SBIR

Small Business Innovation Research

FY 2000

DOC PROGRAM SOLICITATION

Closing Date: January 12, 2000

October 1999 DOC 2000-1

U.S. DEPARTMENT OF COMMERCE

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U.S. DEPARTMENT OF COMMERCE

PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Department of Commerce (DOC) invites small businesses to submit research proposals under this solicitation. Firms with strong research capabilities in any of the areas listed in Section 8 of this solicitation are encouraged to participate. **Unsolicited proposals are not accepted under the Small Business Innovation Research (SBIR) program**.

Objectives of this program include stimulating technological innovation in the private sector and strengthening the role of small business in meeting Federal research and development (R&D) needs. This program also seeks to increase the commercial application of innovations derived from Federal research and improve the return on investment from Federally-funded research for the economic benefit of the Nation.

1.2 Three-Phase Program

The "Small Business Research and Development Enhancement Act of 1992" requires the Department of Commerce to establish a three-phase SBIR program by reserving a percentage of its extramural R&D budget to be awarded to small business concerns for innovation research.

The funding vehicles for DOC's SBIR program in both Phase 1 and Phase 2 are contracts. This document solicits Phase 1 proposals only.

DOC has the unilateral right to select SBIR research topics and awardees in both Phase 1 and Phase 2, and to award several or no contracts under a given topic.

1.2.1 Phase 1 - Feasibility Research

The purpose of Phase 1 is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. Therefore, the proposal should concentrate on research that will significantly contribute to proving the feasibility of the proposed research, a prerequisite to further support in Phase 2.

1.2.2 Phase 2 - Research and Development

Only firms that are awarded Phase 1 contracts under this solicitation will be given the opportunity of submitting a Phase 2 proposal immediately following completion of Phase 1.

Phase 2 is the R&D or prototype development phase. It will require a comprehensive proposal outlining the research in detail. Further information regarding Phase 2 proposal requirements will be provided to all firms receiving Phase 1 contracts.

1.2.3 Phase 3 - Commercialization

In Phase 3, it is intended that non-SBIR capital be used by the small business to pursue commercial applications of Phase 2.

1.3 Eligibility

Each organization submitting a proposal **must** qualify as a small business (Section 2.1) for research or R&D purposes (Section 2.2). In addition, the primary employment of the principal investigator must be with the small business at the time of the award. More than one-half of the principal investigator's time must be spent with the small business for the period covered by the award. **Primary employment with a small business precludes full-time employment with another organization.**

Also, for both Phase 1 and Phase 2, the work must be performed in the United States. "United States" means the fifty states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are eligible, provided the entity created qualifies as a small business as defined in this solicitation. **Consultative arrangements between firms and universities or other non-profit organizations are encouraged, with the small business serving as the prime contractor.**

1.4 Contact with DOC

In the interest of competitive fairness, oral or written communication with DOC or any of its components concerning additional information on the technical topics described in Section 8 of this solicitation **is prohibited**.

Requests for general information on the DOC SBIR program may be addresses to:

Dr. Joseph M. Bishop, DOC SBIR Program Manager
1315 East-West Highway
Silver Spring, MD 20910
Telephone: (301) 713-3565, Fax: (301) 713-4100
E-mail: joseph.bishop@noaa.gov

Information sources and/or document services are listed in Section 7.

2.0 DEFINITIONS

2.1 Small Business

A small business concern is one that, at the time of award for Phase 1 and Phase 2:

(a) is independently owned and operated, is organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States (Section 1.3);

(b) is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens; and

(c) has, including its affiliates, a number of employees not exceeding 500, and meets the other small business regulatory requirements found in 13 Code of Federal Regulations Part 121. Business concerns are affiliates of one another when, either directly or indirectly, (1) one concern controls or has the power to control the other, or (2) a third party controls both. Control can be exercised through common ownership, common management, and contractual relationships. Business concerns include, but are not limited to, any individual, partnership, joint venture, association, or cooperative.

2.2 Research or Research and Development

Any activity that is (a) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (b) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (c) a systematic application of knowledge toward the production of useful materials, devices, services, or methods, and includes design, development, and improvement of prototypes and new processes to meet specific requirements.

In general, the DOC SBIR program will fund Phase 1 and 2 proposals with objectives that can be defined by (b) and (c) above.

2.3 Socially and Economically Disadvantaged Small Business Concern

Is one that is:

(a) at least 51 percent owned by (1) an American Indian tribe or a native Hawaiian organization, or (2) one or more socially and economically disadvantaged individuals, and

(b) controlled by one or more such individuals in its management and daily business operations.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, or any other individual found to be socially and economically disadvantaged by the Small Business Administration (SBA) pursuant to Section 8(a) of the Small Business Act, 15 U.S. Code (U.S.C.) 637(a).

2.4 Women-Owned Small Business

A small business that is at least 51 percent owned by a woman or women who also control (meaning to exercise the power to make policy decisions) and operate (meaning being actively involved in the day-to-day management) the small business.

2.5 Subcontract

This is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government funding awardee, calling for supplies or services required solely for the performance of the original funding agreement.

2.6 Commercialization

This is locating or developing markets and producing and delivering products for sale (whether by the originating party or by others). As used here, commercialization includes both Government and private sector markets.

3.0 PROPOSAL PREPARATION

3.1 Proposal Requirements

The objective is to provide sufficient information to demonstrate that the proposed work represents a sound approach to the investigation of an important scientific or engineering innovation worthy of support. **The proposal must meet all the requirements of the subtopic in Section 8 to which it applies**.

A proposal must be self-contained and written with all the care and thoroughness of a scientific paper submitted for publication. It should indicate a thorough knowledge of the current status of research in the subtopic area addressed by the proposal. Each proposal should be checked carefully by the offeror to ensure inclusion of all essential material needed for a complete evaluation. The proposal will be peer reviewed as a scientific paper (all units of measurement should be in the metric system).

DOC reserves the right not to submit to technical review any proposal which it finds to have insufficient scientific and technical information, or one which fails to comply with the administrative procedures as outlined on the Checklist of Requirements in Section 9.

The proposal must not only be responsive to the specific DOC program interests described in Section 8 of the solicitation, but also serve as the basis for technological innovation leading to new commercial products, processes, or services that benefit the public. An organization may submit different proposals on different subtopics or different proposals on the same subtopic under this solicitation. When the proposed innovation applies to more than one subtopic, the offeror must choose that subtopic which is most relevant to the offeror's technical concept.

Proposals principally for the commercialization of proven concepts or for market research must not be submitted for Phase 1 funding, since such efforts are considered the responsibility of the private sector.

The proposal should be direct, concise, and informative. Promotional and other material not related to the project shall be omitted. **The Phase 1 proposal must provide a description of potential commercial applications.**

3.2 Phase 1 Proposal Limitations

- **!** Page Length - **no more than 25 pages**, consecutively numbered, including the cover page, project summary, main text, references, resumes, any other enclosures or attachments, and the proposal summary budget.
- **!** Paper Size - must be 21.6 cm X 27.9 cm (8 ½" X 11").
- **!** Print Size - **must be easy to read with a fixed pitch font of 12 or fewer characters per inch or proportionally spaced font of point size 10 or larger with no more than 6 lines per inch.**

Supplementary material, revisions, substitutions, audio or video tapes, or computer floppy disks will **not** be accepted.

Proposals not meeting these requirements will be returned without review.

3.3 Phase 1 Proposal Format

3.3.1 Cover Sheet

Complete Section 9 "Cover Page" as page 1 of each copy of each proposal. **NO OTHER COVER WILL BE ACCEPTED.** Xerox copies are permitted.

3.3.2 Project Summary

Complete Section 9 "Project Summary" as page 2 of your proposal. The technical abstract should include a brief description of the problem or opportunity, the innovation, project objectives, and technical approach.

In summarizing anticipated results, include technical implications of the approach (for both Phase 1 and 2) and the potential commercial applications of the research. **The Project Summary of proposals that received an award will be published by DOC and, therefore, must not contain proprietary information.**

3.3.3 Technical Content

Beginning on page 3 of the proposal, include the following items with headings as shown:

(a) **Identification and Significance of the Problem or Opportunity.** Make a clear statement of the specific research problem or opportunity addressed, its innovativeness, commercial potential, and why it is important. Show how it applies to a specific subtopic in Section 8.

(b) **Phase 1 Technical Objectives.** State the specific objectives of the Phase 1 effort, including the technical questions it will try to answer, to determine the feasibility of the proposed approach.

(c) **Phase 1 Work Plan.** Include a detailed description of the Phase 1 R&D plan. The plan should indicate not only what will be done, but where it will be done, and how the R&D will be carried out. The methods planned to achieve each objective or task should be discussed in detail. **This section should be at least one-third of the proposal.**

(d) **Related Research or R&D.** Describe research or R&D that is directly related to the proposal, including any conducted by the principal investigator or by the proposer's firm. Describe how it relates to the proposed effort, and describe any planned coordination with outside sources. The purpose of this section is to persuade reviewers of the proposer's awareness of recent developments in the specific topic area.

(e) **Key Personnel and Bibliography of Related Work.** Identify key personnel involved in Phase 1, including their related education, experience, and publications. Where resumes are extensive, summaries that focus on the most relevant experience and publications are suggested. List all other commitments that key personnel have during the proposed period of contract performance.

(f) **Relationship with Future R&D.** Discuss the significance of the Phase 1 effort in providing a foundation for the Phase 2 R&D effort. Also state the anticipated results of the proposed approach, if Phases 1 and 2 of the project are successful.

(g) **Facilities and Equipment.** The conduct of advanced research may require the use of sophisticated instrumentation or computer facilities. The proposer should

provide a detailed description of the availability and location of the facilities and equipment necessary to carry out Phase 1.

(h) **Consultants and Subcontracts.** The purpose of this section is to convince DOC that: (1) research assistance from outside the firm materially benefits the proposed effort, and (2) arrangements for such assistance are in place at the time the proposal is submitted.

Outside involvement in the project is encouraged where it strengthens the conduct of the research; such involvement is not a requirement of this solicitation.

1. Consultant - A person outside the firm, named in the proposal as contributing to the research, must provide a signed statement confirming his/her availability, role in the project, and agreed consulting rate for participation in the project. *This statement is part of the page count.*

2. Subcontract - Similarly, where a subcontract is involved in the research, the subcontracting institution must furnish a letter signed by an appropriate official describing the programmatic arrangements and confirming its agreed participation in the research, with its proposed budget for this participation. *This letter is part of the page count.*

(i) **Potential Commercial Application and Follow-on Funding Commitment.** Describe in detail the commercial potential of the proposed research, how commercialization would be pursued, and potential use by the Federal Government.

(j) **Cooperative Research and Development Agreements (CRADA).** State if the applicant is a current CRADA partner with DOC, or with any other Federal agency, naming the agency, title of the CRADA, and any relationship with the proposed work.

(k) **Guest Researcher.** State if the applicant is a guest researcher at DOC, naming the sponsoring laboratory.

3.4 Equivalent Proposals or Awards

A firm may have received other SBIR awards or elected to submit essentially equivalent proposals under other SBIR program solicitations. In these cases, a statement **must** follow the Technical Content section in the proposal indicating:

(a) the name and address of any agency to which a proposal was submitted or from which an SBIR award was received;

(b) the date of proposal submission or date of award;

(c) the title, number, and date of the SBIR program solicitation under which a proposal was submitted or award received;

(d) the title of the research project; and

(e) the name and title of the principal investigator for each proposal submitted or award received.

If no equivalent proposal is under consideration or equivalent award received, a statement to that effect **must** be included in this section.

3.5 Prior SBIR Phase 2 Awards

If a small business concern has received more than 15 Phase 2 awards from **all** Federal agencies in the prior 5 fiscal years, it must submit on a separate page, the names of awarding agencies, dates of awards, funding agreements numbers, amounts, topics or subtopic titles, follow-on agreements amounts, sources and dates of commitments, and current commercialization status for each Phase 2. This required information shall not be part of the page count limitation.

