

# Program Announcement To DOE National Laboratories LAB 05-11

## *Scientific Discovery through Advanced Computing - Fusion Simulation Prototype Centers*

**SUMMARY:** The SciDAC Program, the Office of Fusion Energy Sciences (OFES) and the Office of Advanced Scientific Computing Research (OASCR) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announce their interest in receiving **peer-reviewable** Field Work Proposals (FWPs) for the development of specific scientific simulation codes that can become components of an integrated fusion plasma simulation. These integrated fusion plasma simulation prototype codes should focus on the development of new capabilities that couple together a wider range of physical phenomena in an integrated package of simulation codes (or code suite) than is currently being done.

The SciDAC Program, the Office of Fusion Energy Sciences and the Office of Advanced Scientific Computing Research are planning a multi-institutional Fusion Simulation Project (FSP) to develop an advanced integrated simulation capability for both existing magnetic fusion experiments and next-generation burning plasma experiments such as the International Thermonuclear Experimental Reactor (ITER). As a first step toward the initiation of the FSP, SciDAC, OFES and OASCR are seeking focused integration initiatives in topical areas that are particularly important to ITER. The goal of each initiative is to develop an integrated predictive modeling capability for a specific topical area while, at the same time, dealing with the integration issues that will be faced by the FSP. The experience with mathematical tools, innovative algorithms and high-performance computer architectures that is gained during these initiatives will be important in later phases of the FSP. Thus, close collaboration among fusion scientists, applied mathematicians and computer scientists is essential for the success of this initiative. The specific areas of interest are:

1) An integrated simulation of the edge/boundary region of a fusion plasma: The plasma edge is defined as the region from the top of the pedestal-a narrow region in the outer part of plasmas in high confinement regimes just inside the separatrix, characterized by sharp temperature and density gradients-to the material wall. The properties of the plasma edge have a strong influence on core confinement and, hence, on the overall performance of the device. In addition, edge conditions have a strong impact on power and particle exhaust and fueling and determine the level of plasma-wall interactions. The multitude of physical processes affecting the properties of the plasma edge (turbulent and collisional transport, MHD, stochasticity, interactions with neutral atoms, molecules and impurities, plasma-wall interactions including sheath effects) with their different spatiotemporal scales evolving on complicated magnetic geometries, make predictive modeling of this region especially challenging and most likely to benefit from an integrated simulation.

A specific topic that should be addressed by an edge initiative is the self-consistent simulation of a full Edge Localized Mode (ELM) cycle and its effect on the pedestal formation, dynamic evolution and characteristics, such as width and height. Proposals should address all relevant physical processes on all spatiotemporal scales, except for interactions with material walls. The formalism should be valid for the expected range of collisionality in present and next-generation experiments from the top of the pedestal to the material wall. This would require extending the present generation of gyrokinetic equations and codes to edge-relevant regimes and developing techniques to bridge the expected collisionality range.

2) An integrated understanding of how electromagnetic waves affect plasma profiles and plasma stability: Experiments over the past 20 years have shown that electromagnetic waves can provide local heating and current drive in plasmas, which in turn can affect the equilibrium, stability, and transport properties of a magnetically confined plasma. Localized wave driven currents have been produced by a wide variety of plasma waves, including electron cyclotron waves, lower hybrid waves, and ion cyclotron frequency waves, and several validated, quantitative current drive simulation codes have been developed. Further, stabilization of magnetohydrodynamic (MHD) modes and modification of plasma flows have been observed in experiments using radio-frequency waves. At the present time, the development of integrated simulation codes and the required physical models and algorithms is at the conceptual stage. The primary goal of this focused integration initiative is to understand how electromagnetic waves affect MHD stability of a fusion plasma and how these effects can be used to optimize the performance of a burning plasma.

A specific product of this focused integration initiative would be a suite of simulation codes that self-consistently couples the time evolution of the plasma equilibrium with the wave-driven modifications of the current, temperature, and flow profiles and includes the analysis of stability limits. Since one objective of this initiative is integration, existing codes or code modules may be used where appropriate. For example, an existing transport code could be used to evolve the plasma profiles and equilibrium. However, since a number of new codes or code modules will be needed, it is expected that the software and algorithm development environment and the code framework will be flexible enough to facilitate recombining of software components into new code capabilities as additional physics is added to the mathematical models. This code suite should be benchmarked against profile control experiments with pulse lengths that are long compared to the magnetic field diffusion times. Such an integrated simulation capability will allow the development of optimized burning plasma scenarios.

