holidays. NPRS will send notification to the investigator confirming proposal receipt within 5 business days of the proposal receipt date; however, there will not be a response from the Office of Biological and Physical Research.

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA NNH04ZUU002N
Number of Copies Required:	Original + 15 copies
Proposals Due:	August 13, 2004
Estimated Selection Announcement:	October 2004
Selecting Officials:	Directors, Bioastronautics Research Division Fundamental Space Biology Division Office of Biological and Physical Research

6. Funding Restrictions

- The construction of facilities is not an allowed activity unless specifically stated so in the program description. For further information on the allowability of costs, refer to the cost principles cited in the Guidebook for Proposers.
- Travel is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for publicizing its results at an appropriate professional meeting. The proposal must include travel funds for the following:
 - Experiments to be performed at BNL
 - Annual Investigators meeting
 - Annual NASA review: Optional Travel
 - Visits to NASA Field Centers
 - Presentation at a professional society meeting (highly desirable)
- U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources, but award funds may not be used to fund research carried out by non-U.S. organizations. However, subject to possible export control restrictions, foreign nationals may conduct research while employed by a U.S. organization.

- Profit for commercial organizations is allowed under contract awards only.
- NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget.
- Regardless of whether functioning as a team lead or as a team member, personnel from NASA Centers must propose budgets based on Full Cost Accounting (FCA). Non-NASA U.S. Government organizations should propose based on FCA unless no such standards are in effect; in that case such proposers should follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board (for further information, see <http://www.hq.nasa.gov/fullcost/>).

V. Proposal Review Information

The following information is specific to this NRA and **supersedes** the information contained in the Guidebook for Proposers.

A. Intrinsic Scientific or Technical Merit Review and Evaluation Criteria

The overall evaluation process for proposals submitted in response to this Announcement will include review of relevance, cost criteria, and merit criteria. All of the following merit criteria will be considered in determining the merit score of the proposal. These criteria will be weighed to the extent that they impact the quality of the scientific results that can be expected from the proposed research.

- **Approach:** Are the proposed component projects adequately developed, well defined, well integrated, and appropriate to the aims of the NSCOR? Is the proposed approach likely to yield the desired results? Does the proposal acknowledge potential problem areas and consider alternative tactics? Is it likely that the proposed implementation timeline will be met?
- **Key Personnel and Investigators:** Do the qualifications, experience and proposed commitment of the proposed Director, Associate Director(s) and Research Leads reflect the scientific knowledge and effective leadership potential that will result in a successful NSCOR?
- **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Are the proposed facilities and equipment to be used adequate to achieve the goals of the NSCOR? Is there evidence of institutional support?
- **Collaboration and Overall Impact:** Will the proposed NSCOR foster effective collaborations between the investigators within the NSCOR? Are the research and knowledge transfer activities strategically integrated such that the whole is greater than the sum of the parts? Are all partners vital participants in the NSCOR effort?

- **Internal Assessment:** Does the proposed NSCOR have an adequate internal advisory group in order to ensure that it will be able to meet the goals established by NASA and adjudicate internal matters efficiently?

B. Review and Selection Process

1. Compliance Matrix

All proposals must comply with the general requirements of the Announcement as described in both this solicitation and the Guidebook for Proposers. Upon receipt, proposals will be reviewed for compliance with these requirements including:

1. Submission of complete proposals specified in this Announcement. Proposals must be responsive to the areas of program element emphasis described in this Announcement and include a project description that is not more than 40 pages in length.
2. Submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects.
3. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding that described in the Announcement.
4. Submission of all other appropriate information as required by this Announcement.

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the investigator without further review.

Compliant proposals submitted in response to this Announcement will undergo an intrinsic scientific or technical merit review. Only those proposals most highly rated in the merit review process will undergo additional reviews for program relevance and cost.

2. Review and Selection

The overall evaluation process for proposals submitted in response to this Announcement will include the following reviews:

First Tier Merit Review: A review for intrinsic technical or scientific merit and overall impact will be conducted for all proposals.

Second Tier Review for Relevance and Cost: Relevance to NASA and proposed project cost.