3.6 Proposed Budget

Complete the "SBIR Proposal Summary Budget" (Section 9) for the Phase 1 effort, and include it as the last page of the proposal. Some items of this form may not apply. Enough information should be provided to allow DOC to understand how the offeror plans to use the requested funds if the contract or grant is awarded. A complete cost breakdown should be provided giving labor rates, proposed number of hours, overhead, G&A, and profit. A reasonable profit will be allowed. When proposing travel, identify the number of trips, people involved, labor categories, destination of travel, duration of trip, commercial air fare or mileage rate, per diem expenses, and purpose of travel. Budgets for travel funds must be justified and related to the needs of the project.

Where equipment is to be purchased, list each individual item with the corresponding cost. The inclusion of equipment will be carefully reviewed relative to need and appropriateness for the research proposed. Equipment is defined as an article of nonexpendable, tangible property having a useful life of more than 1 year and an acquisition cost of $5,000 or more per unit. **Title to equipment will be vested with DOC, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment. Equipment purchased with DOC funds will be inventoried by DOC.**

SBA Policy requires that DOC not issue SBIR awards that include provisions for subcontracting any portion of the contract back to the originating agency or any other Federal agency.

For Phase 1, a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm. The total cost for all consultant fees, facility leases, usage fees, and other subcontract or purchase agreements may not exceed one-third of the total contract. For Phase 2, one-half of the research and/or analytical effort must be performed by the proposing firm.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

All Phase 1 and 2 proposals will be evaluated on a competitive basis. Each Phase 1 proposal will be screened by DOC to ensure that it meets the administrative requirements outlined in Section 4.2. Proposals that meet these requirements will be peer reviewed, undergo competition within each laboratory, and may also undergo a third round of competition across the agency.

4.2 Phase 1 Screening Criteria

To avoid misunderstanding, small businesses are cautioned that Phase 1 proposals not satisfying all the screening criteria shall be returned without peer review and eliminated from consideration for a contract. Proposals may not be resubmitted (with or without revision) under this solicitation. All copies of proposals that fail the screening process will be returned. The screening criteria are:

(a) The proposing firm must qualify as a small business (Section 2.1). If it is a subsidiary of another firm, this limit applies to all employees under control of the parent organization.

(b) The Phase 1 proposal must meet **all** of the requirements stated in Section 3.

(c) The Phase 1 proposal must be limited to one subtopic and clearly address research for that subtopic.

(d) **Phase 1 proposal budgets must not exceed $75,000 (except subtopics with the suffix "SG", which are limited to $50,000),** including subcontract, indirect cost, and fee.

(e) **The project duration for the Phase 1 research must not exceed 6 months.**

(f) A minimum of two-thirds of expenditures under each Phase 1 project must be carried out by the proposing firm.

(g) The proposal must contain information sufficient to be peer reviewed as research.

4.3 Phase 1 Evaluation and Selection Criteria

Phase 1 proposals will be rated by NOAA and NIST scientists or engineers with equal consideration given to the following criteria, except for item (a), which will receive twice the value of any of the other items:

(a) The scientific and technical merit of the Phase 1 research plan and its relevance to the objectives, with special emphasis on its innovativeness and originality.

(b) Importance of the problem or opportunity and anticipated benefits of the proposed research to DOC, and the commercial potential, if successful.

(c) How well the research objectives, if achieved, establish the feasibility of the proposed concept and justify a Phase 2 effort.

(d) Qualifications of the principal investigator(s), other key staff, and consultants, and the probable adequacy of available or obtainable instrumentation and facilities.

Technical reviewers will base their ratings on information contained in the proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to, key individuals, or the firm.

Final award decisions will be made by DOC based upon ratings assigned by reviewers and consideration of additional factors, including possible duplication of other research, the importance of the proposed research as it relates to DOC needs, and the availability of funding. DOC may elect to fund several or none of the proposals received on a given subtopic. Upon selection of a proposal for a Phase 1 award, DOC reserves the right to negotiate the amount of the award.

4.4 Phase 2 Evaluation and Selection Criteria

The Phase 2 proposal will undergo DOC and/or external peer review for the purpose of determining overall technical or scientific merit. Each of the following evaluation criteria will receive approximately equal weight, except for item (a), which will receive twice the value of any of the other items:

(a) The scientific and technical merit with emphasis on innovation and originality.

(b) Degree to which the Phase 1 objectives were met.

(c) The commercial potential of the proposal as evidenced by: a) a record of commercialization, b) the existence of Phase 2 funding commitments from non-

SBIR sources, c) existence of Phase 3 follow-on commitments, and d) the presence of other indications of commercial potential of the research.

(d) The adequacy of the Phase 2 objectives to meet the problem or opportunity.

(e) The qualifications of the principal investigator and other key personnel to carry out the proposed work.

Upon selection of a proposal for Phase 2 award, DOC reserves the right to negotiate the amount of the award.

4.5 Release of Proposal Review Information

After final award decisions have been announced, the technical evaluations of a proposal will be provided to the proposer only upon written request and for a period not to exceed 90 days. The identity of the reviewers will not be disclosed.

5.0 CONSIDERATIONS

5.1 Awards

Contingent upon availability of funds, DOC anticipates making about **40** Phase 1 firm-fixed-price contracts of no more than **$75,000** each (except for subtopics with the suffix "SG", which are limited to $50,000). Of these, approximately **10** will be made by the National Oceanic and Atmospheric Administration (NOAA) and approximately **30** by the National Institute of Standards and Technology (NIST). Performance period shall be no more than 6 months beginning on the contract start date.

Historically, DOC has funded five to ten percent of the Phase 1 proposals submitted.

Phase 2 awards shall be for no more than **$300,000** (except subtopics with an "SG" suffix, which are limited to $200,000). The period of performance in Phase 2 will depend upon the scope of the research, but should not exceed 24 months.

It is anticipated that **approximately one-third of the Phase 1 awardees will receive Phase 2 awards,** depending upon the availability of funds. To provide for an in-depth review of the Phase 1 final report and the Phase 2 proposal and commercialization plan, Phase 2 awards will be made approximately 7 months after the completion of Phase 1.

For planning purposes, proposers should understand that Phase 1 awards are made in July, Phase 2 proposals are due the following February, and Phase 2 awards are made during August and September.

This solicitation does not obligate DOC to make any awards under either Phase 1 or Phase 2. Furthermore, DOC is not responsible for any monies expended by the proposer before award of any contract or grant resulting from this solicitation.

5.2 Reports

Seven copies of a final report on the Phase 1 project shall be submitted to DOC within 30 calendar days after completion of the Phase 1 research. The final report shall include a single-page project summary as the first page, identifying the purpose of the research, and giving a brief description of the research carried out, the research findings or results, and the commercial applications of the research in a final paragraph. The remainder of the report should indicate in detail the research objectives, research work carried out, results obtained, and estimates of technical feasibility.

All final reports must carry an acknowledgment on the cover page such as: "This material is based upon work supported by the Department of Commerce under contract number_____. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the Department of Commerce."

5.3 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the Government and the successful Phase 1 or Phase 2 contractor.

5.4 Proprietary Information, Inventions, and Patents

5.4.1 Limited Rights Information and Data

Information contained in unsuccessful proposals will remain the property of the proposer. Any proposal which is funded will not be made available to the public, except for the "Project Summary" page.

The inclusion of proprietary information is discouraged unless it is necessary for the proper evaluation of the proposal.

Proprietary information submitted to DOC will be treated in confidence, to the extent permitted by law, if it is confined to a separate page or pages and marked with a legend reading:

> "Following is proprietary information which (name of proposing firm) requests not be released to persons outside the Government, except for purposes of evaluation."

Any other legend will be unacceptable to the Department of Commerce and may constitute grounds for return of the proposal without further consideration. Without assuming any liability for inadvertent disclosure, DOC will limit dissemination of such information to its employees and, where necessary for evaluation, to outside reviewers on a confidential basis.

Since technical reports may eventually be made available to the public, such reports shall not contain any language limiting their use other than for SBIR data as described below.

5.4.2 Copyrights

The contractor may normally establish claim to copyright any written material first produced in the performance of an SBIR contract. If a claim to copyright is made, the contractor shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the material when delivered to the Government, as well as when the written material or data are published or deposited for registration as a published work in the U.S. Copyright Office. For other than computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

For computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license for all such computer software to reproduce, prepare derivative works, and perform publicly and display publicly, by or on behalf of the Government.

5.4.3 Data Rights

Except for copyrighted data, the Government shall normally have unlimited rights in:

(a) data specifically identified in the SBIR contract to be delivered without restriction;

(b) form, fit, and function data delivered under the contract;

(c) data delivered under the contract that constitute manuals or instructions and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under the contract; and

(d) all other data delivered under the contract unless identified as SBIR data.

According to Federal Acquisition Regulation 52.227-20, Rights and Data - SBIR Program (March 1994), the contractor is authorized to affix the following "SBIR Rights Notice" to SBIR data delivered under the contract:

SBIR RIGHTS NOTICE

These SBIR data are furnished with SBIR rights under Contract No._____ (and subcontract_____, if appropriate). For a period of 4 years after acceptance of all items to be delivered under this contract, the Government agrees to use these data for Government purposes only, and they shall not be disclosed outside the Government (including disclosure for procurement purposes) during such period without permission of the contractor, except that, subject to the forgoing use and use by support contractors. After the aforesaid 4-year period, the Government has a royalty-free license to use, and to authorize others to use on its behalf, these data for Government purposes, but is relieved of all disclosure prohibitions and assumes no liability for unauthorized use of these data by third parties. This Notice shall be affixed to any reproductions of these data, in whole or in part.

(END OF NOTICE)

The Government's sole obligation with respect to any properly identified SBIR data shall be as set forth in the paragraph above.

5.4.4 Patents

Small business firms normally may retain the worldwide patent rights to any invention made with DOC support. DOC receives a royalty-free license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must manufacture it domestically. To the extent authorized by P.L. 102-564, DOC will not make public any information disclosing a DOC-supported invention for a 4-year period to allow the contractor a reasonable time to pursue a patent.

5.5 Awardee Commitments

Upon the award of a contract, the contractor will be required to make certain legal commitments. The outline that follows illustrates the types of provisions that will be included in the Phase 1 contract.

(a) Standards of Work. Work performed under the contract must conform to high professional standards.

(b) Inspection of Work. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

(c) Examination of Records. The Comptroller General (or a duly authorized representative) shall have the right to examine pertinent records of the contractor involving transactions related to this contract.

(d) Default. The Government may terminate the agreement if the contractor fails to perform the work contracted.

(e) Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in the best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

(f) Disputes. Any dispute concerning the contract, which cannot be resolved by agreement, shall be decided by the Contracting Officer with right to appeal.

(g) Contract Work Hours. The contractor cannot require an employee to work more than 8 hours a day or 40 hours a week, unless the employee is compensated accordingly (i.e., receives overtime pay).

(h) Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(i) Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran of the Vietnam era.

(j) Affirmative Action for the Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

(k) Officials Not to Benefit. No member of or delegate to Congress shall benefit from any SBIR contract.

(l) Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation, except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

(m) Gratuities. The contract may be terminated by the Government if any gratuity has been offered to any representative of the Government to secure the contract.

(n) Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

(o) American-Made Equipment and Products. When purchasing either equipment or a product with funds provided through the contract, purchase only American-made equipment and products, to the extent possible in keeping with the overall research needs of the project.

5.6 Additional Information

(a) Projects--The responsibility for the performance of the principal investigator, and other employees or consultants who carry out the proposed work, lies with the management of the organization receiving an award.

(b) Organizational Information--Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to assure responsibility of the proposer.

(c) **Duplicate Awards--If an award is made under this solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by any agency of the Federal Government. Severe penalties may result from such actions.**

This program solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

6.0 SUBMISSION OF PROPOSALS

6.1 Deadline for Proposals

Deadline for Phase 1 proposal receipt (7 copies) at the Department of Commerce Contract Administration Branch is noon on January 12, 2000.

DOC assumes no responsibility for evaluating proposals received after the stated deadline or that do not adhere to the other requirements of this solicitation (see checklist at back of booklet). Such proposals may be returned to the proposer without review.