**DATES: A Letter-of-Intent (LOI) to submit a proposal is REQUIRED and should be submitted by February 23, 2005. Failure to submit a Letter-of-Intent by a proposer may preclude the full proposal from due considerations.**

To permit timely consideration for awards in FY 2005, formal proposals submitted in response to this notice must be received by DOE no later than 4:30 p.m., Eastern Time, March 23, 2005.

Please see the "Supplementary Information" section below for further instructions on the preparation of the Letter-of-Intent and the full proposal. Electronic submission of the Letter-of-Intent and the formal proposal in PDF format are required. It is important that the submission be

in a single PDF file. Please see the "Addresses" and "Proposal Submission" sections below for further instructions on the method of proposal submission.

**ADDRESSES:** The Letter-of-Intent should be submitted electronically by email to John.Sauter@science.doe.gov, Michael.Strayer@science.doe.gov and Steve.Eckstrand@science.doe.gov. Please include "Letter-of- Intent for LAB 05-11" in the subject line.

A completed formal FWP in a single Portable Document Format (PDF) file of less than 10 MB referencing Program Announcement LAB 05-11 must be submitted via email to: John.Sauter@science.doe.gov; Mr. John Sauter, SC-55, U.S. Department of Energy, Office of Science, Germantown, MD. Please use "Program Announcement LAB 05-11" in the subject line of the email. Proposers may provide a back-up CD- ROM containing the proposal in PDF by commercial courier, express mail service, or hand carried by proposer to: Mr. John Sauter, SC-55, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Announcement LAB 05-11. The label on the CD must clearly identify the institution, principal investigator, and title of the proposal. All submissions and inquiries about this program should reference Program Announcement LAB 05-11.

**FOR FURTHER INFORMATION CONTACT:** Office of Fusion Energy Sciences, U.S. Department of Energy, SC-55/Germantown Building, 1000 Independence Avenue, SW, Washington, DC 20585-1290. Dr. Stephen Eckstrand, SC-55, (301) 903-5546, steve.eckstrand@science.doe.gov, is the Program Manager for the OFES SciDAC Program, and may be contacted for technical information. Mr. John Sauter, SC-55, (301) 903-3287, john.sauter@science.doe.gov may be contacted for administrative information relating to the submission of the proposal and Letter-of-Intent.

#### **SUPPLEMENTARY INFORMATION:**

##### **Background: Scientific Discovery through Advanced Computing**

In addition to scientific computing and computational science research included in the Office of Science (SC) core research programs, SC invests in a portfolio of coordinated research efforts directed at exploiting the emerging capabilities of terascale, and eventually petascale, computing under the collective title of Scientific Discovery through Advanced Computing (SciDAC). The research projects in the SciDAC portfolio are addressing the extraordinary difficulties of achieving sustained peak performance on modern supercomputers for scientific applications, such as simulating supernovas, making multi-century climate predictions, and understanding and controlling a burning plasma. In recognition of these difficulties, the SciDAC research projects are collaborative efforts involving teams of physical scientists, applied mathematicians, computer scientists, and computational scientists working on major software and algorithm development to solve complex problems important to the core research programs of the Office of Science. Research funded in the SciDAC portfolio is enabling teams of laboratory and university researchers to solve some of the most challenging scientific problems facing the core programs of the Office of Science at a level of accuracy and detail never before achieved. A complete description of the SciDAC program can be found at: <http://www.osti.gov/scidac/>.

## Collaboration and Coordination

It is expected that all proposals submitted in response to this program announcement will be for collaborative centers involving multidisciplinary teams from more than one institution. Each institution involved in a proposed collaborative research project must submit a separate proposal. The proposal from the lead institution must identify the lead Principal Investigator (PI) who is responsible for the overall project, and the proposals from the other institutions must identify the co-PI who is responsible for the part of the research to be carried out at his/her institution. Also, each institution must include a separate budget page. These collaborative research proposals may include a common technical description of the overall research project, but if the distinct scope of the work that will be carried out by the institution submitting the proposal is not indicated in the common scope of work, it must be summarized in a 1-2 page appendix to the common technical description. The lead PI for the project should also include a summary budget for the entire project, including the annual funding proposed for each institution. Synergistic collaborations with researchers in universities or industry are encouraged, though no funds will be provided to these organizations under this Program Announcement. A separate Financial Assistance Program Notice will be posted (**Program Notice DE-FG01-05ER05-11**).

