Program Announcement
To DOE National Laboratories

LAB 12-603

Office of Science
Office of Fusion Energy Sciences

Materials Solicitation with Focus on Structural Materials, Blanket First Walls, and Divertor Plasma Facing Components

GENERAL INQUIRIES ABOUT THIS PROGRAM ANNOUNCEMENT TO DOE NATIONAL LABORATORIES SHOULD BE DIRECTED TO:

Technical/Scientific Program Contact:

Dr. Peter Pappano, Office of Fusion Energy Sciences, SC-24.2
PHONE: (301) 903-4883
E-MAIL: Peter.Pappano@science.doe.gov

SUMMARY: The Office of Fusion Energy Sciences (FES), U.S. Department of Energy (DOE), hereby announce their interest in receiving proposals from single or multi-institution teams to the Materials area of fusion energy sciences, specifically structural materials, blankets, and plasma facing components. The FES Materials portfolio focuses on the development, testing, joining, and modeling/simulations of metals, alloys, coatings, and composites that are appropriate for various locations in the fusion environment. The specific areas of interest under this Program Announcement are:

1. Structural materials
2. Blanket first-wall materials (both liquid and solid)
3. Divertor plasma facing components (both liquid and solid)

More specific information on each area of interest is included in the Description of Topical Areas section under SUPPLEMENTARY INFORMATION below.

PRE-PROPOSAL: (Required)

Pre-proposals are **REQUIRED** and must be submitted by November 14, 2011, 11:59 PM Eastern Time. **Failure to submit a pre-proposal by an applicant will preclude the full proposal from due consideration.** The pre-proposal should be submitted electronically by E-mail to Peter.Pappano@science.doe.gov and John.Sauter@science.doe.gov. **Please include "Pre-proposal for Program Announcement LAB 12-603" in the subject line.** A response to the pre-applications encouraging or discouraging formal applications will be communicated to the applicants by November 21, 2011. Applicants who have not received a response regarding the status of their pre-application by this date are responsible for contacting the program to confirm this status.

Pre-proposal should include cover page information, a brief description of the proposed work (1-2 pages, including text with minimum font size 11 point, figures, and references), and a one-page curriculum vitae from each Principal Investigator (PI), co-Principal Investigator (co-PI), and senior collaborator or consultant. The cover page should include: (a) A statement that the document is a pre-proposal in response to Program Announcement LAB 12-603; (b) Lead PI information: name, institutional affiliation, telephone number, fax number, and e-mail address; and, (c) names and institutions of all Institutional PIs, and senior collaborators or consultants (excluding postdoctoral associates). Since among the purposes of the pre-proposal is to facilitate FES in planning the merit review and the selection of peer-reviewers without conflicts of interest, it is important that applicants ensure their list of supported or unsupported participants is as comprehensive as possible.

Pre-proposals will be reviewed by FES program officials for responsiveness to this Program Announcement, eligibility of the applicant organization, and qualification of the applicant's personnel for carrying out materials research activities. Only those applicants who receive notification from DOE encouraging a full proposal may submit a formal proposal.

No other formal applications will be considered.

PROPOSAL DUE DATE:

Formal proposals submitted in response to this Program Announcement must be submitted from the DOE National Laboratory to the site office through Searchable FWP by **Friday, December 23, 2011, 11:59 p.m. Eastern Time**, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2012. **Each proposal should be in a single PDF file. The first few pages of the PDF should be the Field Work Proposal (FWP) followed in the same PDF by the full technical proposal. You are encouraged to transmit your proposal well before the deadline. Only those proposers that receive notification from DOE encouraging a formal proposal may submit full proposals. PROPOSALS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

SUBMISSION INSTRUCTIONS:

LAB administrators should submit the entire LAB proposal and FWP via searchable FWP (https://www.osti.gov/fwp). Questions regarding the appropriate LAB administrator or other questions regarding submission procedures can be addressed to the Searchable FWP Support Center. All submission and inquiries about this Program Announcement must reference Program Announcement LAB 12-603.

SUPPLEMENTARY INFORMATION:

Description of Topical Areas

1. Structural Materials

Proposals are solicited for the development and characterization of advanced structural materials for fusion reactors. Structural materials are those that have a load bearing purpose in the fusion reactor. The environments produced in a fusion reactor present a significant materials challenge. Materials used to build the structure of the plasma chamber are subjected to intense heat, radiation, reactive chemicals, and stresses (both thermal and mechanical). Structural materials must be able to withstand large heat fluxes (5-15 MW/m2) while exhibiting minimal changes to key properties such as ductility, corrosion resistance, mechanical strength, and resistance to crack propagation. The materials must also be relatively free of impurities, or elements that undergo transmutation reactions during irradiation, as they enhance the formation of helium bubbles or long half-life elements. The formation of helium affects the properties of the material, particularly mechanical properties, while long half-life elements present environmental storage issues in reactor change-out or end of life scenarios.