Federal Acquisition Regulation (FAR 52 215-1) regarding late proposals shall apply.

Letters of instruction will be sent to those eligible to submit Phase 2 proposals. The Phase 2 proposals are due at about the same time as Phase 1 final reports - 7 months after commencement of the Phase 1 contract.

Proposers are cautioned to be careful of unforeseen delays which can cause late arrival of proposals at DOC, resulting in them not being included in the evaluation procedures. No information on the status of proposals under scientific/technical evaluation will be available until formal notification is made.

6.2 Proposal Submission

Proposals (7 copies) should only be addressed to:

ATTN: SBIR Proposals
U.S. Department of Commerce, NOAA
Contract Administration Branch, Code OFA513
1305 East-West Highway, SSMC4, Station 7604
Silver Spring, Maryland 20910
Telephone: (301) 713-0829

For local delivery, the Contract Administration Branch is located near the intersection of East-West Highway and Colesville Road, and close to the Silver Spring Metro stop.

Acknowledgment of receipt of a proposal by DOC will be made by **mail only**. Electronic submissions will not be accepted. All correspondence relating to proposals must cite the specific **proposal number** identified on the acknowledgment letter and be sent to the above address.

(a) **Packaging--Secure packaging is mandatory. The DOC cannot process proposals damaged in transit. All 7 copies of the proposal must be sent in the same package. Do not send separate "information copies," or several packages containing parts of a single proposal, or two packages of 7 copies of the same proposal. The top copy must be signed as an original by the principal investigator and the corporate official. Other copies may be photocopies.**

(b) Bindings--**Do not use special bindings or covers.** Staple the pages in the upper left hand corner of each proposal. Separation or loss of proposal pages cannot be the responsibility of DOC.

6.3 Warning

While it is permissible, with proper notification to DOC, to submit identical or essentially equivalent proposals for consideration under numerous Federal program solicitations, it is unlawful to enter into contracts requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 General Information

The following organizations may be sources for providing technology search and/or document services and may be contacted directly:

NOAA Library
1315 East-West Highway
Second Floor, SSMC3
Silver Spring, MD 20910
(301) 713-2600

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 605-6000

NIST Library
Admin. Bldg., Room E106
Gaithersburg, MD 20899
(301) 975-3052

NERAC, Inc.
One Technology Drive
Tolland, CT 06084
(860) 872-7000

National Technology Transfer Center (NTTC)
316 Washington Avenue
Wheeling, WV 26003
(800) 678-6882

Small Business Innovation Center
Advanced Technology Center of Southeastern Pennsylvania
3624 Market Street
Philadelphia, PA 19104
(215) 972-0877

Mid-Atlantic Technology Applications Center
3400 Forbes Avenue
5th Floor, Eureka Building
Pittsburg, PA 15260
(412) 648-7000

NASA Far West Regional Technology Transfer Center
University of Southern California
3716 South Hope Street, #200
Los Angeles, CA 90007
(213) 743-2353

7.2 Oceanography and Marine Science

Scientific information in the areas of oceanography and marine science may be obtained from the following organizations:

University of Alaska
P.O. Box 755040
Fairbanks, AK 99775
907/474-7086

University of California-San Diego
9500 Gilman Drive
LaJolla, CA 92093
619/534-4440

Hancock Institute for Marine Studies
University Park
Los Angeles, CA 90089
213/740-1961

University of Connecticut
1084 Shennecossett Road
Groton, CT 06340
203/445-3457

University of Delaware
Robinson Hall, Rm 111
Newark, DE 19716
302/831-2841

University of Florida
Building 803
Gainesville, FL 32611
904/392-5870

University of Georgia
Ecology Building
Athens, GA 30602
706/542-6009

University of Hawaii
1000 Pope Road, Rm. 223
Honolulu, HI 96822
808/956-7031

University of Illinois
65 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 61801
217/333-9448

Purdue University
1159 Forestry Building
W. Lafayette, IN 47907
317/494-3573

Louisiana State University
128 Wetland Resources
Baton Rouge, LA 70803
504/388-6710

University of Maine
14 Coburn Hall
Orono, ME 04469- 0114
207/581-1436

University of Maryland
0112 Skinner Hall
College Park, MD 20742
301/405-6371

Massachusetts Institute of Technology
Bldg. E38, Room 330
77 Massachusetts Avenue
Cambridge, MA 02139
617/253-7131

Woods Hole Oceanographic Inst.
CRL 209
Woods Hole, MA 02543
508/457-2000 ext. 2665

University of Michigan
4107 I.S.T. Building
2200 Bonisteel Blvd.
Ann Arbor, MI 48109
313/763-1437

University of Minnesota
2305 East 5th Street
Duluth, MN 55812
218/726-8106

MS-AL Sea Grant Consortium
P.O. Box 7000
703 East Beach Drive
Ocean Springs, MS 39564
601/875-9341

University of New Hampshire
Ocean Process Analysis Lab.
142 Morse Hall
Durham, NH 03824
603/862-3505

NJ Marine Sciences Consortium
Building No. 22
Ft. Hancock, NJ 07732
908/872-1300

State University of New York
115 Nassau Hall
Stony Brook, NY 11794
516/632-6905

North Carolina State University
Box 8605
Raleigh, NC 27695
919/515-1454

Ohio State University
1541 Research Center
1314 Kinnear Road
Columbus, OH 43212
614/292-8949

Oregon State University
Administrative Services
Corvallis, OR 97331
503/737-3396

University of Puerto Rico
Dept. of Marine Science
P.O. Box 5000
Mayaguez, PR 00681
809/832-3585

University of Rhode Island
Marine Resources Bldg.
Narragansett Bay Campus
Narragansett, RI 02882
401/792-6800

South Carolina Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
803/727-2078

Texas A&M University
1716 Briarcrest Drive
Suite 702
Bryan, TX 77802
409/845-3854

Virginia Graduate Marine Science Consortium
Madison House 170
Rugby Road
Charlottesville, VA 22903
804/924-5965

University of Washington
HG-30
3716 Brooklyn Ave, N.E.
Seattle, WA 98105-6716
206/543-6600

University of WI- Madison
1800 University Avenue
Madison, WI 53705
608/262-0905

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8.0 TECHNICAL TOPICS

The subtopics in sections 8.1 through 8.5 are from the National Oceanic and Atmospheric Administration (NOAA). Approximately 10 awards will be made on these subtopics.

8.1 NOAA TOPIC: ATMOSPHERIC SCIENCES

8.1.1W Subtopic: Development of Ground System That provides Real Time Access to X-Band Next Generation Satellites

There is a need for a new generation of relatively low-cost commercial ground systems that can receive data in the X-band and would contain application software which is suitable for use in the operational forecast environment. This system would encompass a device for acquiring, processing and utilizing unique real-time multi-satellite data from the next generation of satellites that will use X-band to transmit data to ground stations. The next generation of weather and earth-observing satellites will transmit data at rates which are orders of magnitude higher than the present downlink transmissions. In addition, these satellites will be launched with new, unique, sophisticated sensors that can provide critical information for operational forecasting. As an example, the Earth Observing System series of satellites will be launched with instrument packages such as AIRS, AMSU-A and B, HSB, CERES, and MODIS. The requirements for the proposed research would address the design and development of relatively low-cost commercial satellite ground systems for capturing and processing X band data from a variety of domestic and foreign weather satellites for real-time operational use. The technical challenges include developing high slew-rate antenna designs to minimize signal drop outs at high elevation, developing a highly accurate antenna pointing system which is critical in X-band, and developing automated application software for creating higher level forecast products from direct broadcast data.

8.1.2W Subtopic: Development of Innovative Modular Solid State Amplifier for Wind Profiler

The development of an advanced solid state power amplifier is being sought for the NOAA Profiler Network (NPN). The National Weather Service and Forecast Systems Laboratory (FSL) operate the NPN, which is made up of 35 wind profilers located mostly in the central part of the country, but with one site in New York, one in California, and 3 in Alaska. These wind profilers are upward looking radars capable of detecting backscatter from the optically clear atmosphere. These signals can be processed to measure the Doppler frequency shift associated with the signals reflected from different altitudes. This Doppler information is then combined geometrically to obtain wind profiles from near the surface to about 50,000 feet. This measurement is made every six minutes.

Data from the NPN are used in both operational and research activities both inside and outside of NOAA. The hourly data are sent to many users for various applications that depend critically on the quality of the data. Problems with the power amplifier have reduced data quality, especially in the upper troposphere and lower stratosphere. Problems have also surfaced with the present UHF solid state power amplifiers using bi-polar solid state devices specifically designed for pulsed operation. NOAA is looking for approaches that would yield better results and a more reliable UHF power amplifier for profiler operations.

For this development, the power amplifier (PA) would need to operate in a pulsed mode 24 hours per day, be air cooled, and employ solid-state active devices. This could encompass technologies such as Metal-Oxide-Semiconductor Field-Effect Transistors designed for continuous operation, or other appropriate components and designs. The following list provides guidelines for the operational requirements of this perspective development:

1. Operate over a frequency range of 440 - 460 MHz.

2. Operate with RF input peak power of +8.5 to +11.0 dBm with 50-ohm nominal input impedance and maximum VSWR of 2.0:1.

3. Have an average power output of 1.5 kW at maximum duty cycle of 15 % and be capable of operating at reduced duty cycles. The nominal load impedance is 50 ohms with a 2.0:1 maximum VSWR.

4. Operate with binary phase coded input pulses whose phase coding transitions are not necessarily synchronized with the RF carrier phase.

5. Operate at a reduced power level (graceful degradation) in the event of the failure of one or more output modules, and have the capability to operate in this state indefinitely.

6. Operate on 115/230 ±15 percent VAC, 57-63 Hz, single-phase power. The PA shall be protected from damage if the AC primary voltage exceeds nominal limits.

7. Operate with input pulse durations of 1.0 to 6.0 microseconds (uncoded) and 2.0 to 20.0 microseconds (coded).

8. Operate with a pulse repetition frequency of 5.0 to 20.0 kHz (PRF and pulse duration consistent with 15 % maximum duty cycle).

9. Have an interpulse spectral density at the output of < -110 dBm per MHz (from 1.0 microsecond after an output pulse has decreased to 10 percent of peak power to the leading edge of the next T-R pulse).

10. Must satisfy the criteria in the Radar Spectrum Engineering Criteria, version E (RSEC-E)

even if the input pulse stream does not. Assume that the input pulse has maximum rise and fall times of 100 nanoseconds where pulse length and rise and fall times are as defined in RSEC-E.

11. Be constructed of reproducible modules with phase and amplitude characteristics that will allow effective power combining.

NOAA is seeking a reliable, efficient power amplifier design using solid state technology for the wind profiler system. The power amplifier design could be composed of replaceable subsystems that may include: 1) driver, 2) pulse shaper, 3) parallel output modules, 4) system status monitor, 5) power supply. It would also be desirable to be able to run the output modules as stand alone units, using other (not to be supplied under this contract) subsystems.

For more information on the NOAA wind profiler system and operations, the following home page can be consulted: <http://www-dd.fsl.noaa.gov/online.html>.

8.1.3W Subtopic: NOAA Weather Radio (NWR) Text Broadcast

The National Weather Service (NWS) is interested in developing advances in modulator technology that can be applied to the NOAA Weather Radio (NWR). The system design would be adapted for the NWR application to provide special modulation to an NWR transmitter. NWR is the voice of the NWS and is the primary means to satisfy a mission critical need to deliver warnings of severe weather and other life threatening events (nuclear, chemical, and biological accidents, earthquakes, etc.) directly from forecasters to the public that is most immediately and specifically at risk. The NWS operates a network of over 500 NWR VHF stations for this purpose in the United States. The broadcast is audio (voice) with a 5,000 Hz bandwidth in a 25 kHz channel in the 162 MHz VHF FM band.

The NWR is the primary and most timely means of getting warnings of severe weather and other hazards directly to the public. However, to 20 million people who are deaf or hard of hearing and to those that cannot listen (asleep, driving a tractor, operating a boat, etc.) to the immediate message, real time audio information is of very limited use. Precious seconds or minutes are lost in waiting for repeats or seeking other warning sources.

