NSF Instrumentation and Laboratory Improvement (ILI)

I. General Program Description

A. Purpose

The objective of the Instrumentation and Laboratory Improvement (ILI) program is to support the development of experiments and laboratory curricula which improve the science, mathematics, engineering, and technology (SME&T) education of undergraduate students, both SME&T majors and non-majors. An important target audience is the students who are preparing to be K-12 teachers.

Proposals are sought for the development of innovative methods for using laboratory experiences to improve student understanding of basic scientific principles. These methods often involve the use of modern instrumentation, new technologies, or new applications that extend the instructional capability of the equipment. In addition, ILI seeks to encourage the creative adaptation of the best existing experiments and laboratory techniques that result in substantial improvement in student learning. Dissemination of project results by means of discipline-based or educational journals, presentations at scientific and technical meetings, delivery by electronic networks and media, published laboratory manuals or experiments, or software is expected.

The ILI program seeks projects that will improve laboratory instruction nationally as well as at the project site and that will produce and adapt national models for the improvement of undergraduate instruction. Accordingly, the ILI program discourages proposals that:

- are justified solely on the basis of financial need or increased enrollments;
- seek replacement equipment without a well conceived plan for enhancing instruction;
- provide only the basic level of support for laboratory instruction needed to maintain a viable program; or
- replicate an existing program without adaptation to the particular student audience.

Such projects are more appropriately supported by the institution.

B. Scope of the Program

ILI projects should be designed to improve the quality of undergraduate instruction by supporting the acquisition of instruments for SME&T laboratory courses. "Laboratory," for ILI purposes, means any setting affording students active participation in learning subject matter. The setting may involve an observatory, a field site, or a computer room, as well as the traditional laboratory. ILI provides matching grants in the range of $5,000 to $100,000 for instrumentation that serves as the basis for undergraduate instructional improvement.

ILI proposals are encouraged for activities such as:

- introductory laboratories;
- courses that acquaint non-SME&T majors with the principles and methods of science, mathematics, engineering, and technology;
- laboratories for majors;
- undergraduate laboratory education for the preparation of pre-service K-12 teachers;
- laboratories designed to encourage under-represented groups to develop a greater interest in science, mathematics, engineering, and technology;
- laboratories that concern fundamental scientific, mathematical, or engineering concepts within technical, professional, or associate degree programs.
- equipment sharing through consortia or centers;
- upgrading or replacing of obsolete or unreliable equipment as long as the new equipment will expose students to concepts and/or techniques that were not previously possible;
- undergraduate honors programs, student research, and independent study; and:

C. Eligibility Criteria and Limitations

1. Eligible Equipment. The types of equipment eligible for inclusion in an ILI proposal are listed under “Budget,” in section IIC, below. The primary use of each equipment item requested must be for undergraduate SME&T instruction. Items may serve additional purposes when they are not being used for undergraduate instruction, but these ancillary uses neither form nor augment the justification required for ILI funding.

2. Ineligible Items. In ILI projects, neither NSF funds nor institutional matching funds may be used to purchase items listed below:
• teaching aids (e.g., films, slides, projectors, "drill and practice" software), word-processing equipment, library reference materials, or expendables (e.g., glassware, chemicals);
• instrumentation that is not mainly for undergraduate use;
• vehicles, laboratory furnishings or general utility items such as office equipment, benches, tables, desks, chairs, storage cases, routine supplies, and general consumables;
• maintenance equipment and maintenance or service contacts - even when these are for equipment procured through the ILI program,
• salaries, honoraria, consulting fees, travel, training courses, etc.,
• institutional indirect costs or overhead;
• costs of building or laboratory modification or construction required for installation of the equipment (as distinct from simply integrating multiple computational resources or interfacing computers to instruments);
• a flat percentage inflation allowance;
• replacement equipment that does not significantly improve instructional capability.

3. Eligible Project Size. ILI seeks proposals that request funds only for instructional scientific equipment. A maximum of $100,000 may be requested from NSF; grantee institutions must provide an equal or greater matching contribution. Project costs in excess of $200,000 must be funded by overmatching. (See the requirements for matching funds below.) The minimum grant request to ILI is $5,000 in NSF funds (for a total project cost of $10,000).

ILI grants are normally made for a 24-month period. Authorized officials at the grantee institutions may approve a one-time extension of the expiration of the grant of up to 12 months if additional time beyond the established expiration date is requested to assure adequate completion of the original scope of work within the funds already made available. This one-time extension may not be exercised merely for the purpose of using an unspent balance. The grantee shall notify the NSF Grants Officer in writing, providing supporting reasons for the extension and the revised extension date, at least ten days prior to the expiration date specified in the grant to ensure accuracy of NSF's grant data.

