

**Program Announcement
To DOE National Laboratories
LAB 07-14**

***New Genomic Strategies and Technologies for Studying
Complex Microbial Communities and Validating Genomic
Annotations***

SUMMARY: The Office of Biological and Environmental Research (BER) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving proposals for research that supports the Genomics: GTL research program

(<http://genomicsgtl.energy.gov/>). In this Notice, two areas of research proposals are sought. The first is concerned with characterization of microbial communities having high priorities for DOE missions in bioenergy production, carbon cycling, and environmental remediation. The science of microbial ecology will be advanced by understanding the activities, composition (at multiple scales of resolution), distribution, diversity, relative abundance, and interactions of the microorganisms in relevant microbial communities. The second area addresses the mismatch between genomic and metagenomic DNA sequencing capabilities and the experimental testing of function annotations derived from the newly displayed sequence. Novel approaches are invited to better characterize microbial communities based on genomic information and/or to accelerate experimental validation of genome, gene set, and metagenomic annotations.

Dates: Potential researchers are **required** to submit a brief preproposal, referencing **LAB 07-14 for receipt by DOE by 4:30 p.m., Eastern Time, January 18, 2007**. Preproposals will be reviewed for conformance with the guidelines presented in this Notice and suitability in the technical areas specified in this Notice. A response to the preproposals encouraging or discouraging formal proposals will be communicated to the researchers by **January 26, 2007**. Researchers who have not received a response regarding the status of their preproposal by this date are responsible for contacting the program to confirm this status.

Only those preproposals that receive notification from DOE encouraging a formal proposal may submit a full proposal. **No other formal proposals will be considered.**

Potential researchers **must** submit a brief preproposal that consists of no more than three pages of narrative stating the research objectives, describing the technical approach(s), and identifying the proposed team members and their expertise. The intent in requesting a preproposal is to save the time and effort of researchers in preparing and submitting a formal project proposal that may be inappropriate for the program. Preproposals will be reviewed relative to the scope and research needs as outlined in the summary paragraph and in the **SUPPLEMENTARY INFORMATION**. The preproposal should identify, on the cover sheet, the title of the project, the institution or organization, principal investigator name, telephone number, fax number, and e-mail address. No budget information or biographical data need be included, nor is an institutional endorsement necessary.

Preproposals referencing the first aim in LAB 07-14 should be sent as a text file without attachments or a single PDF file attachment via e-mail to: **genomicsGTL@science.doe.gov** with "**Preproposal LAB 07-14 Microbial Communities Lastname Institution**" as the subject. Preproposals referencing the second aim in LAB 07-14 should be sent as a text file without attachments or a single PDF file attachment via e-mail to: **genomicsGTL@science.doe.gov** with "**Preproposal LAB 07-14 Annotation Lastname Institution**" as the subject. No FAX or mail submission of preproposals will be accepted.

Eligibility: Researchers from FFRDCs (Federally Funded Research and Development Centers) or DOE National Laboratories. BER reserves the right to encourage, in whole or in part, any, all, or none of the preproposals submitted, and may issue further guidance on the scope of the full proposal submissions of those encouraged.

Formal proposals in response to this Notice should be submitted via ePMA and must be received by 8:00 pm Eastern Time, **March 20, 2007**.

This section pertains only to those proposers that have been encouraged to submit a full proposal. A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (<https://epma.doe.gov>) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:

Fiscal Year:

Proposal Reason:

Program Announcement Number: Lab 07-14 *

Program announcement Title: New Genomic Strategies and Technologies for Studying Complex Microbial Communities and Validating Genomic Annotations *

Proposal Purpose:

Estimated Proposal Begin Date:

HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this Program Announcement.

In order to expedite the review process, please submit a CD and three copies of the proposal using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

Ms. Joanne Corcoran
U.S. Department of Energy
Office of Biological and Environmental Research, SC-23.2
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 07-14

FOR FURTHER INFORMATION CONTACT:

For the first aim of this notice, contact Dr. Daniel Drell,
telephone: (301) 903-4742, E-mail: Daniel.drell@science.doe.gov .