The addition of text or digital information to this continuous audio broadcast on an inaudible sub-carrier would significantly increase the value of NWR as a low cost means of directly warning those who are specifically at risk, but who for any number of reasons, cannot make use of, or cannot immediately react to a real time audio alert. The warnings would be stored or in hard copy.

The objective of the first phase of this effort is to (1) research newly developed technologies, for carrying large amounts of digital information over existing telecommunications media, that

were designed and are available for wire and wireless telecommunications involved in Internet, cable, satellite broadcast, cellular, and paging applications; (2) determine if they can be adapted to provide a low cost, high capacity data subchannel that can be carried over NWR without extensive modification to the existing station technology and that can be incorporated into existing, low cost NWR receiver technology; and (3)design a system to demonstrate the concept at an NWR station.

The modulator development would need to allow the injection of a digital data stream, at 9600 bps or greater, onto the NWR carrier in a manner that would not impact the quality of the audio broadcast, require extensive modification to the transmitter, or decrease the reliability of the transmission. Reception of the digital data stream would be through commercially available, low cost, currently available NWR receivers adapted through the addition of a low cost internal or external demodulator. Text information would be output from a printer built into the receiver or as an ASCII stream to an external printer or personal computer coupled to the receiver with an interconnecting cable.

If the capacity of this sub-carrier technology was great enough, existing NWS data streams, that are currently independently carried on separate telecommunications systems, could be combined and universally made available on NWR. The capability to deliver five to six times the amount of information currently being delivered by NWR, directly to users in a more timely manner, using existing telecommunications media more efficiently, with a substantial decrease in cost for receivers, stored or in hardcopy would revolutionize the dissemination of NWS information.

This technology would be adaptable to a wide range of commercial broadcast communications activities and made available for incorporation into existing telecommunications systems through the sale of integrated circuit chips sets or licensing.

An information package on NWR is available from William Fellows, tel.: (301) 713-1833.

8.1.4R Subtopic: Detection of the Acoustic Air Wave from Avalanches: The Basis for a New Warning System

There is a great need to warn motorists and skiers of avalanches in progress. Measurements at NOAA's Environmental Technology Laboratory have shown that a large-amplitude, low-frequency sound wave is launched during the initial and subsequent stages of an avalanche. This energy (between .5 and 5 Hz) at about several tenths of a millibar and easily detected by sensitive pressure sensors at a distance of a mile from the source. The need is for a pressure sensor integrated with a microprocessor that can identify the avalanche signal and provide warnings (e.g. activate warning signs that would alert motorists to leave or not enter the path region). At this distance, one minute warnings would be possible and valuable. Such a device would also be useful to skiers. An automatic indication to remote centers that an avalanche

had occurred at a particular site would be of great help to rescue and road clearance crews. It will probably be necessary to provide a method of reducing the effects of local wind on the pressure sensor.

8.1.5R Subtopic: Modernization of Aging Infrastructure in the National Atmospheric Deposition Program

The National Atmospheric Deposition Program (NADP), provides monitoring of wet atmospheric deposition at approximately 265 sites throughout the United States. A fundamental program objective is to provide scientific investigators world-wide with long-term, high-quality atmospheric deposition data for research support in the areas of air quality, water quality, and many other fields of science. NADP is a cooperative program funded by nine Federal agencies (including NOAA) and many state and local organizations.

NADP requires replacement of the existing precipitation chemistry sampler with a collector that will eliminate present problems with sampler reliability and associated downtime. The new sampler must be a modular unit, capable of simultaneous collection of weekly, event, and mercury samples, and should be capable of handling additional analytes (heavy metals, organic compounds, etc.) should they be added to the program. The instrument shall expose up to four independent collection arrays to precipitation within five seconds of initiation of any form of precipitation and shall end exposure of sampling arrays to ambient conditions within 120 seconds of cessation of any form of precipitation.. The sampler must provide reliable and representative sample collection for 0-25 cm liquid water equivalent of precipitation during unattended operation. Samples must not be compromised by splash from exposed surfaces. The instrument shall report initiation and ending of sample collection array exposure, current to within five minutes of a remotely polled request for data, in response to all precipitation. The sampler must be capable of operation under a wide array of ambient conditions including extremes of wind and temperature. The sampler shall be powered by 110 V AC line power or by 12 V DC battery; provision for optional back-up DC power should be made for areas where line current is unreliable. The design should include mechanical and electrical components that can be readily repaired or replaced by a station operator lacking technical expertise.

NOAA and NADP request proposals for a robust sampler that exposes multiple sampling orifices to precipitation. An examination of other deposition samplers used throughout the world has not identified another sampler meeting this requirement. In addition to accommodating all NADP sample collection protocols with a single sampler, a new sampler would also provide the capability to add additional sampling capabilities to address emerging issues -- without adding additional collectors. The successful applicant will demonstrate a successful design at the end of Phase 1. It is expected that the final product will be marketable at a cost between $5000 and $10,000.

8.1.6R Subtopic: Extreme Ultraviolet and X-ray Detectors and Filters for Solar Observations

The EUV solar flux incident on the upper atmosphere both heats the atmosphere and creates the ionosphere. Variability in the solar EUV flux will change the neutral and electron density by an order of magnitude over the course of a solar cycle. Fluctuations in electron density can affect radio communication and navigation systems worldwide. The ability to monitor and predict ionospheric parameters requires that we improve our knowledge of the solar EUV flux. Since the atmosphere absorbs the EUV radiation from the sun, it is impossible to measure the EUV flux from the ground and, therefore, space-based sensors are required. The next generation of GOES spacecraft will include an EUV sensor that observes 5 EUV bands in the 10 to 120 nm range.

The ability to measure the total integrated solar flux with high levels of accuracy and precision has been a difficult task. The development of silicon diode detectors has improved the long term stability of these measurements. Thin metallic film filters are commonly used to isolate desired wavelength bands for observation. These thin films are often quite fragile and susceptible to mechanical failure as well as internal structural changes. Oxidation during the pre-launch period (exposure to air) also causes degradation in the filter performance.

The development of thin films that are both mechanically and optically stable is a task that requires additional research. In addition, these filters must block visible light by 5-10 orders of magnitude. The wavelength range of interest is from less than 0.1 nm to 100 nm. In particular, the 50 to 100 nm spectral region is quite difficult to observe with transmission stability to 5% over several years of space operation. The development of thin film filters that will provide the required stability of transmission, wavelength band pass, and out of band rejection, will be critical to improving the performance of future EUV sensors. These technologies can be directly applied to other government programs from NASA and DOD as well as commercial uses in medicine and science.

8.1.7W Subtopic: Improved Aerodynamic Wind Shields for Precipitation Gages

The National Weather Service (NWS) is seeking innovative designs for wind shields used with precipitation gauges. For many years the NWS has been working to improve the accuracy and capability of its rain gauges. New precipitation gauges using such technologies as load cells have been developed, improving the rain/precipitation measurement and data. There still remains the error induced by windy conditions that reduces and changes the rain/precipitation that falls through the gauge orifice. The greater the speed of the wind, the greater the error in

precipitation catch measured. Errors in the water equivalent of snowfall can sometimes be quite significant. With new aerodynamic designs and computer model simulations, the development of optimal wind shield designs can be done. Prototype development and testing of new wind shield designs would verify any improvements gained in precipitation measurement. The NWS uses various weighing and tipping bucket gauges. The wind shield designs and proposed prototypes for this topic should be universally compatible and adaptable with existing and future precipitation gauges. An information package is available from William Fellows, tel.: (301) 713-1833.

8.2 NOAA TOPIC: OCEAN OBSERVATION SYSTEMS

8.2.1O Subtopic: Operational Ocean Instrumentation, Measurement, and Data/Information Dissemination Systems

Development of operational ocean instrumentation, measurement, and data/information dissemination systems is sought to support a wide range of NOAA's National Ocean Service (NOS) operational activities, such as the Physical Oceanographic Real-Time System (PORTS) Program, the National Water Level Observation Network (NWLON), coastal and estuarine forecast systems, and environmental monitoring associated with sustaining healthy coasts. Development generally includes sensing, data acquisition, and information dissemination. One area of emphasis is systems that can be operated in an unattended mode. These systems should provide near real-time data acquisition and dissemination. Another area of emphasis is remote sensing systems which allow rapid acquisition of data from large coastal areas. High reliability, known accuracy, and cost effectiveness are important design considerations. The parameters of interest are comprehensive, including (1) physical, chemical, and biological properties of the coastal ocean environment; (2) pollutants; and (3) overlying atmospheric parameters. These systems provide marine environmental information in support of safe navigation, safe transportation of hazardous materials, economic benefits to marine commerce, management of marine resources, and assessment of coastal ecosystems health.

Of particular interest this year are proposals relative to the following:

a.) Long-Term and Real-Time Water Quality Monitoring System - Water quality in estuarine waters, such as bays and harbors, is important to coastal ecological health, recreation, and commerce. A reliable, in-situ system that can measure dissolved oxygen, and /or chlorophyll is sought. Features such as an unattended long service interval (3-month or longer) and real-time reporting (interval of 1-hour or less) are essential. Solutions to technical problems associated with marine fouling and corrosion should be emphasized. The technology is a candidate for integration with NOS PORTS or NWLON installations.

b.) Airborne Spectrofluorometer for Coastal Mapping - NOAA is soliciting for a small-aircraft mountable airborne spectrofluorometer system to enable the mapping of photosynthetic pigment containing marine organisms, such as zooxanthellae, phytoplankton and submerged aquatic vegetation. This instrument will enable the assessment of such applications as coral reef health, phytoplankton concentrations, and submerged aquatic vegetation set forth in the critical strategic plan. An airborne spectrofluorometer will have a great commercial potential for

cross-cutting oceanographic and fishery applications as well as many other terrestrial applications. Spectral issues to be considered are the typical excitation wavelengths for chlorophyll of about 532 and 337 nm, with emission wavelengths of about 685 nm and 740 nm. The red region of the electromagnetic spectrum is greatly attenuated by the water column and thus an innovative approach is needed in optoelectronics. To assist in the differentiation of plant types, as well as some dissolved organic material, a programmable range of excitation wavelength and a scanned emission wavelength range should be incorporated into the instrument. An imaging, synoptic system is required for the strategic mapping plan and thus such systems as a scanner or an array system is required. Spatial considerations are that a data stabilized platform is required, such as one that incorporates an inertial measurement unit (IMU). NOAA is seeking innovation which enables deployment from small aircraft, as well as large aircraft, flying between 100-200 knots and with GPS navigation of one part per thousand. Hoge (1. Instrumentation) described an instrument that has many of the criterion and applications (Hoge, 2. Applications) that NOAA is seeking. Software considerations include: 1) programmable excitation wavelength and scanned emission wavelengths in very narrow wavelength bands; 2) the system will need to collect large data volumes; 3) process and display raw data in flight; 4) post-process to a radiometric calibrated/corrected, and rectified data set; and 5) a format that can be utilized by off the shelf image processing software, such as ENVI or Imagine.

References:

Hoge, F.E., R.E. Berry, and R.N. Swift. “Active-passive Airborne Ocean Color Measurement. 1: Instrumentation.” Applied Optics: vol. 25, no.1 p39-47, 1986.

Hoge, F.E., R.N. Swift, and J.K. Yungel. “Active-passive Airborne Ocean Color Measurement. 2: Applications.” Applied Optics: vol. 25, no.1 p. 48-57,1986.

