Program Announcement
To DOE National Laboratories

LAB 12-695

Office of Science

Office of Advanced Scientific Computing Research (ASCR)

Scientific Collaborations at Extreme-Scale

GENERAL INQUIRIES ABOUT THIS LAB ANNOUNCEMENT SHOULD BE DIRECTED TO:

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SUMMARY:

The Office of Advanced Scientific Computing Research (ASCR) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby invites proposals for research and development that represents transformational advances in scientific collaboration systems and distributed data systems addressing the fundamental challenges related to extreme-scale science collaborations.

Scientific grand challenges in the next decade in areas such as combustion modeling, climate science, energy generation, bio-remediation processes, and material structure aging will usher in the era of extreme-scale science. Increasingly these challenges may only be solved by multi-disciplinary teams working with unique scientific instruments, exascale class computers, and/or handling extreme amounts of data. To meet these challenges these teams will need a distributed science environment that promotes scientific collaboration and resource sharing.

Scientists currently rely on basic, and fairly primitive, tools and services designed for social networking and commercial activities to carry out simple collaboration tasks. However, these primitive collaboration tools are proving to be inadequate for large-scale scientific efforts involving the sharing of massive data sets or complex instruments, among thousands of distributed researchers.The focus of this announcement is on transformative approaches to understanding and/or enabling scientific collaborations at a scale not possible with today's knowledge or using current Internet-based services and tools.

More specific information is included under SUPPLEMENTARY INFORMATION below.

A companion Funding Opportunity Announcement (FOA) DE-FOA-0000695 will also be posted at grants.gov and on the SC Grants and Contracts web site at: http://www.science.doe.gov/grants.

PROPOSAL DUE DATE:

Formal proposals submitted in response to this Program Announcement must be submitted from the Laboratory to the site office through Searchable FWP by **April 27, 2012, 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 followed in the same PDF by the full technical proposal. You are encouraged to transmit your proposal well before the deadline. PROPOSALS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

SUBMISSION INSTRUCTIONS:

LAB administrators should submit the entire LAB proposal and Field Work Proposal (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 12-695

SUPPLEMENTARY INFORMATION:

Extraordinary advances in computing and communication technologies are transforming the scientific process from a labor intensive manual process to one where discovery can take place over large distances or with multiple collaborators. The scale and complexity of some of today's major scientific undertakings require that scientists work in large globally distributed multi-disciplinary teams. Other experiments require that individuals or small groups of scientists work remotely to achieve their scientific goals. In either case, these scientists must manage large data sets; access national and international instruments in real-time from hundreds to thousands of miles away, run simulations on leadership class supercomputers, and effectively communicate with peers located at remote institutions.

Currently the understanding of how to build, operate, maintain, and expand scientific collaboration systems relies on a basic understanding of how scientists work together and a primitive set of tools and services to support this work. Future collaboration systems will be expected to support scientific exploration at the extreme-scale: handling the generation, archiving, and distribution of massive data sets; providing support for real-time and near-time co-development activities; and allowing scientists to access remote instruments and computing resources as if they were local. These collaboration systems must also be simple to use and integrate multiple tools and services into an intuitive whole that enhances the scientific discovery process.

Given that scientific data will come from different sources (extreme-scale computing and unique scientific instruments), take different forms (structured and unstructured), and in some cases require streaming or near-time processing, it is unlikely that conventional data management approaches will adequately address these emerging scientific data management challenges. Key attributes of extreme data sets include: data volume, complexity, heterogeneity, ownership, provenance, and sharing mechanisms.

Real-time and near-time activities span a wide range of activities from interactive manipulation of a simulation output to time limited data analysis activities (e.g., analyzing the output of a tokamak experiment to set the parameters for the next shot). These activities require interacting with both the generated data and the scientists and engineers looking at this data. Enabling attributes of time sensitive activities include: latency impacts, jitter and loss impacts, and synchronization between multiple independent data streams.