For the second aim of this notice, contact Dr. Arthur Katz,
telephone: (301) 903-4932, E-mail: Arthur.katz@science.doe.gov

SUPPLEMENTARY INFORMATION: The Genomics:GTL Program is a systems biology research program addressing key DOE missions and national priorities including: developing abundant sources of clean energy, controlling greenhouse gases like carbon dioxide (a key factor in global climate change), and helping to clean up past contamination of the environment.

Microorganisms are the largest reservoir of genetic and biochemical diversity on Earth and they and their resulting communities mediate many natural processes of direct mission relevance to the DOE Genomics:GTL Program, including: 1) biodegradation and bioconversion of complex polymers into simpler component substances, many of which offer great promise as sources of potential energy sources and fuels (e.g. ethanol, butanol, hydrogen, methane, etc.); 2) management of the fate and transport of contaminants comprising or containing heavy metals, radionuclides, or chlorinated solvents (e.g. uranium, chromium, plutonium, mercury, carbon tetrachloride, trichloroethylene, perchlorethylene) in subsurface areas at DOE sites; and 3) management of the flow and fate of carbon (including carbon dioxide) through terrestrial and marine environments with consequent impacts on atmospheric CO₂ concentrations.

Studies of single microbes have revealed some of the relevant biochemistries but do not capture the properties of natural microbial communities that mediate these processes. Recent examinations of microbial communities have revealed that hard-to-culture microbes make up more than 99% of many natural microbial communities and thus much of our present knowledge is based on a very small subset of their component members. DNA isolated directly from environmental samples is a tremendous resource for examining, in a more comprehensive and representative way, the structure and functioning of microbial communities but analyses of "metagenomic" DNA are not well advanced. The science of microbial ecology pertinent to DOE missions in bioenergy, fate and transport of contaminants, and carbon cycling will be advanced by understanding the activities, compositions, distribution, diversity, relative abundance, and interactions of the full range of microorganisms in relevant communities. A challenge to achieving this objective, however, is the difficulty in characterizing the complexity of microbial communities in nature and the ways they may change over time. Recent "metagenomic" sequencing surveys have indicated the presence of extraordinary numbers (in the tens of millions) of previously unknown genes. Thus, new strategies and technologies are needed to help define and assess the repertoire of metabolic capabilities as embodied in the collective genomic sequence of a microbial community.

In addition, there is a mismatch between genome DNA sequencing capabilities and the validation of proposed functional assignments derived from sequence interpretation. Gene structure recognition within genome sequence uses any of several software packages. A subsequent functional annotation is then derived from comparisons of the resulting gene models with those from other organisms previously sequenced and annotated. For a microbial species not

previously sequenced, about a third of the putative genes lack homologues from which to predict function. For those sequences having homologues, the initial functional assignments may be questionable due to errors from a variety of sources. Some initial annotations in the public databases are simply not correct. The deduced gene model may not be correct due to erroneous DNA sequence calls or novelties in gene structure not yet recognizable by the software. Homology based sequence assignments become less reliable as the phylogenetic distance between compared species grows. Examples are known of proteins with very similar structures but different functions. Similarly, examples exist of proteins with dramatically different structures but very similar functions. Some proteins have multiple functions. While human curation can correct some annotation errors, the flood of new sequences is swamping curatorial efforts. Ultimately, there is no substitute for high-throughput experimental methods to test gene annotations which are crucial to practical applications. The aim of this part of this call is to improve annotation testing for genes having greatest impact on DOE projects.

This leads directly to the two main thrusts of this Notice: 1) to develop technologies for characterization and functional analyses of microbial communities involved in DOE mission relevant activities and 2) to further stimulate innovative experimental technologies and approaches to test predicted gene/protein function(s) including those entirely lacking homologues.

1) New technologies and strategies for characterization and functional analyses of microbial communities involved in DOE mission relevant activities are encouraged that will:

- Use genome sequences from microbial communities to identify, in high-throughput, the mission relevant genes, metabolic pathways, regulatory networks and proteins needed for (or that impact) survival, growth and adaptation to the environment and especially the metabolic and physiologic reactions carrying out degradations of cellulose (and cellulose-linked compounds) or other bioenergy relevant processes, carbon cycling, or management of the fate and transport of high-priority contaminants. In particular, novel and innovative methods and approaches are needed to identify community composition and genetic diversity in microbial communities of interest to the DOE. Methods for conceptual reconstruction, from sequence data, of essential metabolic and DOE mission relevant pathways are of interest. It is critical to understand the relationships between genetic diversity, community diversity, and microbial community functioning to provide insights into community "functional regulation" as a result of microbial community composition. Better approaches to "binning" sequences of novel genes into putative (operationally defined) "species" and pathways are needed. In responding to this part of this notice, researchers should take particular care to define the extent of the "community" they intend to study.