8.2.2F Subtopic: Electro-Optic Imaging of the Sea Floor

Electro-optic imaging such as laser-line scanning is a promising technology for producing high resolution(cm-mm)mapping of the sea floor. This technology is applicable to solution of a wide range of research and technical problems, including benthic aquatic resource assessment; identification, mapping and assessment of benthic habitats and anthropogenic disturbances of same; investigating micro geology; search, location and identification of important objects on the sea floor; oil rig and pipeline inspection; etc. The technology offers the promise of bridging the gap between meter scale resolution acoustic imaging, such as side-scan sonar and swath bathymetry with very high resolution, but cost prohibitive and sea state limited, and in situ observation using manned submersibles and remotely operated vehicles. However, general application of electro-optic imaging to solution of the above example problems is limited by the inability to produce mosaic maps from digital images. While conceptually similar to digital acoustic mapping that requires simultaneous processing of stored digital images and towing vessel (differential GPS) and towfish (short-baseline acoustic tracking) positional data to produce a georeferenced mosaic, electro-optic data sets are unusually large and unwieldy and

techniques have not been developed to produce digital mosaics of the sea floor**.**

References:

Gordon, A.C. “Use of Laser Scanning System on Mobile Underwater Platforms.” IEEE Oceanic Engineering Soc., Proc. of Symposium on Autonomous Underwater Vehicle Technology, June 1992,Washington,DC, vol.92CH3170-8,pp.202-205, 1992.

Strand,M.P., et al.. ‘Laser Line Scan Florescence and Multi-spectral Imaging of Coral Reef Environments,” 1998. <http://www.ncsc.navy.mil/CSS/Papers/oceanopeoid.htm>

Coles, B.W. “Project 4309 Technical Report Laser Line Scan System (LLSS) Laboratory Evaluation.” Subsea Engineering Associates, Inc. San Diego, CA, 1990.

8.2.3R Subtopic: Low-cost Transportable HF Skywave Radar

The NOAA**,** Environmental Technology Laboratory**,** invites research proposals for a low-cost, transportable HF skywave (ionospheric) radar for long-range monitoring of ocean-surface winds, waves, and currents. The range and spatial resolution of the radar would be comparable to that achieved by the Navy's Relocatable Over-the-Horizon Radar (ROTHR) system, but it is expected that reduced requirements for transmitter power, ruggedness, target tracking, and other military specifications would reduce the cost to one-tenth that of the ROTHR. The radar will operate between 10 and 28 MHz and would employ linear frequency modulation. Innovative antenna/signal-processing technology will reduce the size and complexity of the receiving and transmitting arrays. Commercial off-the-shelf components will be extensively employed to keep hardware costs to a minimum, and software and other concepts already developed for military skywave radar systems will be adapted to the maximum extent possible. The radar will incorporate a rudimentary sweep-frequency backscatter sounder and a spectrum monitor for frequency management. Proposals must demonstrate innovative ideas for achieving simplicity, ease of operation and maintenance, and economy, consistent with the requirements for usable sea-echo signals.

8.2.4G Subtopic: Automated Ocean/Atmosphere Observations from Volunteer Observing Ships

Proposals are sought to develop a research quality, low cost, integrated Volunteer Observing Ship (VOS) observing system that will automatically sense ocean and atmospheric conditions, and automatically report near-real-time via NOAA SEAS (Shipboard Environmental [data] Acquisition System). A critical element of the global ocean observing system that supports NOAA’s climate and weather forecast mission is the VOS fleet. Accurate, timely weather and sea condition reports from commercial ships transiting the vast ocean regions are essential for initializing climate and weather forecasts; and the long term data sets compiled from these ship observations are of fundamental importance to climate research. A data continuity/reliability

problem exists due to the variety of instruments and techniques used by various ships to make the at sea observations. Over the past ten years, highly accurate meteorological and ocean temperature sensors have been developed for use aboard research vessels, but these research instruments have not been integrated into an automated shipboard system and they remain too expensive to be practically deployed operationally, on a large scale, aboard volunteer ships. The VOS observing system must have the capability to measure sea surface temperature, true wind speed and direction, barometric pressure, precipitation, air temperature and relative humidity, and provide for optional measurement of other environmental parameters of interest to climate research such as radiation, salinity, and carbon. An interface to accept input from standard XBTs and report/display upper ocean thermal profiles is required. The system must be designed for ease of installation (less than twelve hours), and have simple maintenance concepts, and provide for routine automatic sensor calibration. A primary objective is to make the VOS observing system as useful to ship operators as it is to scientists and forecasters. The system should provide a shipboard computer generated real-time graphical display of local conditions as measured by the automated sensors, and be capable of semi-automatically producing the ships weather log by combining the automated observations with manual entry of visual observations (waves, clouds, sea ice, etc.). Capability to interface via satellite communications with marine forecast services for providing shipboard display of weather maps, ship routing, and/or other environmental products of value to ship operations is a desired feature of the system.

8.3 NOAA TOPIC: LIVING MARINE RESOURCES

8.3.1F Subtopic: Rapid and Sensitive Methods for the Identification of Viral Pathogens of Shrimp

The objective is to develop a reliable, easy to use, field kit method for rapid sensitive, non-lethal method for the identification of important viral pathogens of shrimp, such as “Yellow Head” or Yellow Head Virus (YHV) and White Spot Syndrome Virus (WSSV), which have been found in shrimp. Penaeid shrimp viruses represent a number of virus families. Among these are the: Parvoviridae (IHHNV, HPV, LPV, & SMV), Picornaviridae (TSV), Baculoviridae (BP, MBV, & BMN), Reoviridae (REO-III & REO-IV), Rhabdoviridae (RPS), and Togaviridae (LOVV). The taxonomic position of two other important shrimp viruses (WSSV and the YHV-group) is uncertain, but these viruses are most closely related to the Baculoviridae (WSSV) and Cornaviridae (YHV-group). The baculovirues (MBV, BP, & BMN) and the WSSV (a baculo-like virus) may be the most important, widely distributed pathogens of cultured penaeid shrimp. WSSV in particular is highly infectious and it has caused significant disease epizootics in farmed shrimp in East Asia, the Indo-Pacific, the U.S. (Texas and South Carolina), and most recently in Central America. YHV has caused serious epizootics in farmed shrimp in East Asia and the Indo-Pacific. Likewise, TSV and IHHNV have been very important pathogens of cultured shrimp in the Western Hemisphere. At present, laboratory extraction of the nucleic acid of these viruses and subsequent identification of viral species specific genomic sequences using genomic (most are DNA) probes or DNA amplification techniques (PCR for DNA viruses and RT-PCR for RNA viruses) have proven to be powerful diagnostic and highly

specific pathogen detection techniques. The intent of this subtopic is to further evaluate this concept and develop methods to automate the various steps to make it applicable for reliable field use. Such a field kit will be extremely useful for managers of various sectors of the shrimp industry including: aquaculture, harvesting and processing facilities, as well as biosecurity protocols for importation of frozen shrimp.

References:

Chang,P.S., C.F.Lo, Y.C.Wang, G.H.Kou." Detection of White Shrimp Syndrome Associated Virus (WSSV)in Experimentally Infected Wild Shrimp, Crabs and Lobsters by In Situ Hybridization. Aquaculture." (Proceedings of the Second International Conference on the Culture of Penaeid Prawns and Shrimp. 14-17 May, SEAFDC, Iloilo, Philippines), 1996.

Flegel, T. W., S. Sriurairtana, C. Wongteerasupaya, V. Boonsaeng, S. Panyim, and B. Withyachumnamkul. Progress in Characterization and Control of Yellow-head Virus of Penaeus monodon. Pp. 76-83. In: E. L. Browdy and J. S. Hopkins (eds.), Swimming Through Troubled Water, Proceedings of the Special Session on Shrimp Farming, Aquaculture 95. World Aquaculture Society, Baton Rouge, LA,1995.

Flegel, T. W., S. Boonyaratapalin and B. Withyachumnamkul. "Current Status of Research on Yellow-head Virus and White-spot Virus in Thailand." World Aquaculture 96 Book of Abstracts, 126-127, 1996.

Lightner, D. V., ed. "A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp." Section 3: Viruses. World Aquaculture Soc., Baton Rouge, LA, 1996.

Lo CF, J.H.Leu, C.H.Ho, C.H.Chen, S.E.Peng, Y.T.Chen, M.Chou, P.Y.Yeh, C.J.Huang, H.Y. Chou, C.H.Wang, G.H.Kou. "Detection of Baculovirus Associated with White Spot Syndrome (WSBV) in Penaeid Shrimps Using Polymerase Chain Reaction". Diseases of Aquatic Organisms (DAO) 25:133-141, 1996.

Wang,C.H.,C.F.Lo,J.H.Leu,C.M.Chou,P.Y.Yeh,H.Y.Chou,M.C.Tung,C.F Chang,M.S.Su,and G.H.Kou. "Purification and Genomic Analysis of Baculovirus Associated with White Spot Syndrome (WSBV) of Penaeus monodon." Diseases of Aquatic Organisms 23:239-242.778, 1995.

8.3.2F Subtopic: Shrimp Virus Disinfection Techniques for Aquaculture and Processing Wastes/Effluent

The objective is to develop large scale low cost virus disinfection treatments for process of shrimp waste products in aquaculture and processing facilities, based on laboratory research scale disinfection treatments already developed.

References:

Chang,et al. “The Effect of Ultraviolet Irradiation, Heat, pH, Ozone, Salinity, and Chemical Disinfectants on the Infectivity of White Spot Syndrome Baculovirus. Aquaculture,” 166: 1-17.and 2, 1998.

Nakano, H., et al. “Inactivation of Penaeid Rod-shaped DNA Virus (PRDV), the Causative Agent of Penaeid Acute Viremia (PAV),” by Some Chemical and Physical Treatments. Fish Pathology 33(2): 65-71, 1998.

8.3.3F Subtopic: Live Aquatic Transportation

The objective is to develop new or improved methods/technologies for the packaging, handling or survivability of live aquatic products for shipment to market. The intent of this research is to develop new handling and care techniques involving but not limited to: respitory rates, ability to handle stress, excretory functions, and temperature tolerances.

Reference:

Marketing and Shipping Live Aquatic Products, Proceedings from the Marketing and Shipping Live Aquatic Products Conference; Northeast Regional Agricultural Engineering Service Cooperative (NRAES-107) <http://www.nraes.org/> 152 Riley-Robb Hall Ithaca, New York 14853-570.

8.4 NOAA TOPIC: OCEAN SCIENCE

8.4.1SG Subtopic: Aquaculture: Developing and Improving Species Culture

Proposals are requested for research which offers to make significant, industry-wide improvements in finfish, shellfish, and ornamental fish culture systems for both small scale and large scale applications. Priority will be given to research which finds innovative approaches that will solve major industry bottlenecks in an economically and environmentally compatible manner. Research aimed at new species for culture and research to adapt techniques being used successfully in other countries are appropriate.

8.4.2SG Subtopic: Aquaculture: Water Reuse and Effluent Treatment Systems

Proposals are requested for developing integrated aquaculture systems with minimum impact on the environment. These include development of innovative water reuse systems for ponds and raceways and other novel systems for treating effluent. Special priority will be given to prototype, modular water reuse systems suitable for producing a variety of species anywhere in the United States.

8.4.3SG Subtopic: Aquaculture of Marine Organisms for Marine Natural Products

Research in the past two decades has found that there are many marine organisms which produce novel natural products of use in treating human diseases. To utilize these products commercially and in clinical trial, however, they need either to be chemically synthesized, produced using biotechnology, or produced through aquaculture of the organism. Research is needed to find economically cost-effective and biologically viable ways to culture marine organisms specifically for their production of novel natural products.

8.4.4SG Subtopic: Open-Ocean Aquaculture Systems

Both engineering and biological technology needs to be explored for the development of open-ocean or offshore culture systems. Large scale, offshore, submersible and floating systems need to be developed for Atlantic, Gulf of Mexico and Pacific conditions. Automation of feeding and harvesting functions as well as telemetry and remote control systems will be considered in this competition. The biological technology would include hatchery, nursery and transport systems for candidate species for open ocean-aquaculture. Field tests of candidate species are encouraged.