4. Requirements for Matching Funds. Prospective ILI grantee institutions must agree to provide matching funds in an amount equal to, or greater than, the equipment funds provided by the Foundation. The proposal budget must detail all expenditures for the project as a whole, that is, for the combined total of requested NSF funds and the institution’s funds. It is not necessary that specific sources for matching funds be identified in the proposal. Matching funds must be from non-Federal sources. Funds from an ILI grant, or the institutional matching contribution to it, may not be counted as an institutional contribution to another Federally-supported project. If a grantee receives a gift of equipment from non-Federal sources that is identical or equivalent to items listed in the project's approved budget, the current cash value of such gifts may be counted as institutional matching funds.

An institution may obligate its matching funds or receive gifts to be counted toward matching at any time following the program closing date under which the awarded proposal was submitted but before the grant expiration date specified in the grant document. This normally provides a period of over two years during which the institution must fulfill the agreement to match NSF funds. To be qualified as matching, these funds must be used specifically for the equipment (or its equivalent) listed in the project's approved budget.

II. Preparation and Submission of Formal Proposals

Additional instructions are given below concerning the Project Description/Narrative and the Budget.

A successful proposal must outline how the planned project will improve the present program of undergraduate instruction. Each proposal should demonstrate that:

• informed, realistic planning has taken place;
• the plan is a logical step to take at this time toward developing the academic program in question;
• provision of the requested equipment will make possible full implementation of the improvements proposed; and
• the project is of potential interest to colleagues at other institutions and will lead to the development of new experiments, techniques, or approaches in laboratory instruction, or it adapts experiments and techniques that are not routine but are particularly appropriate for the academic program.

A. Narrative. The narrative presents most of the information that determines whether or not a grant will be awarded. It must focus on one coherent project that would improve undergraduate instruction. The equipment requested must be appropriate for the project's objectives.
The narrative must show how the proposed curriculum improvement will take place, how the requested equipment is necessary for the project, and how the equipment will be used to improve student learning. Since the Foundation aims to support projects with maximum potential for continuing impact, each proposal should show how the equipment fits into the department's current holdings and must give a clear outline of the institution's plans for the extended maintenance of the equipment. A proposal seeking support for several unrelated projects or for a list of equipment to be used in unrelated ways is not appropriate.

For ILI, the narrative section must not exceed 12 double-spaced pages with a standard-sized font of 12 point or greater. Pages must have 1 inch margins and be numbered at the bottom center. Information applicable in more than one place may be referred to by page and paragraph. Appended information should be restricted to those appendices described in the subsection below. The use of tabular format for reporting details is encouraged. Such information should be cross-referenced to the appropriate portions of the narrative.

The narrative should conform to the following outline:

1. Current Situation. Discuss the institutional context and the perceived need. Open with a brief description of the institution, the students it serves, the department, and the student clientele for the project. Also discuss the curriculum that contains the courses affected by the project. Do not assume that the reviewers are acquainted with the institution and its programs.

Secondly, describe the relevant resources of the department in order to answer the question, "Is there an adequately supported program into which the present project will fit?"

Finally, present the curricular need that the project would address. Answer the question, "What is currently missing from the curriculum or could be done more effectively?" This section should not exceed 3 double-spaced pages.

2. Development Plan. In this section of the narrative, answer the question, "How are the course or courses and the curriculum to be improved by this project?" Include a detailed description of the specific developments intended. Specific new experiments, student projects, or course work that would be conducted with the requested equipment must be presented in terms of the principles or phenomena to be taught, how they will be taught, what experiments or material will be replaced, and how the overall plan is an improvement. Specific examples of proposed new teaching materials are useful to illustrate the planned innovations. This portion of the narrative should enable a group of colleagues to judge the suitability of the planned change for the intended student audience in the academic context. The scientific and pedagogical aspect of the proposed project will be weighed to assess the impact on SME&T education. Review the appropriate literature (e.g., disciplinary and educational journals, meeting abstracts, proceedings, etc.) and provide references to relevant materials including results of other ILI awards to establish how the project and its contribution to undergraduate laboratory development has the potential to advance scientific education beyond the local setting. Where the project is an adaptation of experiments, or techniques developed elsewhere, describe how the adaptation is appropriate in the particular academic setting, and in what way such an adaptation may be useful to other institutions and departments of a similar kind.