The **first review tier** will be a merit review by a panel of scientific or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in this announcement. The merit review panel will assign *a score from 0-100* based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel *will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance of the proposed work to NASA*. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

The **second review** will evaluate the programmatic relevance and cost of all proposed work. This review will be conducted by NASA Program Scientists and Managers. Evaluation of the cost of a proposed effort includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

Programmatic relevance will include an evaluation of the extent to which the proposal covers the areas of interest within each NSCOR and the extent to which the combined effort is likely to exceed the contribution expected from the collection of individual projects. Proposers are not required to cover the entire discipline area solicited in each NSCOR, but only that part of the solicited research that best matches the NSCOR criteria with the investigators' expertise. The degree of integration, i.e., the extent to which the whole is likely to be greater than the sum of the parts, will be emphasized by NASA reviewers more than breadth of coverage. However, proposals are expected to cover a scientifically significant area of the solicited area of research and to avoid a narrow focus.

The most important element in the evaluation process is the merit review, which carries the highest weight in final evaluation and selection. The other factors are approximately equal in weight to each other.

The information resulting from these two levels of review, as described above, will be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the program elements described in this announcement. This recommendation will be based on:

1. The scientific or technical merit review score from the peer review panel.
2. The programmatic relevance.
3. The cost of each proposal.

This **selection recommendation** is the responsibility of the NASA program scientist(s). Selection for funding will be made by the selecting official identified in this announcement.

VI. Award Administration Information

A. Award Notices

At the end of the selection process, each proposing organization is notified of its selection or nonselection status. NASA provides debriefings to those investigators who request one. The selection letters will include a statement indicating that the selected organization's business office will be contacted by a NASA Contracting or Grant Officer, who is the only official authorized to obligate the Government, and a reminder that any costs incurred by the investigator

in anticipation of an award are at their own risk. Selection notification will be made by a letter signed by the selecting official.

The NASA Procurement Office will determine the type of award instrument, request further business data, negotiate the resultant action, and are the only personnel with the authority to obligate government funds.

NASA reserves the right to offer selection of only a portion of a proposal. In these instances, the investigator will be given the opportunity to accept or decline the offer.

B. Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or National policy requirements, nor do the award(s) that will be made involve any special terms and conditions that differ from NASA's general terms and conditions as given in the Guidebook for Proposers.

C. Program Reporting/Individual Researcher Reporting

The proposal must indicate how the NSCOR will maintain awareness of NASA's needs in the technical areas described in this Announcement and maintain communication with the appropriate points of contact at NASA, which are listed in this announcement.

As a vital measure of productivity, results from NSCOR research should be submitted to peer-reviewed journals as the work progresses. Only those published papers that acknowledge NASA's support and identify the NSCOR grant as a funding source will be counted as resulting from the NSCOR and used to evaluate its productivity.

The Director, project leaders, and other members of the team (by agreement with NASA management) shall attend an annual review at a location specified by NASA, where they shall present an overview of their progress and discuss appropriate revisions to the NSCOR plans.

The Director, project leaders, and participating investigators shall present current results of their research at the Annual Space Radiation Health Investigators' Workshop.

Annual Reporting

The Office of Biological and Physical Research publishes a comprehensive online document titled OBPR Program Tasks and Bibliography (Task Book) which includes descriptions of all current peer-reviewed activities funded by the division. Since its inception, the Task Book has served as an invaluable source of information for OBPR as well as the scientific and technical communities.

Investigators are required to provide NASA with this summary information at a minimum of once per year. This information will be made available to the scientific community and will be used to assess the strength of the Division's programs. It will also serve as the basis for determining the degree of progress of the project. The information provided for the Task Book

will meet both the requirements for program annual reporting requirements and the individual researcher Task Book reporting. Updates can be made throughout the duration of the project at anytime during the year, with a due date of at least once per year, 60 days prior to the anniversary date of the grant start date.

Please note that each individual research project undertaken at the NSCOR needs to comply with the Task Book requirement.

The information requested will include

- an abstract,
- a brief statement of progress during,
- a brief statement of benefits of the research with respect to life on Earth,
- an updated bibliographic list,
- a copy or reprint of each publication listed in the bibliography,
- a listing of presentations or activities conducted at 6-12 educational institutions,
- a listing of interactions, presentations, or other activities with the general public, and
- a statement of potential scientific, technological, economic or societal impact.