Further information on preparation of collaborative proposals may be accessed via the Internet at: <http://www.science.doe.gov/grants/Colab.html>.

Since each center will be developing new physics models and computational tools that are needed for an integrated fusion simulation capability, it is important that there be good communication between the different centers. It is also important to have guidance on code capabilities and development priorities from the broader fusion, scientific and computational communities. Thus, all successful projects should plan to work with the SciDAC management processes established by the Office of Advanced Scientific Computing Research and the Office of Fusion Energy Sciences at the beginning of the SciDAC program. This includes an annual principal investigators meeting to ensure good communication between the SciDAC applications projects and the SciDAC applied mathematics and computer science projects. The Office of Fusion Energy Sciences' oversight of the fusion SciDAC projects includes a program advisory committee, which holds an annual coordination meeting to review the progress of each of the fusion SciDAC projects and to develop priorities for future work.

**LETTER OF INTENT:** The primary purpose of the Letter-of-Intent (LOI) is to assist the OFES and OASCR in planning the review and the selection of potential reviewers for the proposal. For this purpose, the LOI must include a one- page abstract of the proposed research, and list the names and institutional affiliations of Principal Investigators, any Co-Principal Investigators, key investigators, collaborators, or consultants, so as to reveal any potential conflict of interest in the selection of reviewers for the proposal.

**PROPOSAL SUBMISSION:** Since we expect that the some reviewers will be asked to review several proposals, all proposals should be limited to a maximum of thirty five (35) pages (including text and figures) of technical information (sections two through seven below). Proposals exceeding these page limits may be rejected without review. The PDF file may also include a few selected publications in an Appendix as background information. In

addition, please limit biographical and publication information for the principal investigator and key personnel to no more than two pages each. Each principal investigator should provide an e-mail address. The page count of 35 does not include the Proposal Cover Page and Budget Pages, the Title Page, the biographical material and publication information, and any Appendices of publications. However, it is important that the 35 page technical information section provide a complete description of the proposed work, since reviewers are not obliged to read the Appendices.

The FWP must be peer-reviewable to be responsive. The proposal should be written in strict compliance with the following format:

1. Abstract - brief description of the project purpose and goals in no more than 250 words
2. Executive Summary - summary of the proposal in one to two pages
3. Background and Recent Accomplishments
  - 3.1. Background - explanation of the importance and relevance of the proposed work
  - 3.2. Recent Accomplishments - description of relevant work carried out by the PI and/or co-PIs during the past two years
4. Proposed research
  - 4.1. Detailed project description
  - 4.2. Project schedules, milestones, and deliverables, including plans for comparison with experimental results
  - 4.3. Description of work assignments (e.g. Work Breakdown Structure (WBS) with WBS managers and resource allocations)
5. Textual summary of the overall budget (in addition to the formal budget pages in each institution's proposal) showing how the budget relates to the proposed work assignments
6. Management plan - description of management structure and processes
7. Description of facilities, resources, and personnel
  - 7.1 Estimates of the amount of computational resources required, including processor hours and storage requirements
  - 7.2. Discussion about other SciDAC and base program support that is assumed in developing budget estimates
8. Other current and pending support.

In addition, while adhering to the above format, the Office of Science FWP proposal preparation guidelines (attached below) should be followed whenever possible.

In selecting proposals for funding, the DOE Office of Fusion Energy Sciences will give priority to proposals that can produce results within three to four years after grant initiation. Preferred proposals in this category would typically have a performance period of five years, assuming successful completion of a merit review during the third year.

As noted in the section on "Collaboration and Coordination" above, each institution involved in a collaborative research project must submit a separate proposal specifying the principal investigator who is responsible for the research to be performed at his or her institution. The description of the work to be carried out by each institution should be clearly described in section 4.3 of the proposal.