3. Equipment

Equipment Request. Here answer the question, "Is each item of equipment requested actually needed to implement this development, is it the right piece of equipment for the job, and is the request appropriate for the department?" Indicate briefly how each major equipment item requested will be used to enhance learning. Also indicate why the particular equipment was chosen, what alternatives were considered and rejected, and why. Reviewers do not need to be told what functions a given piece of equipment can perform unless those functions are unusual. Establish the precise correlation between the subject matter developments described in the previous sections and the items of equipment being requested. In the event of an award, any items regarded by NSF as ineligible, not germane, or inadequately justified will be deleted from the authorized list of purchases.

Special arguments may be needed to explain requests for: 1) apparatus of a quality or cost not usually encountered in undergraduate instruction; 2) equipment which is to be fabricated rather than purchased as a unit; or 3) purchases which might appear to be at variance with the academic setting in which the project would operate. Justification of these items must be related to the development of improved undergraduate instruction. Arguments based on enhancement of graduate-level courses, improvement of faculty
research capabilities, or other activities outside the scope of ILI are inappropriate.

Equipment on Hand for the Project. This section should answer the question, "Has there been a thorough survey of the current equipment inventory and does the project plan to make full use of it?" Discuss major equipment on hand that will be available for the project, but that is not included in this request.

Implementation and Equipment Maintenance. Answer the question, "Is a reasonable plan presented to ensure a maximum usable lifetime for the equipment?" Briefly, but explicitly, outline the institution's plan for starting the project and for extending the maintenance of the equipment beyond the duration of the grant.

4. Dissemination and Evaluation. Describe plans for communicating the results of the project to the scientific or engineering community. Vehicles for dissemination might include scholarly publications or presentations, software, written reports or experiments, or laboratory manuals. While use of electronic networks is encouraged, proposers should provide details regarding maintenance of the quality and currency of their material and the means of ensuring its effective use. Plans should be described for obtaining information on the impact of the project. Such information might include the number and academic level of students involved, the attitude of students in the affected laboratories, evidence that students have learned material developed by or presented within the project, and the effect of the project on departmental offerings.

B. References Cited. Include appropriate references to the literature cited in the narrative.

C. Budget. Prepare the budget according to the format at the end of this document. This should be a complete, detailed list of anticipated equipment acquisitions showing list and discounted unit prices and discounted totals. Each item or functional unit of equipment must have a minimum unit acquisition cost of $500 and a life expectancy of more than two years. The budget must be limited to the following categories, with a subtotal shown for each:

- Scientific and Computing Equipment
- Shipping Costs
- Required Taxes

Guidelines for the assignment of eligible items to the three budget categories follow. Note that these guidelines and restrictions apply to equipment purchased with institutional matching funds as well as to that bought with NSF funds.

1. Scientific and computing equipment, to be used in any phase of undergraduate SME&T education, may be requested. The equipment must be for use in specific curricular improvements discussed in the narrative. Software essential to the scientific, technical, and educational objectives of the project is permitted. Each software package must be itemized, justified, and the cost indicated. Software ordered in conjunction with new computing equipment is regarded as part of a functional unit and, accordingly, need not cost $500 in order to be eligible.

Construction of equipment, including material and labor costs, is allowed. Sufficient justification must accompany requests for equipment construction funds, such as a detailed explanation of the advantages of the proposed units over commercially available items. Requests for equipment fabrication must be supported by drawings, diagrams, parts lists, and estimates for labor charges, as appropriate. Any use of project funds (NSF or institutional matching funds) for the modification or construction of laboratories or other buildings, or for the installation of equipment is specifically prohibited.

Equipment assembly costs for on-site assembly of multi-component instruments, as distinct from equipment installation or building or laboratory modification, are allowable.

Specialized safety equipment may be purchased under this program where necessary for the safe utilization of the equipment requested.

2. Shipping costs, if not included in the purchase price, should be separately itemized. Reasonable estimates should be used, as opposed to a percentage of equipment cost.

3. Required taxes may be included if the institution cannot be exempted from paying them.

Following the total amount of project costs (rounded to the nearest whole dollar), list the actual dollar amount requested from NSF. The amount requested from NSF may not exceed 50% of the total equipment budget or $100,000, whichever is less, and may not be less than $5,000.
Please note the following:

- Reviewers must be able to recognize the function of the requested equipment. Therefore, in the detailed budget list all individual items by a descriptive name and the probable brand, model, and price. (Such selections may be changed after an award.)
- Budget items may be either single items meeting the minimum cost requested ($500), or part(s) of a functional unit where the sum of the components meet the minimum cost requirement. A functional unit is an assemblage of instruments, modules, and components which together perform a specific task or which will normally be used together. Each component of a functional unit must be itemized and the cost indicated, the subtotal for the entire unit should be entered as the unit cost.