Key technologies needed to achieve these goals include, but are not limited to:

- New highly parallel comparative approaches that allow unique microbial community DNA fragments to be identified and the community to be characterized in automated high-throughput ways.

- Novel technologies and approaches for defining the patterns of expression and functions of genes from, and co-incident with, microbial communities under different environmental conditions.

2. Develop and apply high-throughput innovative technologies and approaches to improve gene/protein functional assignments:

Genome sequence is available for a rapidly growing number of individual microbes, plants, and microbial communities. This sequence information is made available to the public, commonly with initial gene identifications and annotations determined by computational analyses. A key challenge is to efficiently test and improve the annotations of these putative genes and their potential function(s).

Currently, annotation of genes largely relies on computational algorithms to recognize genes within DNA sequence, and then carry out a homology-based search of the sequences of genes already characterized to infer possible function. However, relying on computational algorithms alone for annotation has substantial limitations. It has been increasingly clear that there is no substitute for experimental methods to test and validate gene annotation.

Consequently, this element addresses this imperative by supporting the development of improved technologies for high throughput experimental validation. Genomics:GTL seeks improvements to high throughput testing of gene annotation for microbes and microbial gene sets of interest to DOE missions in bioenergy, carbon cycling, and bioremediation. The Genomics:GTL Program seeks creative and innovative thinking and strategies that can propose new approaches as well as the coupling, where appropriate, of a combination of new and/or existing technologies into flexible and efficient systems for experimental annotation.

High throughput innovative approaches to functional analyses can use a variety of new and existing formats and technologies, individually or in combination, that can include but are not limited to, physiological assays, structural and physical measurements using purified proteins, and *in vivo* phenotypic analyses of microbes. Microarrays, mass, force and electromagnetic spectroscopies, single cell analyses, phage display approaches, and/or other structural characterizations are among the possible techniques that may be used.

While the ultimate goal of this element is to develop experimental techniques to rapidly validate annotations, an initial test of these techniques would be to identify and validate genes and gene sets from genomic and metagenomic data that are part of networks and pathways that carry out functions of particular interest to DOE. Possible targets could include activities mediated by cytochromes, rhodopsins, dehydrogenases, cellulases, dehalogenases, etc.

Improvements to experimental technologies and strategies are thus sought to:

Develop and/or innovatively apply techniques that can rapidly, with a high degree of confidence, improve gene/protein functional assignments. **These approaches should strive to be compatible with other complementary tools for gene/protein functional assignments.**

Potential approaches to the goal of high throughput experimental annotation include but are not limited to:

- The development of systems that combine protein and protein domain production with high throughput functional testing,
- The development of systems that combine genetic and reverse genetic approaches with high throughput functional testing.

Microbes of Interest to DOE. The focus of Genomics:GTL is on nonpathogenic microbes (including fungi) and some plants that are directly relevant to DOE mission needs in energy (biomass conversion to energy sources, carbon sequestration, and the global carbon cycle both terrestrial and ocean) or the environment (fate and transport of metals, radionuclides, and certain organics at DOE sites). When possible, research within this solicitation should take advantage of and focus on microbes whose complete DNA sequence is already known or microbial communities of interest to, directly relevant to, or that would contribute substantially to an ability to address DOE mission needs. **Researchers should identify proposed high throughput DNA sequencing needs, if any, in their proposal; subject to merit review, accepted proposals can expect sequencing needs to be satisfied at the DOE-Joint Genome Institute (DOE-JGI) at no cost following a technical review at the DOE-JGI.** Researchers should also provide a clear, scientifically justified description for their choice of microbe(s) in the context of DOE mission needs as outlined above.