Additionally, the annual report must also include the following information for the entire NSCOR (encompassing all projects):

- A report on interactions and collaborations with groups outside the NSCOR
- A plan for the next 12 months
- Status information on the NSCOR's management and financial condition, projects (completed and in-progress), personnel changes and partnerships

Note that portions of this publication will be made available to the general scientific community. This report is not a substitute for traditional scientific reporting in journals and elsewhere. It will also serve as the basis for determining the degree of progress of the NSCOR.

All articles submitted for publication must include the following statement: "This research was funded in whole or in part by a grant from the Office of Biological and Physical Research of the National Aeronautics and Space Administration." Publications not including this acknowledgement will not be considered to be the product of NASA-funded research when NASA assesses the progress of the grant.

Annual NASA Review

The Director, project leaders, and selected members of the team (by agreement with NASA management) shall attend an annual review (at a location specified by NASA, either Washington DC or an appropriate NASA Center) where they shall present an overview of their progress, and discuss appropriate revisions to the NSCOR plans with NASA management. Selected members of the original merit review panel and additional scientific experts may be invited to participate in the evaluation of scientific progress. This review is intended to be both scientific and programmatic, and to provide a frank exchange of opinions without the constraints of public presentations at a formal meeting or workshop. Its purpose is to enable NASA and the participating scientists to arrive at a clear assessment of progress and to facilitate the adoption of

new approaches where these might be productive.

Annual Investigators' Meeting

All scientific participants in the NSCOR are required to attend the Annual Space Radiation Health Investigators' Workshop. This includes the Director, the Principal Investigators, the participating researchers, and especially postdoctoral fellows and graduate students. These meetings are generally held in spring or summer and often have international participation. No proceedings are published, in order to encourage informal exchanges of information between scientists.

Final Report

A final report must be provided to the appropriate Division Director at NASA HQ at the end of the five-year funding period, including a detailed listing of all peer-reviewed publications. Information required for inclusion in final reports is

- a summary of the NSCOR research activities;
- a statement of the specific objectives;
- significance of the work;
- background;
- overall progress during the performance period;
- a narrative discussion of technical approaches including problems encountered;
- accomplishments related to approach; and
- an appendix with bibliography and copies of all publications and reports. Any publications or other public materials containing data are particularly important to include in this section.

VII. Points of Contact for Further Information

Additional technical information for the NASA programs is available from

David L. Tomko, Ph.D.
NASA Headquarters, Code UB
Washington, DC 20546-0001
Telephone: (202) 358-2211
Fax: (202) 358-4168
E-mail: dtomko@hq.nasa.gov

The contracting point of contact will be specified in each selection notification letter.

For specific information on the DOE/BER Low Dose Radiation Research Program interests, contact Dr. Noelle Metting, telephone: (301) 903- 8309, E-mail: noelle.metting@science.doe.gov, Office of Biological and Environmental Research, U.S. Department of Energy, SC-72/Germantown Building, 1000 Independence Avenue SW, Washington, DC 20585-1290.

Potential investigators should read with care the program descriptions that are of interest and focus their proposals on the specific research emphases defined in this Announcement.

Your interest and cooperation in participating in this effort is appreciated.

Original signed by

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

VIII. Other Information

A. NASA Space Radiation Laboratory (NSRL)

NASA has signed Memoranda of Agreement (MOA) with the Department of Energy (DOE) and with Brookhaven National Laboratory (BNL) to utilize the Alternating Gradient Synchrotron (AGS) (beams of iron and other heavy nuclei, with energies as low as 600 MeV/nucleon, up to 10 GeV/nucleon) and to build and operate a new facility, the NASA Space Radiation Laboratory (NSRL). The AGS machine is a U.S. Department of Energy (DOE) facility that is funded by the DOE primarily for research in high-energy particle and nuclear physics. The DOE allows Brookhaven to provide additional AGS beam time to other scientific users of the machine, as long as operating funds are provided by the sponsor of such proposed work. Delivery of beam time is directly funded by a contract between NASA and Brookhaven.