- Many equipment manufacturers routinely offer educational or institutional discounts. In preparing the ILI budget, contact manufacturers or distributors to obtain discounted prices. On the budget page, show both the list price and the discounted price used to compute the total cost of the project. If it is possible to negotiate on an individual basis a special discount not routinely available to educational institutions, list the usual discounted price in the project's budget. The amount by which the special discount exceeds the standard educational discount may be counted as matching funds.

### ILI DETAILED BUDGET (EQUIPMENT LIST) FORMAT

<table>
<thead>
<tr>
<th>Item (Descriptive name, probable brand, and model)</th>
<th>Quantity</th>
<th>Unit Price (list)</th>
<th>Unit Price (discounted)</th>
<th>Total Cost (discounted)</th>
</tr>
</thead>
</table>

Total project cost:

Non-NSF contribution:
(including any overmatch)

NSF Request:

Use additional page(s) if needed.
Advice to Proposal Writers (From NSF)

Planning the Proposal

What makes a good proposal? A good proposal stems from a good concept. Other things being equal, the better the idea the more likely the proposal is to be funded. The best proposals are those to which the reviewers respond, “I wish I had thought of that!”

A good proposal begins with a clear idea of the goals of the project - for example, creating a course or curriculum, improving a laboratory by teaching new concepts directly, teaching new material to undergraduate faculty, or preparing future technicians or K-12 teachers in a more effective way.

Envision the goals of your project, and then ask what course(s) must be developed, what instruments will be needed, or what coalitions must be formed to achieve these goals. Focusing first on the goals and objectives helps ensure that the activities will take place as a means for carrying out the goals. In addition, a good project begins with a sense of why it will be a significant improvement over current practice. After the goals are well defined, consider what resources - people, time, equipment, technical support, etc. - will be necessary as part of the request to NSF. A better proposal is likely to result if the goals and objectives are clear before resources are considered.

In planning, consider how the goals of your project fit the objectives of a particular NSF program. If questions arise, call a Program Director at NSF for clarification or explanation.

The project should be innovative within its context. It should not be designed merely to bring your institution up to the level of similar institutions, nor should it be used to fill program deficiencies that have been caused by increased student registration. Projects should explore teaching and learning methods that use equipment, scientific knowledge, or teaching techniques in effective ways; perhaps by adapting techniques to a new context or by teaching in a novel or attractive way. In addition, more extensive projects, as well as Centers and coalitions, must show clearly that they can initiate important changes in the teaching of undergraduate science, mathematics, engineering, or technology for a significant segment of the community.

It is necessary to indicate what work has been done in preparation for the project, and what attempts have been made to try the proposed activity on a small scale. Evidence of preliminary work demonstrates planning and commitment to the project and often indicates the project's potential for success. In addition, the relationship of the proposed project to previous work should be described. The proposal must give appropriate attention to the existing relevant knowledge base, including awareness of current literature. Also, consider how the project relates to other similar projects. Results of previous projects may have been presented at professional meetings or published in journals, and NSF regularly publishes abstracts of its recently awarded grants. Information can also be obtained from NSF's site on the World Wide Web at http://www.nsf.gov/. When the proposal requests significant funds for equipment, it is helpful to consider alternatives and explain why the instruments chosen are particularly suitable for the project and why others, especially less expensive ones, are less suitable.

When several departments, several universities, or constituencies outside the university are involved in the project, it is important to have these groups involved in the planning and to obtain letters of commitment to the project. Letters should include contributions from the participants’ supporting institutions. These commitments should be specific, rather than general expressions of good will. Unique letters of commitment from different institutions are better than nearly identical letters. If the proposed project's size and potential for national impact are significant, consider designing the project with an advisory board of outside experts to provide additional levels of expertise and experience and to help disseminate the project results. When faculty or teacher enhancement activities or industry partners are included, involve these potential participants in the planning of the project.