### **Program Funding**

This is a new initiative. DOE identified total funding up to an amount of \$1,200,000 in FY 2005 for this initiative. In addition, approximately \$1,200,000 will be available for competition by universities and industry under a separate solicitation (Program Notice DE-FG01-05ER05-11).

Awards are expected to be made for a period of five years, with out-year support contingent on the availability of funds and satisfactory progress. Funding for the final two years is contingent on satisfactory completion of a merit review during the third year of the project. OFES reserves the right not to make any awards if no proposal is judged to be of suitable scientific quality or of sufficient relevance to the SciDAC program.

The cost-effectiveness of a proposal will be considered when comparing proposals with differing funding requirements. One or two awards may be made depending on the number and quality of the proposals received and favorably reviewed. It is anticipated that total project awards may range from \$1,500,000 to \$2,000,000 per year.

The instructions and format described below should be followed. Please reference Program Announcement LAB 05-11 on all submissions and inquiries about this program.

## **OFFICE OF SCIENCE GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS TO BE SUBMITTED BY NATIONAL LABORATORIES**

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

### **1. Evaluation Criteria**

Proposals will be subjected to formal merit review and will be evaluated against the following criteria. Included with each criterion are the detailed questions that are asked of the reviewers.

1. Scientific and/or technical merit of the project;

- Does this proposal address an important problem in plasma science that is relevant to integrated simulation of fusion plasmas in the long term?
- What is the likelihood that it will lead to new or fundamental advances in its field?
- How well does the proposal demonstrate the need for extraordinary computing resources?
- What is the potential of the proposed research to advance the state-of-the-art in computational modeling and simulation of plasma behavior?
- How does the proposed research compare with other research in its field, both in terms of scientific and/or technical merit and originality?

2. Appropriateness of the proposed method or approach;

- Are the conceptual framework, methods, and analyses adequately developed and sound?
- Is the proposed method or approach likely to lead to scientifically valid conclusions or advances in the field?
- How sound is the plan for managing the project? Is the balance between computational plasma physicists, computer scientists, and applied mathematicians appropriate for the proposed scope of work?
- How good is the plan for verifying and validating the models developed, including close coupling with experiments for ultimate validation?
- Are there significant potential problems and how well does the applicant address these problems?

3. Competency of the applicant's personnel and adequacy of the proposed resources;

- How well qualified are the applicant's personnel to carry out the proposed research? (If appropriate, please comment on the scientific reputation and quality of recent research by the principal investigator and other key personnel.)
- Do the applicants have demonstrated abilities to use terascale computers?
- Please assess the reasonableness of the estimates of the required computational resources.
- Does the proposed work take advantage of unique facilities and capabilities and/or make good use of collaborative arrangements?

4. Reasonableness and appropriateness of the proposed budget.

The reviewers are also asked to comment on Other Appropriate Factors:

- Could the proposed research make a significant contribution to another field?
- If applicable, please comment on the educational benefits of the proposed activity.

The Office of Fusion Energy Sciences and the Office of Advanced Scientific Computing Research will also consider, as part of the evaluation, other available advice or information as well as program policy factors such as ensuring an appropriate balance among the program areas and within the program areas and quality of previous performance. Selection of proposals for award will be based upon the findings of the technical evaluations, the importance and relevance of the proposed research to the missions of the Office of Fusion Energy Sciences and the Office of Advanced Scientific Computing Research in fusion plasma simulation, and funding availability. Funding under this Notice is limited to supporting research activities based in the U.S., though subcontracts with limited funding for collaborators outside the U.S. may be allowed with appropriate justifications.

## **2. Summary of Proposal Contents**

- Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C) (DOE ONLY)
- Proposal Cover Page
- Table of Contents
- Abstract
- Narrative
- Literature Cited
- Budget and Budget Explanation
- Other support of investigators
- Biographical Sketches
- Description of facilities and resources
- Appendix

### **2.1 Number of Copies to Submit**

Each FWP must be submitted in a single Portable Document Format (PDF) of less than 10 MB by email to John.Sauter@science.doe.gov. Proposers may provide a back-up CD-ROM containing the proposal in PDF by commercial courier, express mail service, or hand carried by proposer to: Mr. John Sauter, SC-55, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Announcement LAB 05-11. The label on the CD must clearly identify the institution, principal investigator, and title of the proposal. All submissions and inquiries about this program should reference Program Announcement LAB 05-11.