Data and Other Results. Microbial DNA sequence data will be publicly released according to the "Data Release Requirements: Microbial Genome Sequencing Projects" (<http://www.jgi.doe.gov/sequencing/collaborators/datarerelease.html>). Data and results that are generated through these investigations that are appropriate to share with the broader community should be provided in timely, open, and machine-readable format where possible. Funded investigators are expected to contribute to and participate with the GTL working group on data management, and to adhere to the group's consensus on data sharing.

The Genomics:GTL program supports a combination of large, well integrated, multidisciplinary research teams and smaller, focused research projects. This solicitation will support smaller, focused research projects to develop new technologies, research strategies, or research resources needed by the Genomics:GTL program.

Information on the research projects currently funded by the Genomics: GTL program and a description of project goals and overall program organization can be found at:
<http://genomicsgtl.energy.gov/>.

Other useful web sites include:

DOE Joint Genome Institute (JGI) Microbial Web Page - http://genome.jgi-psf.org/mic_cur1.html;

DOE Joint Genome Institute Sequencing projects:
<http://www.jgi.doe.gov/sequencing/seqplans.html>

Microbe Project Interagency Working Group Home Page: <http://www.microbeproject.gov/>

Genomes On Line Database: <http://www.genomesonline.org/>

Program Funding: It is anticipated that up to \$4 million total will be available for multiple awards to be made in FY 2007 for New Genomic Strategies and Technologies for Studying Complex Microbial Communities and Validating Genomic Annotations. The number of awards will be contingent on satisfactory peer review, the availability of appropriated funds, and the size of the awards. Multiple year funding is expected. Proposals may request project support for up to three years, with out-year support contingent on the availability of funds, progress of the research, and programmatic needs. Annual budgets are expected to range from \$250,000 to \$600,000 total costs. DOE is under no obligation to pay for any costs associated with the preparation or submission of an proposal. DOE reserves the right to fund, in whole or in part, any, all, or none of the proposals submitted in response to this Notice.

Submission Information

Full Proposal

The Department of Energy will accept Full Proposals by invitation only, based upon the evaluation of the preproposals. After receiving notification from DOE concerning successful preproposals, researchers may prepare formal proposals. The Project Description must not exceed 20 pages, including tables and figures, but exclusive of attachments. The proposal must contain an abstract or project summary, short vitae, and letters of intent from collaborators if appropriate.

Full proposals adhering to DOE Field Work Proposal format (Reference DOE Order 412.1) are to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Laboratories may submit proposals directly to the SC Program Office listed above. A copy should also be provided to the appropriate DOE Operations Office.

The instructions and format described below should be followed. You must reference Program Announcement LAB 07-14 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 (peer review) and will be evaluated against the following criteria which are listed in descending order of importance:

Scientific and/or technical merit of the project

Appropriateness of the proposed method or approach

Competency of the personnel and adequacy of the proposed resources

Reasonableness and appropriateness of the proposed budget

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the Department's programmatic needs. External peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. 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 O 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)
- Literature Cited
- Biographical Sketch(es)
- Description of Facilities and Resources
- Other Support of Investigator(s)
- Appendix (optional)

2.1 Number of Copies to Submit

This section pertains only to those proposers that have been encouraged to submit a full proposal. A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (<https://epma.doe.gov>) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:

Fiscal Year:

Proposal Reason:

Program Announcement Number: Lab 07-14 *

Program announcement Title: New Genomic Strategies and Technologies for Studying

Complex Microbial Communities and Validating Genomic Annotations *

Proposal Purpose:

Estimated Proposal Begin Date:

HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this Program Announcement.

In order to expedite the review process, please submit a CD and three copies of the proposal using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

Ms. Joanne Corcoran
U.S. Department of Energy
Office of Biological and Environmental Research, SC-23.2
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 07-14

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 their proposals. 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 10 point or larger. 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 O 412.1A) (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 ePMA.

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 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

Provide an abstract of less than 400 words. 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 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 20 pages (maximum). 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.

If any portion of the project is to be done in collaboration with another institution (or institutions), provide information on the institution(s) and what part of the project it will carry out. 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".

3.7 Literature Cited

Give full bibliographic entries for each publication cited in the narrative.

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.

To assist in the identification of potential conflicts of interest or bias in the selection of reviewers, the following information **must 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. 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. 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 5 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 \$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.