Writing the Proposal

It is important to read the program announcement carefully. Each program section of this Announcement specifies the information that NSF needs to review the proposal properly. In addition, the proposal should conform to the formal requirements such as page limits, font size, budget limits, matching funds, deadline dates, etc. The proposal should be concise and clearly written. Proofread carefully before submitting the proposal, checking for spelling and grammatical errors and inconsistencies. The first time you use an acronym, write out what it stands for and put the acronym in parentheses. Check the accuracy of references.
A. The Narrative

Provide specific descriptions of the proposed activities. Reviewers want details of the project's organization, the course content, laboratory and other inquiry-based experiments, and participant activities, both to show that groundwork has been laid and to help them understand why the particular ideas you propose are better than others. Describe in detail the roles of the various people and institutions in the project. Identify project leaders, and describe their roles, qualifications and credentials to undertake specific project tasks. In the limited space available, careful writing will permit enough description of the project to give the reviewers a sense of exactly what you plan to do and why your plan is an effective one. How will your plan ultimately improve students' understanding of concepts in science, mathematics, engineering, or technology? How would the project improve education at your institution and how might it be emulated at other similar institutions?

You must demonstrate in the narrative of your proposal that you have a broad knowledge of current scholarship and activities in your field and how this is relevant to your project's design. This should include citations to current literature on research in teaching and teaming practices. The project description and narrative of the proposal should be written by the person or people in the science, engineering, or mathematics departments who will be the principal investigator(s). Grant administration experts at submitting institutions can assist in some aspects of proposal writing, but usually do not have the scientific qualifications or classroom experience to adequately describe the project.

A good evaluation plan appropriate to the scale of the project will provide information as the project is developing and will indicate how effectively the project has achieved its goals. Explain in detail how you will disseminate information on the success and content of your project to other scientists. What products - text, software, CD ROMS, manuals, or other publications - might result, and what plans are in place to distribute them effectively?

If extensive use of educational technology is expected, how will the student learning outcomes be evaluated? What are the plans to ensure that electronic dissemination will lead to broad implementation of material so provided, and that such material will be subjected to continued scrutiny for editorial quality and currency of content?

The demographic characteristics of the target audience should be clearly explained (size, special characteristics or challenges faced by the group, etc.). The project should be designed in a manner which will effectively assist the participant group in addressing those special challenges. If the project intends to address the needs of women, under-represented minorities, or persons with disabilities, explain in detail how your project will result in increased participation by and success of these groups. A focused plan that describes specific activities must be included.

B. The Budget

The budget request should be realistic for the project and consistent with the requirements of the particular program. It should request sufficient resources needed to carry out the project, but it should not be excessively high. Institutional and other leveraged commitments toward the budget is one way to demonstrate institutional support of the project. However, if cost sharing is proposed, it must be fulfilled or NSF may reduce the amount of the grant. Budgets are often negotiated as a proposal is being considered but a clear, realistic budget request strengthens a proposal. Consult the Program Announcement for eligible and ineligible budget items.

C. Local Review Before Submission

It is often helpful to have someone not connected with the project read and comment on a draft of the proposal. This person can help identify omissions or inconsistent logic before reviewers see the proposal. When a checklist is provided in the program announcement, use it to ensure that all needed information, signatures, and/or administrative details are included. It might also be helpful to look again at the goals and objectives and at your written plans and procedures for achieving the goals. Check to see that the goals are well-developed and realistic and that your plans are innovative and appropriate. It might also be helpful to consider using graphics to make your point clearer. A time line can be particularly effective. Including a table of contents makes it easy for reviewers to locate important sections of your proposal.

D. The Project Summary and Project Data Form

The first thing that reviewers and NSF staff read is the project summary. It should be written clearly and concisely. In the space allotted, it should outline the problem, the objectives and expected outcomes of the project, project activities, and the audience to be addressed. Program directors use the summary to choose reviewers of the proposal. It is also the
reviewers' introduction to the project. It is what NSF publishes (both in hard copy and electronically) about your project should it be funded. Considerable effort and thought should be spent in preparing a well-written project summary.

Afterwards

A. If Successful

If the proposal is successful, make the best possible use of the funds awarded. Situations may arise where changes in your plans may be necessary to accomplish the goals of the project. Within broad limits described in the grant conditions and within the overall budget, such changes are possible. In addition, let others know about your project. This may include providing advice or assistance to faculty developing similar projects. It clearly includes disseminating products and results. Finally, reference the National Science Foundation in all presentations and publications.

B. If Not Successful

If unsuccessful, consider the reviews and NSF staff comments objectively, consult the staff if necessary and, unless the feedback indicates otherwise, submit a revised or new proposal the following year. Many awards made in the programs have been for proposals that were revised thoughtfully and resubmitted after having been declined initially.