Materials and/or materials with bonded thin layers or coatings that have been considered for structural applications are: beryllium, graphite, molybdenum, reduced activation ferritic/martensitic steels, nanostructured ferritic alloys with nanofeatures, oxide dispersion strengthened steels, tungsten alloys, and silicon carbide composites. FES requests pre-proposals on the development, fabrication, joining, characterization, irradiation response, and high heat flux testing of these specific materials. The mechanical properties are of most interest here, as a result of their structural purpose in the fusion reactor.

Development is defined as manipulation of the elemental ratios or raw materials used in the given starting material such that the final material exhibits a structure or morphology that is superior to the original for a given property. Fabrication is defined as a forming technique for a given material that enhances its properties and will make it more appropriate for the fusion environment. Joining is defined as the connecting of two similar or dissimilar materials via a true bond, on the atomistic scale, or mechanical bond in order to benefit one or both material's performance in the fusion environment. Characterization is defined as the determination of a given material's property, followed by an inference of how this data can be used to improve the property. Irradiation response is defined as the characterization of a material's properties before and after neutron irradiation. High heat flux testing involves subjecting a material to a fusion relevant heat flux and evaluating the material's response. Because these materials are used for structural applications (i.e. have a load-bearing purpose) the mechanical properties are of most interest.

2. Blankets first wall materials

Proposals are solicited for the development and characterization of blanket first wall materials. The blankets used in a fusion reactor are comprised of numerous different materials, joints, and tritium breeding systems via nuclear reactions with lithium. The materials used in the blanket, therefore, have different functions. Some materials comprise the first wall and face the plasma, while others are integrated into the tritium breeding system that sits behind the first wall. Therefore the blanket is composed of both structural and non-structural materials. Structural materials will see the environment explained above in Supplementary Information Topic 1 and will therefore require the same improved property development. An example of a non-structural material is a thin plasma facing layer. Examples of this thin layer are, but not limited to, beryllium, tungsten, graphite, and liquid lithium, gallium, or tin. The temperatures, stresses, heat flux, and neutron dose vary considerably depending on the materials location in the blanket. The blanket system is also associated with cooling and tritium processing systems, which also present significant material challenges. The coolant (helium, liquid metals, etc.) can have deleterious effects on the coolant system if purity is not controlled. Also, the temperature at which the coolant must operate 400-700°C present corrosion issues to the material housing it.

FES requests pre-proposals in specifically the first wall of the blanket system. The first wall may be either a liquid or solid, depending on the design of the fusion reactor and blanket system. Solid first wall materials are similar to those described in Supplementary Information Topic 1 and the same research and development needs are present. However in the case of a blanket first wall the structural material may have to be bonded to a thin layer of plasma facing material, thus joining or coating technologies are of interest here. The coatings or thin layers that face the plasma and are joined to the blanket are non-structural. The material properties of interest for these coatings or thin layers are neutron irradiation response, heat flux, and corrosion resistance.

Liquid first walls may be lithium, gallium, or tin and also serve a non-structural purpose. Research topics for liquid first walls also include irradiation response, heat flux, corrosion, and sputtering/re-deposition.

Because blanket first wall materials are part of a multi-material, multi-functional component, design studies that incorporate experimental work and could provide some guidance for material property requirements, based on the conditions present in a fusion reactor, will also be considered.

3. Divertor Plasma Facing Components

Proposals are solicited for the development and characterization of divertor plasma facing components (PFC). Based on the design of the divertor, the plasma facing components could be structural or non-structural. The PFCs of a divertor in a fusion reactor see a particularly high heat flux and irradiation dose. One option for the PFCs is to use solid refractory type materials, which would be structural materials in nature. Accordingly, the requirements outlined in Supplementary Information Topic 1 would also apply here. Another solid PFC option is to use high-Z materials joined to low-Z coatings, such as carbon/graphite. In this case the PFC would be a thin coating and therefore non-structural in nature. Solid divertor PFCs are then bonded to a

heat sink, which is either liquid or gas cooled. Another divertor PFC option is stationary or flowing liquids, such as lithium, gallium, and tin. These liquids are also adhered to a heat sink. Pre-proposals are sought on: (1) innovative solid divertor PFCs that can withstand heat fluxes of 5-15 W/m2 or greater, (2) fabrication techniques, (3) coating technology, and (4) bonding or joining techniques for the PFCs to the heat sink. Pre-proposals are also sought on: (5) innovative liquid divertor PFCs that can withstand heat fluxes of 5-15 W/m2 or greater, (6) irradiation response and (7) joining science for the liquid PFC to the heat sink.