Use of the Brookhaven facilities requires a separate application, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation for running at the AGS, which includes familiarization with AGS rules and policies (safety being the paramount consideration among these) and registration with the laboratory as a guest scientist. Applications for beam time are required to provide realistic experimental protocols, using appropriate estimates of irradiation times, numbers of samples, and choice of irradiation parameters.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding cave containing the beam, the biological experiment station, and laboratory space and animal facilities in the Brookhaven Medical Department. A 10-foot-long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing, and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. In addition, laboratory space and access to animal facilities accredited by the Association for Assessment and Accreditation of Laboratory Animal Care are available in the Medical Department, subject to

standard use charges. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units).

A representative sample of beams, energies and LET values that have been used for radiation research at Brookhaven National Laboratory is shown in the adjacent table. A full set of beams and energies required to accomplish the radiation program objectives continues to be developed with input from the science community and Brookhaven experts. Information on beams and energies used in previous experiments is available from the Brookhaven liaison scientists listed below and in the Bibliography.

BEAM CHARACTERISTICS		
Beam	Energy (GeV/u)	LET (keV/μm)
¹² C	.29	13
²⁸ Si	1.2	42
	0.6	50
⁴⁸ Ti	1.0	108
⁵⁶ Fe	1.1	150
	0.6	170
¹⁹⁷ Au	10.8	1445

Normally, circular beam spots are provided, with diameters up to 10 cm and center-to-edge uniformity between 10 and 20 percent (depending on dose rate—high dose rate beams are less uniform than low-dose rate beams). Dose rates have been measured up to 11 Gy/min. Investigators currently funded by the NASA program participate in research using these beams; coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

The NASA Space Radiation Laboratory (NSRL) is an irradiation facility based on BNL Booster Synchrotron beams—ions from protons to gold in the energy range of 40-3000 MeV/nucleon. This synchrotron is placed between the Van de Graaff injectors and the higher energy AGS. The NSRL is a joint effort of the collider-accelerator department, providing accelerated ion beams; the BNL Biology department, providing experimental area support; and the Medical department, which provides animal care facilities and cell laboratories. The NSRL includes irradiation stations, beam controls, and laboratory facilities required for most radiobiological investigations.

For further information regarding Brookhaven National Laboratory, contact Dr. Marcelo Vazquez (e-mail: vazquez@bnl.gov), Dr. Betsy Sutherland (e-mail: betsy@image.bio.bnl.gov), or Dr. Phil Pile (e-mail: pile@bnldag.ags.bnl.gov). The address is Brookhaven National Laboratory, PO Box 5000, Upton, NY 11973-5000. Information about this facility is also available online at http://bnlstb.bio.bnl.gov/biodocs/nasa/nasa_ags.html.

B. Other Technical Information

For additional information about NASA and its mission and goals, please visit <http://www.nasa.gov/>. For additional information about the Office of Biological and Physical Research, please visit <http://spaceresearch.nasa.gov/>.

C. References

1. General References

Guidebook for Proposers Responding to a NASA Research Announcement (NRA). This document is available online at the following address:

<http://www.hq.nasa.gov/office/procurement/nraguidebook>.

OBPR Program Tasks and Bibliography (Task Book) for FY 1995 through FY 2003 are available online at the following address: <http://research.hq.nasa.gov/taskbook.cfm>.

Space Life Sciences Ground Facilities Information Package. This document is available online at the following address:

http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU003N/index.html.

Life sciences research publications: <http://spaceline.usuhs.mil/>, and <http://www.nlm.nih.gov/>.

Additional information may be obtained from the SPACELINE Project (phone: (301) 295-2482; e-mail: spaceline@usuhs.mil)

National Academy of Science. National Research Council Committee on Space Biology and Medicine. Mary J. Osborn, Committee Chairperson. **A Strategy for Research in Space Biology and Medicine in the New Century.** 1998. Washington D.C: National Academy Press. Web address: <http://www.nas.edu/ssb/csbn1.html>

A. Nicogossian, C. Huntoon, and S. Pool. (Eds.) **Space Physiology and Medicine, 3rd ed.** Lea & Febiger. Philadelphia, PA (1994).