Scientific collaborations come in a variety of sizes ranging from an individual scientist accessing a remote instrument to a globally distributed experiment with thousands of scientists and engineers interacting on a long term project. These collaborations involve many actions from finding resources (data, instruments, and people) to use these resources in an effective manner. Enabling attributes of scientific collaborations include: resource discovery, access, usage, and scheduling.

Research activities in these topics should focus on developing knowledge, algorithms, libraries, tools, services, and frameworks for a new scientific exploration environment that supports collaborative scientific discovery effectively at extreme-scales. This work will have revolutionary impacts on critical science facilities (instruments, computing systems, data archives) which are accessed and shared by distributed scientific communities across the DOE-SC complex. The topics of interest for this announcement include but are not limited to:

- Resource discovery and management – the ability to find and use the appropriate resources (people, data, instruments, computers, and/or documents) that are scattered around the globe. Large scale collaborations rely on the user's ability to find and use resources scattered throughout the collaborative environment. This subsection requests proposals that simplify the use of distributed resources or develop fundamental principles of how such systems will operate. Examples include: workflow frameworks, distributed registration/query systems (standards based tools/services that allow objects to advertise their capabilities and users to find these objects), dynamic and flexible resource provisioning mechanisms (resource brokers and meta-schedulers), VM image creation and management tools (reduce/eliminate the need for a scientist to be a local sys-admin), and grid/cloud provisioning and management services (cluster management systems).

- Identity Management – the ability to securely access local and remote resources, or have resources securely act on a user's behalf, while continuing to support local control over physical resources. The ability for a collaboration to control its physical resources while accessing resources owned by resource providers is key to the collaborations' success. This subsection requests proposals that enable this resource sharing by developing tools, services, protocols, and open standards. Examples include: site management tools (tools a lab/facility manager would use to define/enforce local policies), standards based back-end services (the

schemas and mechanisms needed to operate an Identity Management service i.e., certificate servers, attribute servers, policy servers, etc) and interactive and batch based services (interactive services rely on a human responding to prompts i.e., web based service, a batch service is launched by a human or automated process and runs to completion autonomously).

- Integration Enhancements – the ability to simplify the establishment and operation of collaborations. Scientific collaborations use a variety of tools and services to enable the interaction between people, instruments, and data. All too often these are stand-alone tools with their own unique discovery and identity management interfaces. Future collaborations will require tools that are simpler to use and integrated multi-vendor tools and services that provides a satisfying user experience with appropriate security mechanisms and interfaces. This subsection requests proposals that deal with this access and integration need. Examples include: integrated discovery and audio conferencing (establish an ad-hoc conference with the person at control room console 4, the shift supervisor, and the remote PI), workspace integration (merging smartphones and other personal devices into a scientist's workspace), and archival services (save the actions taken to establish/run a collaboration task so it can be done again in the future).

- Streaming data management – Scientific collaborations may have time sensitive elements or tasks that must be accomplished in a fixed amount of time. This subsection requests proposals for innovative approaches to support interactive data-intensive collaborations involving data streaming and near-time data processing that may be needed to support time-sensitive collaboration activities such as computational steering, remote instrument operations, and remote visualization.

The DOE science community is a highly diverse domain-specific science environment, each with unique modality of scientific research collaboration requirements. Developing collaborative software sub-systems that can adapt to meet the needs of these diverse communities is a daunting challenge. Proposers are therefore encouraged to propose and use software development methodologies and open architecture frameworks that encourage re-usability, extensibility, and scalability to facilitate the adoption of their tools into different domain-specific environments.

The Scientific Collaborations for Extreme-Scale Science (SCESS) workshop report provides more details on the research needs for future scientific collaborations. Submissions that propose partnerships with other DOE program offices are strongly encouraged. Submitters should contact the ASCR program manager to discuss potential partnership proposals to ensure that the proposal will benefit both ASCR and the other DOE program office. The Office of Biological and Environmental Research (BER), the Office of Fusion Energy Sciences (FES), and the Office of High Energy Physics (HEP) program offices have expressed interest in partnerships.