8.4.5SG Subtopic: Technology for Sampling Marine Organisms and Their Native Environment at Deep-Sea Hydrothermal Vents

The diversity of marine organisms, primarily microbes, at deep-sea hydrothermal vents is currently getting much attention. Techniques to sample these organisms in a manner which allows for collecting live samples in their native environment is currently not available. We need sample techniques to gather organisms so they can survive uncontaminated in their native environment, and probe technology to sample the native micro environment of the organisms. Culture techniques are also needed which can replicate the natural environment of these organisms, so they can be studied at the surface and in the laboratory. These technologies would greatly enhance our ability to study the organisms from the deep-sea hydrothermal vents, the extremophiles, and their natural processes and products.

8.4.6SG Subtopic: Disease Diagnostics and Controls

Given the severe problems with aquaculture disease diagnostics and controls, we seek proposals in those areas in order to reduce the impacts on the US aquaculture industry.

8.5 NOAA TOPICS: CARTOGRAPHY, PHOTOGRAMMETRY, HYDROGRAPHY, and GEODESY

8.5.1O Subtopic: Cartographic Data and Geographic Information Systems (GIS)

Innovations with commercial potential are sought incorporating new and emerging technologies related to digital cartographic imaging and GIS systems to support National Ocean Service (NOS) requirements. The NOS makes its products, data, and metadata available to agencies, academia and the public through electronic access via computer networks. Needed research critical to the NOS mission includes:

a) New methods for generation, update, and transfer of geo-data products and data files from spatial data bases, including raster images, to meet emerging requirements of Electronic Chart Display and Information System (ECDIS) and similar shipboard electronic navigation systems using raster displays.

b) User-transparent approaches to geo-data and geo-processing interoperability across networks (e.g., the Internet), for: Software Interoperability: Automatically invoked platform independent processing functions; and Data Interoperability: User-transparent autonomous standard file format conversions.

c) Innovations for easily locating, accessing, searching, transferring, reformatting, and portraying geo-data and GIS graphic products across networks. These could involve knowledge processing via expert systems and/or neural nets, hyper-links (e.g., Netscape-like), geospatial search engines, or improved conventional techniques.

d) New methods for enhancing/compressing raster images of nautical chart features, including text and feature symbology. These can range from conventional image processing and optical character recognition algorithms to the use of expert systems, fuzzy logic, neural nets, and specialized pattern recognition/matching algorithms.

e) Improved methods for error-free raster-to-vector and vector-to-raster conversion/compression for digital raster images, including semi-automated GIS data attribution and metadata generation directly from the vectorized raster data files.

f) Heads-up raster and vector navigation and nautical charting display systems. Such systems could show data in 2 and 3 dimensional displays for mariners. Such practical information could be shown on (semi-)transparent, portable, heads-up displays superimposed in novel ways on the actual environment to help mariners navigate, especially in conditions of limited visibility.

g) A comprehensive method for remote, real-time monitoring and display of navigation channel depths to within 1 foot and widths to within 10 feet throughout the entire channel length (1 mile to 100 miles). The method must be comparable in cost to the periodic sonar surveys currently in use. A “survey” by this method should not take more than 24 hours, if possible.

8.5.2O Subtopic: Hydrographic Data Acquisition and Data Processing

The National Ocean Service is seeking to improve the efficiency and effectiveness of its hydrographic operations. This request is for the development of software and algorithm solutions to problems of data acquisition and data processing. This does not, however, preclude solutions that are primarily hardware in nature. Of particular interest are: a) the blending of bathymetric data and acoustic imagery; b) improved data editing techniques which utilize both the acoustic backscatter strength and slant range time of flight on the several beams of a multibeam bathymetric sonar; c) efficient 3-D visualization of large fields of spatial data; and d) online tools for assessing/assigning quality parameters to bathymetric data as a function of nadir angle and natural variability of the local bathymetry.

8.5.3O Subtopic: Airborne Gravity Measurement System

Airborne gravity provides better coverage and faster and more complete data acquisition than land-based measurements. This is especially important in coastal regions where gravity knowledge is limited due to the lack of airborne instrumentation. Airborne gravimetry also makes is possible to map harsh and rugged terrain that is difficult to access on the ground. There is also a great potential commercial benefit for the oil/gas exploration market. Currently airborne gravity measurements are limited to spring-type instruments that suffer severe problems of drift, calibration, and tares. These disadvantages can be overcome. By combining land-based absolute gravity technology together with an increased ability to measure aircraft accelerations using Global Positioning System (GPS), this becomes an attractive instrument development track.

8.5.4O Subtopic: GPS Antenna for Geodesy and Navigation

The National Geodetic Survey seeks a multipath-rejecting dual-band GPS antenna for use in precise (mm-level) geodesy and navigation applications. Theoretical simulations show that the antenna should have high efficiency, s stable phase center, and a fixed (non-steerable) beam that is omni-directional in the upper hemisphere while rejecting signals from the lower hemisphere.

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The subtopics in Sections 8.6 through 8.21 are from the National Institute of Standards and Technology (NIST). Approximately 30 awards will be made on these subtopics. Only questions of clarification are permitted and must be posted at the NIST SBIR website: www.nist.gov/sbir.

8.6 NIST TOPIC: ADAPTIVE LEARNING SYSTEMS

8.6.1T Subtopic: Distributed Interactive Learning

Object oriented technology and the robustness of the Internet and WWW are allowing the emergence of distributed interactive learning as a provably sound environment for education and training, and as a viable economy for learning content authors, developers, publishers, and educators. Further, distributed interactive learning is viewed as a mechanism for helping U.S. companies and industries maintain their competitive edge by having a well-trained workforce.

Proposals are being solicited that will develop enabling technologies that support flexible, network-based or Web-based learning systems. These enabling technologies should provide support for one or more of the following adaptive learning system areas: intelligent authoring systems to reduce the cost and time to market for educational and training content; knowledge management technologies to improve the delivery of instructional content in its most useful form, when and where needed; and large-scale modular components, instructional frameworks and middleware to support highly usable, reliable networked learning environments that include special transactions needed for training and education.

The goal is to develop technical solutions that reduce the costs of producing instructional software and systems, make educational systems easier to use, and improve manageability and quality of distributed educational systems. Proposals that align with emerging industry standards in Web-based instruction or address the particular needs of the U.S. workforce are encouraged.

8.7 NIST TOPIC: ADVANCED BUILDING MATERIALS AND SYSTEMS

8.7.1T Subtopic: Direct Electrical Measurement of Cement Hydration

A problem of long-standing interest and importance is to find a method to directly measure the degree of hydration of cement, in a non-destructive manner, and suitable for the field. All of the ultimate properties of concrete depend on the hydration of the cement paste matrix: strength, pore structure, stiffness, etc. These properties determine, to a large degree, the service life of the concrete. Such a technique would be useful for construction, in telling quantitatively when enough curing aids have been used on fresh concrete (plastic covering, curing compounds, water added to the surface, etc.). It would also be useful in determining the service life, as the

total curing that a concrete will attain could be assessed to see if it is enough to produce a reasonable service life.

We are interested in obtaining such a device to carry out the measurement described above. To be simple, inexpensive, non-destructive, and portable for field work, such a measurement should be electrical in nature. It must directly measure the degree of hydration of the cement, and not just be a correlation between, say, D.C. conductivity and degree of hydration. Such empirical correlations do not hold up well between different materials. This device should operate by measuring the changes taking place in either the cement or the water, which are both being consumed in the hydration reaction. The device's operation should be validated on cements from the proficiency sample program of the Cement and Concrete Reference Laboratory at NIST.

8.7.2T Subtopic: Software Package for Optimizing Refrigerant Circuitry in Finned-Tube Condenser

The goal of a heat exchanger design engineer is to obtain the maximum capacity for specified general heat exchanger parameters. One of the important design tasks for a finned-tube heat exchanger design is designing refrigerant circuitry, i.e., specifying the refrigerant path through the heat exchanger assembly. Designing an optimized circuitry is particularly challenging when a zeotropic mixture is used as a refrigerant or when the air entering the heat exchanger has a non-uniform velocity profile. Recent work has demonstrated the feasibility of designing an optimized refrigerant circuitry for a finned-tube evaporator using a learnable evolution module. The module works in conjunction with NIST's tube-by-tube evaporator model, which evaluates proposed circuitry architectures. The studied cases showed that the developed software package can design an optimized circuitry for both R-22 (a single-component refrigerant) and R-407C (a ternary zeotropic mixture) in cases involving uniform and non-uniform air distribution.

The circuitry of a finned-tube condenser differs from that for a finned tube evaporator in that circuitry branches merge in the condenser while they are designed to split in the evaporator in the direction of refrigerant flow. For this reason, the condenser and evaporator will require separate modules for circuitry optimization, although several concepts developed so far can be shared. NIST welcomes proposals for the development of a module for optimizing refrigerant circuitry for a finned-tube condenser. The heat exchanger under consideration is a condenser up to 20 kW capacity. The module should operate on a PC in a Windows environment.

References:

Michalski, R., K.Kaufman, "An Intelligent System for Heat Exchanger Design," final report to NIST to be available in June, 1999.

Domanski, P.A., "EVSIM – An Evaporator Simulation Model Accounting for Refrigerant and One Dimensional Air Distribution," NISTIR 89-4133.

8.7.3T Subtopic: Measurement of Concrete Permeability at High Temperature

While high performance concrete is superior to conventional concrete in many respects, it presents a higher probability for rapid spalling upon exposure to a fire. This compromises the major purpose of the concrete during a fire, to protect the embedded steel from exceeding its yield temperature. To provide a fundamental understanding of this phenomenon, data on the heat and mass transfer properties of concrete as a function of temperature must be obtained. Thus, NIST would welcome proposals for a simple prototype system to measure the permeability of a concrete exposed to high temperatures. The minimal operating temperature range should be between room temperature and 300EC. Since saturated water vapor at a temperature of 300EC has an absolute pressure of about 1250 psi, the designed and constructed equipment should be able to handle high pressures, with the downstream side maintained at atmospheric pressure.

8.8 NIST TOPIC: ADVANCED DETECTION AND SUPPRESSION OF FIRES

8.8.1T Subtopic: Temperature Measurements During Water Sprinkler Extinguishment of Fires

The development of models for describing the extinguishment of fires by water sprinklers is a current research priority of the Building and Fire Research Laboratory (BFRL). An important parameter to be used for validation of such models is the gas temperature field in the region influenced by both the sprinkler and the fire. Such measurements are particularly difficult due to the presence of both heated fire gases and water droplets. Innovative proposals are solicited by BFRL for a temperature sensor which is capable of measuring local gas-phase temperatures (room temperature to 500 K) with a minimum sampling rate of 100 Hx during sprinkler-extinguishment of fires. Important considerations include high spatial resolution, ease of use in fire test, robustness, ability for automated data acquisition, and reasonable cost.

8.8.2T Subtopic: Advanced Fire Suppression Technologies and Concepts

State-of-the-art fire protection systems require suppressants that are environmentally acceptable and will minimize reversibly or irreversibly collateral damage to a facility or its contents. With these constraints, advanced fire suppression strategy will require innovative thinking in improving the performance of less effective, but inherently safe, fire suppressants. Proposals are solicited which will improve any aspect of automatic fire suppression systems, such as deployment technologies to enhance agent transport to a fire and to minimize collateral damage. Other topics on advanced fire suppression technologies (e.g., the development of next-generation gas generators and advanced water mist systems) are also sought. The proposed fire suppression technologies will likely lead to the development of products with commercial potential. Topics on advanced fire suppression concepts, which include the identification of novel physical and chemical fire suppressants and synergistic action of suppressants, are also solicited. Techniques to evaluate these advanced concepts at a bench-

scale which reliably predict full-scale performance should be addressed in the proposal. Refer to related descriptions in annual summaries of BFRL research.

8.8.3T Subtopic: Advanced Incident Command System

Currently, many fire departments follow a prescribed protocol for handling incident command for a wide variety of emergencies. This system provides command structure and allows for the direction of all resources on the scene from a central location. Unfortunately, communication is typically limited to radio transmission. Confusion can easily occur due to miscommunication or lack of communication between the engine companies and the incident commander. Many times the resources are not positioned where they are needed the most. Or, in the case of conflagrations, it may not be clear where the resources are needed the most.