FASEB Journal, Vol. 13, Supplement, **Cell & Molecular Biology Research in Space.** (1999). *Brain Research Reviews*, **Space Neuroscience Research.** Volume 28, Numbers 1/2, Special Issue, (1998).

NASA Space Radiation Health Program:

http://spaceresearch.nasa.gov/common/docs/radiation_strat_plan_1998.pdf

Space Radiation Health Project at Johnson Space Center: <http://srhp.jsc.nasa.gov/>

2. Selected Radiation References

Alpen, E.L., Powers-Risius, P., Curtis, S.B., and DeGuzman, R. Tumorigenic potential of high-Z, high-LET charged particle irradiations. *Radiat. Res.* 88, 132-143 (1993).

Blakely, E.A., Bjornstad, K.A., Chang, P.Y., McNamara, M.P., Chang, E., Aragon, G., Lin, S.P., Lui, G., and Polansky, J.R. Growth and differentiation of human lens epithelial cells in vitro on matrix. *Inv. Opth. & Vis. Sci.* 41, 3898-3907 (1999).

Cucinotta, F. A., W. Schimmerling, J. W. Wilson, L. E. Peterson, G. Badhwar, P. Saganti, and J. Dicello. Space Radiation Cancer Risks and Uncertainties for Mars Missions. *Radiat. Res.* 156: (2001)156, 682–688.

Cucinotta, F. A., F.K. Manuel, J. Jones, G. Iszard, J. Murrey, B. Djojonegro, and M. Wear. Space Radiation and Cataracts in Astronauts. *Radiat. Res.* 156: 460-466 (2001).

Cucinotta, F.A., Nikjoo, H., and Goodhead, D.T. The effects of delta rays on the number of particle-track traversals per cell in laboratory and space exposures. *Radiat. Res.* 150, 115-119 (1998).

Cucinotta, F.A., Wilson, J.W., Williams, J.R., and Dicello, J.F. Analysis of Mir-18 results for physical and biological dosimetry: radiation shielding effectiveness in *LEO*. *Radiat. Meas.* **31**, 181-191 (2000).

Ernhart, E.J., E.L. Gillette, E.L., and Barcellos-Hoff, M.H. Immunohistochemical evidence for rapid extracellular matrix remodeling after iron-particle irradiation of mouse mammary gland. *Radiat. Res.* 145, 157-162 (1996).

Fry R.J.M., Powers-Risius P., Alpen E.L., Ainsworth, E.J. High LET radiation carcinogenesis. *Radiat. Res.* 104, S188-195 (1985).

Goodhead, D.T. Initial events in the cellular effects of ionizing radiations: clustered damage in DNA. *Int. J. Radiat. Biol.* **65**, 7-17 (1994).

Joseph, J.A., Hunt, W.A., Rabin, B.M., Dalton, T.K. Possible accelerated aging induced by ⁵⁶Fe heavy particle irradiation: Implications for manned space flights. *Radiat. Res.* 130, 88-93 (1992).

National Council on Radiation Protection and Measurements (NCRP). Guidance on Radiation Received in Space Activities. Report 98. Washington, DC (1989).

National Council on Radiation Protection and Measurements (NCRP). Uncertainties in Fatal Cancer risk Estimates Used in Radiation Protection. Report 126. Washington, DC (2000).

National Council on Radiation Protection and Measurements (NCRP). Radiation Protection Guidance for Activities in Low-Earth Orbit. Report 132. Washington, DC (2000).

National Research Council. Radiation Hazards to Crews of Interplanetary Missions: Biological Issues and Research Strategies. National Academy Press, Washington, DC (1996).

National Research Council. Radiation and the International Space Station. National Academy Press, Washington, DC (2000).

Schimmerling, W. Space and radiation protection: scientific requirements for space research. *Radiat. Environ. Biophys.* 34: 133-137 (1995).

Zeitlin, C., J. Miller, L. Heilbronn, K. Frankel, W. Gong and W. Schimmerling, The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. I. Fragment Fluence Spectra. Radiat. Res. 145: 655-665 (1996).