Because divertor plasma facing component materials are part of a multi-material component, design studies that incorporate experimental work and could provide some guidance for material property requirements, based on the conditions present in a fusion reactor, will also be considered.

Additional Considerations

Management structure

The applicants must identify a management structure that enables an effective collaboration among the participants from various disciplines. The structure and management must be sufficiently flexible to adapt quickly to changing technical challenges and scientific needs. To that end, the applicants must identify a Lead Principal Investigator, Principal Investigator(s), and Senior/Key Personnel. Typical duties, responsibilities and authorities for each category are provided below:

- **Lead Principal Investigator** - The Lead Principal Investigator must be employed by the Lead institution and will serve as the primary contact responsible for communications with the DOE Program Officers on behalf of all of the Principal Investigators in the Partnership.
- **Principal Investigator** - A Principal Investigator (PI) is the individual designated by the collaborating institution and empowered with the appropriate level of authority and responsibility for the proper conduct of the research within that organization. These authorities and responsibilities include the appropriate use of funds and administrative requirements such as the submission of scientific progress reports to DOE.
- **Senior/Key Personnel** - A senior/key person is an individual who contributes in a substantive, measurable way to the scientific or technical development or execution of the project.

Additional Guidance to Applicants

Additional Resources

1. Magnetic Fusion Energy Sciences Research Needs Workshop (ReNeW) report, June 2009, http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf

Collaboration

Please list ALL Collaborating Institutions/PIs and indicate which ones will also be submitting proposals. Also indicate the PI who will be the point of contact and coordinator for the combined research activity.

Collaborative proposals submitted from different institutions should clearly indicate they are part of a collaborative project/group. Every partner institution must submit a proposal through its own business office. Each proposal within the collaborative group, including the narrative and all required appendices and attachments, should be identical with one exception: The exception is that each proposal should contain unique budget and budget justification documents corresponding to the expenditures for that application's submitting institution only. Each collaborative group can have only one lead institution, which should be identified in the common narrative. The common narrative should also contain a summary table describing the budget breakdown by institution for all participants.

Each proposal belonging to a collaborative group should have the same title.

Our intent is to create from the various applications associated with a collaborative group one document for merit review that consists of the common, identical required appendices and attachments combined with a set of detailed budgets from the partner institutions. Thus, it is very important that every proposal in the collaborative group be exactly identical (including the title) with the exception of the budget and budget justification pages.

Program Funding:

It is anticipated that up to $2,600,000 total will be available for multiple awards to be made in FY 2012, contingent on the availability of appropriated funds. Awards are expected to be made for a period of three years at a funding level appropriate for the proposed scope, with out-year support contingent on the availability of appropriated funds and satisfactory progress. Funding for the final year is contingent upon satisfactory completion of a progress review during the second year of each project.

DOE is under no obligation to pay for any costs associated with the preparation or submission of a proposal. DOE reserves the right to fund, in whole or in part, any, all, or none of the proposals submitted in response to this Program Announcement. FES reserves the right to make fewer awards than would be possible at $2,600,000 per year, if an insufficient number of proposals are judged to be of suitable scientific quality or of sufficient relevance to the programs.

The instructions and format described below should be followed. You must reference Program Announcement LAB 12-603 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 DOE 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 (FWP) 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 scientific merit review (peer review) and will be evaluated against the following evaluation criteria which are listed in descending order of importance. Included within each criterion are specific questions that the merit reviewers will be asked to consider:

a) Scientific and/or Technical Merit of the Project
b) Appropriateness of the Proposed Method or Approach
c) Competency of Applicant's Personnel and Adequacy of Proposed Resources; and
d) Reasonableness and Appropriateness of the Proposed Budget.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the Announcement and the agency's programmatic needs. Note that external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Both Federal and non-Federal reviewers may be used, and submission of a proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

2. Summary of Proposal Contents

- Field Work Proposal (FWP) Format (Reference DOE Order 412.1A) (DOE ONLY)
- Proposal Cover Page
- Table of Contents
- Budget (DOE Form 4620.1) and Budget Explanation
- Abstract (one page)
- Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel – 20-page limit
- Literature Cited
- Biographical Sketch(es)
- Description of Facilities and Resources
- Other Support of Investigator(s)
- Appendix (optional)

2.1 Submission Instructions

LAB administrators should submit the entire LAB proposal and FWP via searchable FWP (https://www.osti.gov/fwp). Questions regarding the appropriate LAB administrator or other questions regarding submission procedures can be addressed to the Searchable FWP Support Center. All submission and inquiries about this Program Announcement must reference Program Announcement LAB 12-603. Full proposals submitted in response to this Program

Announcement must be submitted to the searchable FWP database no later than 11:59 pm, Eastern Time, **December 23, 2011**. It is important that the entire peer reviewable proposal be submitted to the searchable FWP system as a single PDF file attachment.