Submissions proposing computer science advancements that have strong synergies with science funded by BER to further the BER mission, such as addressing the distributed computing and data needs of the Earth System Grid (ESG) for the climate modeling community will be considered. The successful proposal will leverage recent advances in high-speed networks and related high-performance middleware technologies to upgrade and enhance the capability of the ESG.

Proposals addressing scientific collaboration issues of importance to FES, including those associated with remote collaborations, remote instrumentation, and data streaming will be considered.

Submissions proposing computer science advancements that have strong synergies with science funded by HEP to further the HEP mission, such as distributed computing and data needs for U.S. Large Hadron Collider (LHC) computing and/or Cosmic Frontier Research will be considered.

All awards are contingent on the availability of funds and programmatic needs. 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 part, any, all, or none of the proposals submitted in response to this Notice.

An official submission with well-delineated tasks, deliverables, and budget pages is required from each participating institution. Respondents interested in pilot/demonstration projects directly tied to an Office of Science Program Office, other than ASCR, should coordinate with the appropriate program office.

DOE Facilities Awareness
Potential awards focusing on technologies that target collaboration environment for scientific instruments should visit the Office of Science user's facility website to ensure that instruments selected are within the scope of DOE's Office of Science mission. Abbreviated lists of user's facilities listed by sponsoring program office include but are not limited to:

Office of Advance Scientific Computing research (ASCR-Facilities)
http://science.energy.gov/ascr/facilities/

- Oak ridge Leadership Computing Facility http://www.olcf.ornl.gov/
- Argonne Leadership Computing Facilities http://www.alcf.anl.gov/
- National Energy Research Scientific Computing Center (NERSC) http://science.energy.gov/ascr/facilities/nersc/
- Energy Sciences Network (ESnet) http://science.energy.gov/ascr/facilities/esnet/

Office of Basic Energy Sciences (BES) http://science.energy.gov/bes/

- National Synchrotron Light Source (NSLS-II) http://www.bnl.gov/ps/nsls2/about-NSLS-II.asp
- Linac Coherent Light Source (LCLS) http://lcls.slac.stanford.edu/aboutlcls.aspx
- Advanced Photon Source (APS) http://aps.anl.gov/
- Spoliation Neutron Source (SNS) http://neutrons.ornl.gov/facilities/SNS/

Office of Biological and Environmental Research (BER) http://science.energy.gov/ber/

- Atmospheric Radiation Measurement Climate Research Facility
  http://science.energy.gov/ber/research/cesd/arm-climate-research-facility/
- William R. Wiley Environmental Molecular Sciences Laboratory (EMSL)
  http://www.emsl.pnl.gov/emslweb/
- Joint Genome Institute (JGI) http://www.jgi.doe.gov/

Office High Energy Physics (HEP) http://science.energy.gov/hep/

- Large Hadron Collider (LHC/CMS) http://www.uslhc.us/

Office Nuclear Energy (NP) http://science.energy.gov/np/

- Large Hadron Collider (LHC/ATLAS) http://www.uslhc.us/

Virtual Facilities

- Earth systems Grid – Biological and Environmental Sciences Research
  http://www.earthsystemgrid.org/home.htm
- Open Science Grid – High Energy Physics and Nuclear Energy Physics
  http://www.opensciencegrid.org/

ASCR Research Initiatives Awareness

ASCR has ongoing large research initiatives that embody many aspects of scientific collaboration requirements described in this announcement. An awareness of scientific collaboration and distributed data-intensive science opportunities and challenges can be beneficial to potential proposers. The major activities include:

- ASCR Co-Design Centers - The co-design is a new paradigm to accelerate the conception and development of productive exascale computer systems through a multi-disciplinary collaborative arrangement that vertically integrates the requirements, expertise, and resources of all stake-holders (scientific applications teams, applied mathematicians, system software developers, supercomputer centers, computer vendors, and technology developers). More information on the current ASCR exascale co-design centers are available at: http://science.energy.gov/ascr/research/scidac/co-design/