Zeitlin, C., L. Heilbronn, J. Miller W. Schimmerling, L. W. Townsend, R.K. Tripathi, and J. Wilson The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. II. Comparisons between Data and a Model. Radiat. Res. 145: 666-672 (1996).

3. Selected Workshop Reports

Modeling Human Risk: Cell & Molecular Biology in Context. June, 1997. Ernest Orlando Lawrence Berkeley National Laboratory Report LBNL-40278. Berkeley, CA

International Space Life Sciences Working Group on Radiation Biology. Banff, Canada, November 1997. Mutation Res., 430: No. 2 (1999)

Models for Evaluation of Radiation Risk Factors. Radiat. Res. 156: Number 5, Part 2. November, 2001.

Second International Workshop on Space Radiation Research and 13th Annual NASA Space Radiation Health Investigators' Workshop, March 10-15, 2002, Nara, Japan:

<http://www.nirs.go.jp/usr/workshop/index.htm>

4. Selected Radiation Web Sites

NASA activities at Brookhaven National Laboratory:

<http://www.bnl.gov/medical/NASA/>

NASA Specialized Center of Research and Training at Lawrence Berkeley Laboratory:

<http://www.lbl.gov/lifesciences/NSCORT/>

CHECKLIST FOR PROPOSERS

- Proposal Cover Page (completed online)
- Checklist for Proposers
- Proposal Title Page
- Response to previous reviews (if applicable, these 2 pages are not included in the 20 page proposal page limit)
- Project Description
- Biographical Sketches
- Facilities and Equipment Description
- IRB or ACUC letter/form (if applicable)
- Summary Budget Form/Budget Justification
- Detailed 12-Month Budget (for each year of support)
- Other Support
- Letters of Collaboration/Support (if applicable)
- Appendices, if any

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel.
Photocopy this page or follow this format for each person.

NAME	POSITION TITLE
------	----------------

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training).

INSTITUTION(S) AND LOCATION	DEGREE(S) (if applicable)	YEAR(S)	FIELD(S) OF STUDY

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years, and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. **DO NOT EXCEED TWO PAGES.**

BUDGET FOR ENTIRE PROJECT PERIOD DIRECT COSTS ONLY

<i>BUDGET CATEGORY TOTALS</i>		<i>1st BUDGET PERIOD</i>	<i>ADDITIONAL YEARS OF SUPPORT REQUESTED</i>			
			2nd	3rd	4th	5th
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)						
SUBCONTRACTS						
CONSULTANT COSTS						
EQUIPMENT						
SUPPLIES						
TRAVEL	DOMESTIC					
	NON-DOMESTIC					
OTHER EXPENSES						
TOTAL DIRECT COSTS FOR EACH PERIOD						
TOTAL INDIRECT COSTS FOR EACH PERIOD						
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD						
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT						

JUSTIFICATION FOR UNUSUAL EXPENSES :

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD		FROM		THROUGH	
DIRECT COSTS ONLY		FUNDING AMOUNT REQUESTED			
Duplicate this form for each year of grant support requested					
PERSONNEL (Applicant Organization Only)					
NAME	ROLE IN PROJECT	EFFORT ON PROJECT	SALARY	FRINGE BENEFITS	TOTALS
	Principal Investigator				
SUBTOTALS					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT (Itemize; use additional sheet if needed)					
SUPPLIES (Itemize by category; use additional sheet if needed)					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES (Itemize by category; use additional sheet if needed)					
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
TOTAL COST FOR FIRST 12-MONTH BUDGET PERIOD					

OTHER SUPPORT

Please provide information regarding specific sources of other support for the principal investigator and each co-investigator (not consultants). This information should be provided separately for each individual in the format shown below. List all active support for an individual before listing pending support. Include the investigator's name at the top of each page and number pages consecutively.

NAME OF INDIVIDUAL		
ACTIVE/PENDING		
Project Number (Principal Investigator)	Dates of Approved/ Proposed Project	Percent Effort
Source Title of Project (or Subproject)	Annual Direct Costs	
One-sentence description of project goals. (The major goals of this project are...)		
Brief description of potential scientific or commitment overlap with respect to this individual between this application and projects described above (summarized for each individual).		