### **3. Detailed Contents of the Proposal**

Proposals must conform to the following three requirements: the height of the letters must be no smaller than 10 point with at least 2 points of spacing between lines (leading); the type density must average no more than 17 characters per inch; the margins must be at least one inch on all sides. Figures, charts, tables, figure legends, etc., may include type smaller than these requirements so long as they are still fully legible.

#### **3.1 Field Work Proposal Format (Reference DOE Order 5700.7C) (DOE ONLY)**

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review.

Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

### **3.2 Proposal Cover Page**

The following proposal cover page information may be placed on plain paper. No form is required.

Title of proposed project  
SC Program announcement title  
Name of laboratory  
Name of principal investigator (PI)  
Position title of PI  
Mailing address of PI  
Telephone of PI  
Fax number of PI  
Electronic mail address of PI  
Name of official signing for laboratory\*  
Title of official  
Fax number of official  
Telephone of official  
Electronic mail address of official  
Requested funding for each year; total request  
Use of human subjects in proposed project:  
    If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.  
Use of vertebrate animals in proposed project:  
    If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.  
Signature of PI, date of signature  
Signature of official, date of signature\*

\*The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

### **3.3 Table of Contents**

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the

top of a new page. Do not use unnumbered pages and do not use suffixes with page numbers, such as 5a, 5b.

### **3.4 Abstract**

Provide an abstract of no more than 250 words. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. State the hypotheses to be tested. Indicate how the proposed research addresses the SC scientific/technical area specifically described in this announcement.

### **3.5 Narrative**

The narrative comprises the research plan for the project and is limited to 25 pages. It should contain the following subsections:

**Background and Significance:** Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps which the project is intended to fill. State concisely the importance of the research described in the proposal. Explain the relevance of the project to the research needs identified by the Office of Fusion Energy Sciences. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

**Preliminary Studies:** Use this section to provide an account of any preliminary studies that may be pertinent to the proposal. Include any other information that will help to establish the experience and competence of the investigators to pursue the proposed project. References to appropriate publications and manuscripts submitted or accepted for publication may be included.

**Research Design and Methods:** Describe the research design and the procedures to be used to accomplish the specific aims of the project. Describe new techniques and methodologies and explain the advantages over existing techniques and methodologies. As part of this section, provide a tentative sequence or timetable for the project.

**Subcontract or Consortium Arrangements:** If any portion of the project described under "Research Design and Methods" is to be done in collaboration with another institution, provide information on the institution and why it is to do the specific component of the project. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation", "Biographical Sketches", and "Description of Facilities and Resources".

### **3.6 Literature Cited**

List all references cited in the narrative. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

### **3.7 Budget and Budget Explanation**

A detailed budget is required for the entire project period, which normally will be three years, and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information\*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.

\* Form 4620.1 is available at web site: <http://www.science.doe.gov/grants/forms-E.html>

### **3.8 Other Support of Investigators**

Other support is defined as all financial resources, whether Federal, non-Federal, commercial or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort devoted to the project.

### **3.9 Biographical Sketches**

This information is required for senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each investigator.

### **3.10 Description of Facilities and Resources**

Describe briefly the facilities to be used for the conduct of the proposed research. Indicate the performance sites and describe pertinent capabilities, including support facilities (such as machine shops) that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution, if any.

### **3.11 Appendix**

Include collated sets of all appendix materials with each copy of the proposal. Do not use the appendix to circumvent the page limitations of the proposal. Information should be included that may not be easily accessible to a reviewer.

Reviewers are not required to consider information in the Appendix, only that in the body of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts (accepted for publication), abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

#### **4. Detailed Instructions for the Budget**

(DOE Form 4620.1 "Budget Page" may be used)

##### **4.1 Salaries and Wages**

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

##### **4.2 Equipment**

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of \$25,000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

##### **4.3 Domestic Travel**

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

##### **4.4 Foreign Travel**

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

#### **4.5 Other Direct Costs**

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off-the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

##### **a. Materials and Supplies**

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

##### **b. Publication Costs/Page Charges**

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

##### **c. Consultant Services**

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

##### **d. Computer Services**

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

##### **e. Subcontracts**

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

#### **4.6 Indirect Costs**

Explain the basis for each overhead and indirect cost. Include the current rates.