NIST has been developing a high resolution wildland/urban, wind driven fire spread computer model. When completed, the model will incorporate a wide variety of spread mechanisms and be able to run on a PC laptop. The software requirements for this model and computer capabilities should converge within the next three years.

Innovative proposals are solicited by BFRL for a PC based advance fire incident command system to provide equipment and resource tracking via GPS, and system of computer based maps onto which the results of NIST's predictive models could be overlaid. Important considerations include compatibility with the NIST model, the framework and expected input and outputs of which will be supplied to respondents, ease of use, and run time on portable windows based PCs.

8.8.4T Subtopic: Monitoring Fires for Hazard Level Assessment and Tactical Suppression Decisions

Currently fielded fire detection technology is focussed on identifying a nascent fire such that people are warned and that hopefully some intervention can take place before the fire causes extensive damage. After detection, there is no indication of hazard levels to escaping people or to firefighters along the routes they take to find refuge, fight the fire, or perform rescues. The most effective use of resources for battling fire, either by automatic suppression or manual fire fighting, requires that the location and size of the fire be determined, and that the effects of suppression action be quantified in terms of hazard reduction. Information from sensors that are capable of detecting and continuously monitoring fire could be used by automatic fire suppression systems in judiciously applying suppressant to minimize the quantity and collateral damage, or to provide occupants with information on the best escape options, or to provide fire fighters with information that would optimize resource deployment. Spaces of interest to the Building and Fire Research Laboratory include residential and commercial structures, industrial facilities, and transportation systems. Research is required to determine how to apply advances in sensing temperature, air flow, heat flux, chemical species, particulate matter, and different portions of the electromagnetic spectrum to the detection and monitoring of a

hazardous fire. Detection and monitoring schemes that involve integration of signals from multiple sensors, either co-located or distributed in space are of particular interest. Proposals for incremental advances to existing fire detection technologies are not solicited. Refer to related descriptions in annual summaries of BFRL research.

8.8.5T Subtopic: Molecular Dynamics Modeling of Polymer Reactivity

Molecular dynamics (MD) has been demonstrated to be a useful tool for the investigation of time dependent properties in synthetic polymers. Recent work conducted in the Building and Fire Research Laboratory has led to extensions of MD to account for the major reaction channels involved in the thermal degradation of polymers. This was accomplished by introducing specific reaction pathways, which are known to be active in the thermal degradations of polymers, and switching functions, which turn-on new bonding interactions when the old bonds approach dissociation, into the force field. There is a clear need to augment this model to account for a greater range of chemical properties and reactivity including the capability to model polymer-monomer and monomer-monomer reactions. NIST welcomes proposals for the further development of our reactive MD code, which could be used within the polymer industry to develop new strategies for polymer synthesis and processing.

8.8.6T Subtopic: Fast-Response Fire Environment Sensors

Command and control of fire fighters relies on cableless voice communication. Little quantitative information is available to decide on rationale fire fighting strategies. Command and control would benefit from two types of quantitative information. The first subtopic involves the transient quantification of environmental conditions, such as the concentrations of carbon monoxide, oxygen, and smoke, as well as ambient temperature. The second subtopic involves understanding the location of fire fighters as they travel through a burning structure. Both types of information are of value. Together, they provide information that could be beneficial for formulating fire fighting strategies including search and rescue. The first subtopic is addressed here; the second subtopic (8.8.7T) follows.

A rugged miniature sensor or sensors attached to a fire fighter's uniform represents a moving detector. Such a detector should be able to quantitatively monitor the transient concentrations of carbon monoxide, oxygen, and smoke, and ambient temperature. The device should be light (less than ½ pound total), small (able to attach to the uniform of a fire fighter), and have a fast time response (preferably less than 1 second). The proposed concentration monitor should address the issue of interference from other gaseous and particulate combustion byproducts such as CO_2, water vapor, and soot. The issue of measurement uncertainty should also be addressed. The information should be displayed for the fire fighter and also relayed to a master unit that could monitor several devices.

The ability to survey an entire room quickly could also be addressed in the proposal. Commercial applications for the proposed monitor could be extended to industrial power plants

and manufacturing sites where combustion processes take place. Proof of concept for the proposed instrument should be demonstrated during Phase 1 research.

8.8.7T Subtopic: Fire Fighter Locator

Command and control of fire fighters relies on cableless voice communication. Little quantitative information is available to decide on rationale fire fighting strategies. Command and control would benefit from two types of quantitative information. The first subtopic (see previous subtopic, 8.8.6T) involves the transient quantification of environmental conditions, such as the concentrations of carbon monoxide, oxygen, and smoke, as well as ambient temperature. The second subtopic involves understanding the location of fire fighters as they travel through a burning structure. Both types of information are of value. Together, they provide information that could be beneficial for formulating fire fighting strategies including search and rescue. The second subtopic is addressed here.

When fire fighters enter a burning structure, there is no information regarding their whereabouts. For those outside the structure, the exact location of a fire fighter would be an important consideration for formulating fire fighting strategies and in terms of response time if search and rescue is needed. A rugged miniature device attached to a fire fighter's uniform is envisioned, which will allow determination of the relative position of fire fighters, preferably referenced to a position on or near the structure. The three-dimensional position should be determined to within 1 meter vertically and 2 meters horizontally within a structure. The device should have a minimum range of 100 to 200 meters and it should provide real-time information on location, relative to some reference position. The device should function under harsh environmental conditions including elevated temperatures and large smoke and water vapor concentrations. The device should be light and small (able to attach to the uniform of a fire fighter). The information should be relayed to a master unit that could monitor several devices. Proof of concept for the proposed instrument should be demonstrated during Phase 1 research.

8.8.8T Subtopic: Silsesquioxane Polymers as Flame Retardants in Commodity Polymers

New, environmentally benign approaches to flame retarding commodity polymers are needed that take advantage of high char yield, silicon-based polymer such as silsesquioxanes and silsesquioxane copolymers. These materials should be designed to yield blends with commodity polymers that have reduced flammability with little or no loss in other physical properties. A structure-property study to determine the important parameters for reducing flammability (as measured in the Cone Calorimeter) should be conducted within this project. The resulting new polymer blends should pass fire tests appropriate for electronic, fabric, foam or other specific applications.

8.8.9T Subtopic: Advanced Temperature Probe for Fire Testing

As the computational methods used to model fire scenarios become more sophisticated, there is a pressing need to reduce the uncertainty of and to improve the temporal resolution of temperature measurements used for validation. Thermocouple-based gas temperature measurements in fires are plagued by uncertainty because of, for example, low local gas velocities, time-varying thermal-radiation exchange between a thermocouple and its warmer and/or cooler surroundings, and thermocouple surface emissivity changes caused by oxidation and soot accumulation. Large thermocouple beads, often used to provide ruggedness, are unable to monitor fluctuating gas temperature measurement techniques for use in and around fires, which are more accurate and possess better temporal resolution than thermocouples. New methods should be able to rapidly measure local gas temperatures somewhere in the region between 300 and 2000 K in a fire environment. The temperature probe should be rugged and possess calculable precision and accuracy.

8.8.10T Subtopic: Drop Size and Velocity in Industrial Fire Sprinklers

The NIST Building and Fire Research Laboratory (BFRL) is currently studying the interaction between sprinklers and fires at realistic scales. Simulations of the interaction rely on a sprinkler submodel calibrated with experimentally measured far field water drop size and velocity distributions. Drops are expected to be falling with roughly their terminal velocity. The range of drop diameters is large (estimated ~10 μm to ~4 mm), sprays are polydisperse, drops may be irregularly shaped, instruments must be protected from large amounts of flowing water (~200 L/min per sprinkler), and delivered water densities are high (locally ~200 cm/hr). Existing measurement techniques have small dynamic drop size ranges, are only accurate for spherical drops, are difficult to protect from water downpours, are sensitive to laser beam obscuration caused by dense sprays, and have high dense-spray drop rejection rates because they rely on the existence of only one particle in the measurement space at a time. Proposals are solicited for novel drop size and velocity measurement techniques which have wide dynamic range, are capable of accurately measuring large, non-spherical drops in a polydisperse spray, are rugged enough to withstand large water flows, and are accurate in high-number-density fire sprinkler sprays. Techniques must have quantifiable uncertainty. Only novel and innovative methods will be considered.

Reference:

McGrattan, K.B., A.Hamins, and D.Stroup, "Sprinkler, Smoke & Heat Vent, Draft Curtain Interaction – Large Scale Experiments and Model Development," NISTIR 6196-1, 1998. Available online at <http://fire.nist.gov/bfrlpubs/fire98/art069.html>.

8.8.11T Subtopic: Integrated Fire Fighter Safety System

Fire fighters are experiencing thousands of burn injuries each year. NIST has a project to measure the "stored energy" in fire fighter protective clothing. NIST has found that by the time the fire fighter feels the heat through the gear, there is no time for corrective action, and a burn injury occurs. The fire fighter needs some type of warning system to provide time for corrective action prior to suffering a burn injury. The next step in the NIST fire fighter safety project is to develop a predictive heat transfer model based on the thermal inputs to the outer shell of the protective garment. If this predictive method could be tied into a lightweight, inexpensive, sensing, decision and warning device, many fire fighters could be spared the pain and suffering due to burns each year.

A system is needed for sensing, analyzing, and warning prior to the onset of thermal injury. This system would be robust in order to withstand the daily rigor of a fire fighting environment. Ideally, the system could be retrofit to existing gear.

8.8.12T Subtopic: Low-Loss, Durable Middle-Infrared Fiber Optics for Industrial Flame Spectroscopy

Many industrial applications involve the need to monitor flames and sense rapid changes in their structure. Remote, immediate-feedback spectroscopic gas sensors combining sturdy, near-infrared (up to 1.8 µm) communications diode lasers with rugged silica fiber optics are being developed for these applications. These sensors suffer because molecular absorption transitions are weak and high-temperature flame spectra are congested in the near infrared spectral region. New room-temperature, high-power lasers with longer emission wavelengths (2 to 5 µm) corresponding to strong molecular absorption transitions are rapidly becoming available. Unfortunately, conventional silica fiber optics and their well-developed components are not usable at these wavelengths. The full potential of long-wavelength diode lasers for remote flame monitoring in practical environments will not be realized until fibers become operative in the middle-infrared region of the electromagnetic spectrum. Existing middle-infrared fiber optics can only be used for short distances because they exhibit high transmission losses. Additionally, they are brittle and lack the sturdy coupling and focusing components available for their near-infrared counterparts. Proposals are solicited for novel technologies (e.g., new fibers, couplers, and optics) which will enable development of low-loss, durable infrared fiber optics suitable for use with newly-emerging, 2 to 5 µm laser light sources. The fibers must be usable in environments surrounding industrial flames. Only novel approaches will be considered.

8.9 NIST TOPIC: COMBINATORIAL DISCOVERY OF MATERIALS AND CHEMICALS

8.9.1T Subtopic: Advanced Sample Deposition Methods for Polymer Analysis

Recent trends in polymer analysis would benefit from automated sample deposition methods that produce multidimensional arrays of controlled composition, chemistry, morphology or other measurable properties. Combinatorial methods of analysis are examples where advanced sample deposition methods are needed to prepare sample libraries. Measurement of the mass distribution in synthetic polymers by matrix assisted laser desorption/ionization mass spectrometry (MALDI-MS) would also benefit by availability of automated sample preparation. The methods developed should be capable of depositing polymer mixtures in solvents onto solid substrates of various types. The deposition may be either continuous or discrete, in the latter sample spot size should range from millimeter to micrometer in scale. The ability to deposit samples at elevated temperatures is also an important aspect.

8.10 NIST TOPIC: CONDITION-BASED MAINTENANCE

8.10.1T Subtopic: Software Tools for Smart Sensor Digital Communication Networks

Digital communications networks promise to become ubiquitous. Applications of such network technology span the range from factories to offices, to homes and to vehicles. Development of domain-oriented tools such as application specific, configuration, testing, deployment, and development tools has lagged behind the development of digital networks. Typically, buyers must commit to single-vendor solutions for many applications. This has limited innovation and concentrated market share in many industries.