- SciDAC- III Institutes and Partnerships – imitated in 2001, SciDAC (Scientific Discovery through Advanced Computing) is highly successful program supporting scientific inquiry that bring together computational scientists (applied mathematicians computers scientists) with domain scientists to apply high performance computing to solve complex problems. Additional information on the current research activities along with anticipated collection of scientific partnerships can be found at: http://www.scidac.gov/institutes.html

References

[1] DOE ASCR 2011 Scientific Collaborations for Extreme-Scale Science (SCESS) Workshop, December 6-7, 2011, Gaithersburg Marriott Washington Center, Gaithersburg, MD - SCESS Workshop Report

[2] Terabits Networks for Extreme-Scale Science, February 16-17, 20011, Rockville Hotel & Executive Meeting Center, MD – PDF Report

[3] Data and Communications in Basic Energy Sciences: Creating a Pathway for Scientific Discovery Workshop, October 24-25, 2011, Bethesda Marriott Hotel and Conference Center, Bethesda, MD – PDF Report

[4] DOE Exascale Workshop on Data Analysis, Management, and Visualization Workshop, February 22-23, 2011, Hilton Hotel, Houston, TX – PDF Report

[5] Cross-cutting Technologies for computing at the Exascale Workshop, February 2-4, 2010, Washington DC – PDF Report

[6] Modeling and Simulation at the Exascale for Energy and the Environment Town Hall Meetings Series June – May 2007 - PDF Report

[7] ASCR SciDAC-III Institutes

[8] ASCR SciDAC-III Scientific Application Partnerships (SAPs) and related FOAs: (1) BES – materials and chemical sciences, 2) HEP – high energy physics, 3) FES - Fusion energy science, and 4) BER – earth system science

[9] The Fourth Paradigm: Data-intensive Scientific Discovery, Microsoft Research publication

[10] Peter Spyn et al., "Data modeling versus Ontology engineering," in http://lsdis.cs.uga.edu/SemNSF/SIGMOD-Record-Dec02/Meersman.pdf

[11] Lori A. Freitag and Raymond M. Loy, "Theoretical Cost Comparison of Remote Visualization Strategies," http://www.mcs.anl.gov/uploads/cels/papers/P1037.pdf

[11] Asbjørn Rygg et al, A Unified Model of Batch and Interactive Scientific Workflow and its Implementation using Windows Workflow, http://eprints.qut.edu.au/9313/1/9313.pdf

[12] Lavanya Ramakrishnan et al, A Multi-Dimensional Classification Model for ScientificWorkflow Characteristics, http://www.cs.indiana.edu/~plale/papers/RamakrishnanWANDS2010.pdf

Additional Proposal Requirements: We are looking for strong teams that address multiple components of the software stack. Collaborative proposals must carefully consider the fact that we will give priority to proposals that have a lean budget, in which overheads are minimized and in which every senior/key personnel has a significant technical contribution to the proposed research.

Each proposal must include the following:

1. Description of plans for developing prototypes of the proposed solution;
2. Description of the proposed path to integration and/or interoperation with existing programming environments, including a proposed timeline;
3. Evaluation plan with respect to scalability, programmability, energy efficiency, and performance metrics using compact applications, mini-applications [11], [12] and/or application skeletons [13].

For official postings see the Office of Science Grants and Contracts web site, http://www.science.doe.gov/grants.

Collaborations: Collaborative research projects with other institutions, such as universities, industry, non- profit organizations, and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, are strongly encouraged. Collaborative proposals submitted from different institutions should clearly indicate they are part of a proposed collaboration and contain the same title, Abstract and Narrative for that research project. In addition, such proposals must describe the work and the associated budget for the research effort being performed under the leadership of the Principal Investigator at that participating institution. These collaborative proposals should all have the same title as the Lead Institution.