3. Detailed Contents of the Proposal

Adherence to type size and line spacing requirements is necessary for several reasons. No researcher should have the advantage, or by using small type, of providing more text in his or her proposal. Small type may also make it difficult for reviewers to read the proposal. Proposals must have 1-inch margins at the top, bottom, and on each side. Type sizes must be at least 11 point. Line spacing is at the discretion of the researcher but there must be no more than 6 lines per vertical inch of text. Pages should be standard 8 1/2" x 11" (or metric A4, i.e., 210 mm x 297 mm).

3.1 Field Work Proposal Format (Reference DOE Order 412.1A) (DOE ONLY)

The 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.

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 and number: **Materials Solicitation with focus on Structural Materials, Blanket First Walls, and Divertor Plasma Facing Components - LAB 12-603**
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 suffices, such as 5a, 5b.

3.4 Budget and Budget Explanation

A detailed budget is required for the entire project period 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/budgetform.pdf

3.5 Abstract

Summarize the proposal in one page. Give the project objectives (in broad scientific terms), the approach to be used, and what the research is intended to accomplish. State the hypotheses to be tested (if any). At the top of the abstract give the lead DOE National Laboratory, project title, names of all the investigators and their institutions, and contact information for the principal investigator, including e-mail address.

3.6 Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel).

The narrative comprises the research plan for the project and is limited to a **maximum of 26 pages**. It should contain enough background material in the Introduction, including review of the relevant literature, to demonstrate sufficient knowledge of the state of the science. The major part of the narrative should be devoted to a description and justification of the proposed project, including details of the methods to be used. It should also include a timeline for the major activities of the proposed project, and should indicate which project personnel will be responsible for which activities. It is important that the 26-page technical information section provide a complete description of the proposed work, because reviewers are not obliged to read the Appendices. Proposals exceeding these page limits may be rejected without review or the first 26 pages may be reviewed without regard to the remainder.

The page count of 26 does not include the Cover Page and Budget Pages, the Title Page, the biographical material and publication information, or any Appendices. Letters of endorsement from unfunded collaborators should also be included, if applicable. Please do not submit general letters of support as these are not used in making funding decisions and can interfere with the selection of peer reviewers.

Background and Recent Accomplishments

- Background – explanation of the importance and relevance of the proposed work.

Proposed Research and Tasks

- In addition to the technical description of the proposed work and tasks, include a discussion of schedule, milestones, and deliverables.

3.7 Literature Cited

Give full bibliographic entries for each publication cited in the narrative. Each reference must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume number, page numbers, and year of publication. Include only bibliographic citations. Principal investigators should be especially careful to follow scholarly practices in providing citations for source materials relied upon when preparing any section of the proposal.

3.8 Biographical Sketches

This information is required for senior personnel at the institution submitting the proposal and at all subcontracting institutions (if any). The biographical sketch is limited to a maximum of two pages for each investigator and must include:

Education and Training. Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.

Research and Professional Experience. Beginning with the current position list, in chronological order, professional/academic positions with a brief description.

Publications. Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they

appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically. Patents, copyrights and software systems developed may be provided in addition to or substituted for publications.

Synergistic Activities. List no more than five professional and scholarly activities related to the effort proposed.

To assist in the identification of potential conflicts of interest or bias in the selection of reviewers, the following information must also be provided in each biographical sketch.

> *Collaborators and Co-editors:* A list of all persons in alphabetical order (including their current organizational affiliations) who are currently, or who have been, collaborators or co-authors with the investigator on a research project, book or book article, report, abstract, or paper during the 48 months preceding the submission of the proposal. For publications or collaborations with more than 10 authors or participants, only list those individuals in the core group with whom the Principal Investigator interacted on a regular basis while the research was being done. Also, include those individuals who are currently or have been co-editors of a special issue of a journal, compendium, or conference proceedings during the 24 months preceding the submission of the proposal. Finally, list any individuals who are not listed in the previous categories with whom you are discussing future collaborations. If there are no collaborators or co-editors to report, this should be so indicated.
>
> *Graduate and Postdoctoral Advisors and Advisees:* A list of the names of the individual's own graduate advisor(s) and principal postdoctoral sponsor(s), and their current organizational affiliations. A list of the names of the individual's graduate students and postdoctoral associates during the past five years, and their current organizational affiliations.

3.9 Description of Facilities and Resources

Facilities to be used for the conduct of the proposed research should be briefly described. Indicate the pertinent capabilities of the institution, 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).

3.10 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 (months per year or percentage of the year) devoted to the project.

3.11 Appendix

Information not easily accessible to a reviewer may be included in an appendix, but **do not use the appendix to circumvent the page limitations of the proposal.** Reviewers are not required to consider information in an appendix, and reviewers may not have time to read extensive appendix materials with the same care they would use with 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 $50,000 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.