Program Funding: It is anticipated that up to of $4.7 million annually for three years will be available for multiple awards in three categories: 1) single individual/single institution award, 2) medium size collaborations, and 3) large demonstrations or pilot awards.

- **Single Investigator Award** – these are traditional awards made to a single investigator in an institution. The funding level for this type of award is up to $150K/year for three years.

- **Medium collaboration Awards** – are multiple investigators projects involving several (two – four) investigators. The funding level for this type of award is up to $450K/year for three years.

- **Pilot/Large Demonstration Awards** – are large awards involving multiple investigators from two or more institutions. These projects may involve work with other DOE-SC program offices, projects that prototype interconnecting a SC instrument to an ASCR compute facility, or projects addressing ASCR basic research needs. The funding level for this type of award is up to $1,000K/year for three years.

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.

The instructions and format described below should be followed. You must reference Program Announcement LAB 12-695 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 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:

1) Scientific and/or technical merit of the project

- Does the proposed research significantly advance the state-of-the-art in algorithms, libraries, tools, services, or frameworks needed to develop or support large scale science collaborations?
- Does the proposed research clearly address scalability, performance, resiliency, or energy efficiency issues?
- Does the proposed research significantly lower the barriers to effective collaborations involving a range of computing resources, large scale science instruments, or geographically dispersed science communities?
- What is the likelihood that the proposer can overcome the key challenges or shift research directions in response to promising advances in basic research?

2) Appropriateness of the proposed method or approach

- Does the research plan contain the development of prototypes of the proposed solution?
- Does the research plan include a demonstration of the viability of the proposed solution for adoption by existing collaborations?
- Does the research plan include validation strategies?
- Does the research plan contain appropriate performance metrics that will allow progress and contributions to be measured?
- If this is a collaborative application, does the management plan addresses the organization, communications, and coordination activities of the collaborating teams?

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

- Do the proposers have a proven record of success in delivering results for collaborative science research?
- Do the proposers have a proven record of research and development in the disciplines needed for success?
- Are the roles and intellectual contributions of the Principal Investigator(s), and each senior/key personnel adequately described? Do you consider the contributions of each senior/key personnel of significant value for the project?

4) Reasonableness and appropriateness of the proposed budget

- Is the proposer's requested budget appropriate? Is the budget as lean as it can be to deliver the promised results? Are the budget overheads minimized?
- Does the requested budget support the proposer's specified management structure in a meaningful way?
- Does the proposer have a process for reallocating individuals funds to address changing priorities?
- Is travel budget appropriate? Are video conferencing technologies proposed to reduce the travel budget?

The selection official will consider the following program policy and management factors in the selection process:

- Potential impact of proposed research activities on the ASCR collaboratories program.
- Potential for developing synergies and/or relation of the proposed research activities to other research efforts supported by ASCR, particularly co-design;
- Total amount of DOE funds available; and
- A management plan that addresses the organization, communications, and coordination of the collaborating researchers. This plan should include mitigation strategies for foreseeable risks and explain how the project will have sufficient flexibility to adapt to changing priorities, challenges, and resources.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the Program 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 – 25-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 Field Work Proposal (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 to DOE National Laboratories LAB 12-695. 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, **April 27, 2012**. 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 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.

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: **Scientific Collaborations at Extreme-Scale - LAB 12-695**
> 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 25 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 25-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 25 pages may be reviewed without regard to the remainder.

The page count of 25 does not include the Cover Page and Budget Pages, the Title Page, the biographical material and publication information, or any Appendices. However, it is important that the 25-page technical information section provide a complete description of the proposed work, since reviewers are not obliged to read the Appendices. 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

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.

Is this a Collaboration? If yes, 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.

* Note that collaborating proposals must be submitted separately.

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. If letters of endorsement are included in a proposal, they will be removed before the proposal is submitted for review.

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.