NIST is working with IEEE and industry to standardize communications interfaces for smart sensors. The recently approved IEEE 1451 Standard for a Smart Transducer Interface for Sensors and Actuators provides a new model for plug and play applications hardware and software that is domain-oriented. Applying this standard, users will be able to assemble 1451-compliant software and hardware modules from diverse suppliers into systems that work seamlessly in concert. A number of companies are now producing 1451-compliant hardware. A need exists for complementary software tools that enable the fast and efficient building of application solutions.

Innovative ideas are sought which create new ways to provide the benefits of the plug and play hardware and software architecture of 1451 to a wider community of users. The goal should be a simplicity that is comparable to the connection, programming, and operation of home audio and video equipment. These ideas may encompass methodologies, tools, applications software, and other such concepts, which reduce the time and effort needed to construct 1451-compliant solutions or to bring existing applications into compliance.

Expected Phase 1 results should be a substantial application which will benefit from the use of a plug and play hardware and software solution, and a detailed design for a software tool that enables the fast and efficient building of solutions for this application. Expected Phase 1 results will provide a set of prototype software development tool(s) and a demonstration of the utility of the tool(s) in a number of practical and commercial applications.

8.10.2T Subtopic: Ambient-powered Wireless Network Smart Sensors for Intelligent Manufacturing

Smart sensors play a key role in intelligent manufacturing systems. These sensors are essential components in closed-loop manufacturing systems and can improve product quality as well as production efficiency. However, for sensors to be more effectively used in manufacturing systems, the sensor intelligence level must to be increased and the price decreased. When integrated with microprocessing technology, the intelligence level of these sensors can be enhanced. Sensors powered by the ambient environment can be free of power cables and the need for battery changes. In addition, sensors with the capability of wireless communication with their host are unencumbered by cabling. This feature, in situations such as on a rotating spindle or grinding wheel, or in a hazardous environment, can ease the integration of sensors into systems and applications.

NIST is working with IEEE and industry to standardize communications interfaces for smart sensors. We are seeking to establish a wireless framework based on protocols such as the emerging wireless data communication standard IEEE 802.11 WLAN Standard or defacto standards such as the Blue Tooth initiative. Hence, we solicit proposals for the development of smart sensors with communication protocols, such as those mentioned above, that can measure acceleration, air and fluid flow, temperature, pressure, vibration, etc. These ambient-powered, wireless, network smart sensors should be easily integrated with the proposed IEEE P1451 family of standards. It is recommended that the proposing party be thoroughly familiar with the proposed IEEE P1451 family of standards. Copies of the standards and draft documents can be obtained from IEEE at 1-800-678-4333.

Expected Phase 1 results are thorough study of the state of the art of the technologies and a design of an ambient-power wireless smart transducer with self-identification capability according to the IEEE 1451.2 TEDS. It is expected that a Phase 2 effort will result in the construction and demonstration of a prototype suitable for commercial application.

8.10.3T Subtopic: Development and Integration of Condition-Based Maintenance Technologies

Improved maintenance programs are often overlooked as an incredibly powerful way of increasing a manufacturing facility's profitability. These profits can be realized in part by taking maintenance programs from a reactive or time-based approach to one that is based on determining the condition of equipment and estimating its remaining useful life. Such condition-

based maintenance programs require the development of technologies that go beyond diagnosing equipment problems, but instead monitor the equipment and continually access its health.

To address the developmental needs of new technologies for condition based maintenance, proposals should address one or more thrust areas deemed necessary for the promotion of prognostication capabilities. These thrust areas are: developing capabilities to predict, and to continuously refine the prediction of, remaining useful life of equipment (failure models, new statistical tools for prediction, data correlation for multiple monitoring systems, reduction of data to useful information); new sensor technologies (smaller, inexpensive, and able to be built into equipment for continuous monitoring); and expert systems for maintenance-related knowledge and advice (integration of condition-based maintenance technologies with existing computer-based maintenance programs, procedures, history, and training).

8.11 NIST TOPIC: INTELLIGENT CONTROL

8.11.1T Subtopic: Component-based Open Architecture Control for Inspection

Open architectures and component-based systems are characterized by logically defined software and hardware components with clearly defined interfaces, allowing plug-and-play and third party component development. Users clearly benefit from open architectures and component-based systems, since it encourages competition, eventually driving down cost and increasing availability. Smaller vendors also benefit, since it allows them better access to existing markets. However, systems for coordinate measuring machines (CMM) are largely closed and proprietary. The controllers for these systems are especially closed. Controllers are normally developed totally in-house and if third party hardware or software exists within the controller, it is inaccessible within the controller "black box."

In the first phase of this SBIR, the awardee would work with NIST Intelligent Systems Division (ISD) researchers to design an open architecture controller for a commercial CMM. It must use the NIST RCS architecture as specified in a variety of publications (e.g., NISTIR 5994) and particularly as instantiated in the NIST ISD's current component-based CMM controller. It must specify a control system development tool (preferably off-the-shelf) that produces component-based output with clearly defined interfaces between subsystems. The subsystems will be defined based on the above mentioned NISTIR. The new controller system must allow and demonstrate plug-and-play with (including but not limited to) standard motion control cards, standard off-the-shelf controllers, trajectory generation software, and PID and model-based controller software. The controller will employ NIST ISD's (Neutral Messaging Language) NML communications facility (specified in <http://www.isd.nist.gov/projects/rcs_lib/>) for any distributed communications required or some similar alternative. The Phase 1 effort will culminate with a realizable system design specification.

In the second phase of this SBIR, the awardee would work with NIST Intelligent Systems Division (ISD) researchers to build and demonstrate the open architecture controller for a commercial CMM specified under phase one. The completed system will meet or exceed the state-of-the-art in industry for CMM motion control and clearly demonstrate market advantages of the open architecture approach. The final system will fully exercise the motion capabilities of the CMM while performing a challenging measurement task on a real part. Plug-and-play capabilities will be demonstrated, at least, as follows: (1) use of two types of control components (e.g., PID and fuzzy); (2) use of two types of motion control boards; (3) use of two types of trajectory generators; and (4) open documentation of all critical component interfaces.

8.11.2T Subtopic: Simulation and Animation Tools Supporting RCS Control Systems Development

The NIST Intelligent System Division (ISD) has been conducting research in intelligent systems and developing the Real-time Control System (RCS) reference model architecture for about two decades. This work is aimed at developing a theory of intelligence, advancing the state-of-the-art in intelligent control, and providing and open-systems framework for investigating proposed interface standards and performance metrics. The Intelligent System Architecture for Manufacturing (ISAM) and 4D/RCS are two instances of RCS targeted for the manufacturing and autonomous vehicle control systems domains, respectively.

NIST ISD has embarked on a generic shell approach to facilitate development of 4D/RCS and ISAM applications. This approach entails development of a toolset, written in C++ code, following the generic architectural principles of the RCS model. The toolset provides facilities for developing and integrating application specific control and knowledge algorithms and task entities to form a complete working controller. The RCS generic shell software also contains embedded communications functions that are mostly transparent to the end users. An extensive library of existing RCS software and documentation is available for downloading from our web page.

ISD seeks software simulation and animation tools to augment the RCS generic shell software libraries. Simulation and animation (S&A) tools are needed to facilitate design debugging and testing of controller applications developed using the RCS generic shell toolset. The S&A toolset should seamlessly interface with RCS controller modules built using the generic shell approach at every level of the RCS hierarchy. The S&A toolset should complement the RCS principles of: hierarchical structure, openness, modularity, standard interfaces, and levels of granularity in time and space. The S&A toolset must support concepts that enable real-time applications, such as events, times, and ordering of such. Graphic animation rendering tools for human visualization of the design behavior can be regarded as separate from the simulation algorithms. Design of the S&A toolset is the primary task for this topic. Development of the S&A algorithms is beyond the scope of Phase 1.

Key desired capabilities of the S&A toolset include computability with the RCS generic shell toolset, support for multiple levels of resolution (i.e., different time scales and spatial spans), openness, modularity, ease of use, and the ability to evolve its functionality over time. The S&A toolset should be capable of interacting with a hierarchical control system application at all the control levels. Some brief examples follow. When testing a control system at the lowest level, the S&A toolset should be able to receive the actuator controller output signals, compute the actuator movements, and graphically render its movements in simulated real-time. These simulated movement values should be integrated in the hierarchically structured simulator to form high-level system perceptions, such as machine or vehicle positions and motions. The simulation results are fed back to control hierarchy via simulated sensors, as a part of the control system. Simulation interfaces that interact with higher levels of abstraction in the controller should also be supported. For example, at the RCS subsystem level, the simulator should be able to receive the corresponding controller output commands, such as kinematic path waypoints for robotic arms or intelligent autonomous vehicles. The simulator should then be able to compute the kinematic effects of the commands, generate the responses, and also integrate the responses at higher levels of the simulator hierarchy to form corresponding perceptions. At the same time the animator should be graphically rendering the machine motions being simulated in simulated real-time on a computer graphics monitor.

A key to the development of open and modular S&A software is the Application Programmers Interfaces (API) development. The S&A toolset should support multiple-level interactions with an RCS control system in real-time. Using the toolset to develop an S&A application will require characterization of the application domain, and development and integration of the S&A application modules--using the API set--with the corresponding RCS control modules at appropriate hierarchical control levels within the controller.

Simulation software developed using the S&A toolset should be modular in the sense that the algorithms for computing the physical entity responses will be separate from those for graphic rendering of such responses. The animation software should be graphical and either real-time or near real-time. The S&A applications software is modular also in the sense that the modules can be easily integrated, disabled, bypassed, or deleted from the system.

References:

Internet site: <http://www.isd.mel.nist.gov/documents/albus/Int_Sys_Arch_Manuf.pdf>.
Internet site: <http://www.isd.mel.nist.gov/documents/albus/demo3.pdf>.
Internet site: <http://www.isd.mel.nist.gov/projects/rcs_lib/>.

8.11.3T Subtopic: CAD-directed, Vision-based Pose Estimation and Part Recognition for Fixtureless Inspection and Setup Reduction

Automating part setup on coordinate measuring machines (CMM) would be a useful productivity enhancement to current systems. Part setup times could be significantly reduced if we were able to automatically recognize the part and determine its position and orientation (pose) accurately enough to then determine the pose precisely using a touch or scanning probe. However, there are several impediments to automating part setup. Besides the technical challenges, they include ease of use and cost. If the automation of part setup is to stimulate a significant productivity gain over manual operation, its ease of use and appropriateness for a variety of parts must be clearly demonstrated, all at a low cost. An obvious low cost solution without sacrificing richness of sensor data is to use single or multiple CCD cameras. These could be permanently mounted on the CMM arm or located somewhere else on the CMM, so that a variety of parts would be completely or largely in the camera's field of view. Measuring devices with combined touch probes and optical measuring devices exist, but they are probably too expensive or would require a much greater change in the product line of existing CMMs. Existing optical measuring devices are typically used to perform precise measurements in their own right and therefore have costly optics associated with them. Processing could be done using available PC hardware or inexpensive vision processing boards. An automated part setup system would also need to be CAD-directed, to enable ease of use. It would need to have sophisticated software that will transform CAD representations of the part (e.g., in a solid boundary representation format) into model features that can be used by the vision system to recognize the part and determine its pose.

In the first phase of this SBIR, the awardee would work with NIST researchers to develop the overall system design, as well as begin to generate algorithms for pose estimation, part recognition, and CAD file transformation. The awardee will utilize algorithms in the design already developed at NIST Intelligent Systems Division (ISD) (including a feature-based pose estimation algorithm). The system design will include (but not be limited to) a specification of the particular CMM to be used, vision processing boards, vision system development software, and algorithms for pose estimation, part recognition, and CAD file transformation. Any interfaces that will be needed to integrate hardware and software into the CMM system need to be clearly specified and a cogent defense made that any required interfaces are actually realizable. The system must be of demonstrably low cost (e.g., <15% additional over and above total cost of the CMM). Phase 1 will conclude with a complete and detailed specification of the system.

Phase 2 of this SBIR will conclude with a demonstration of a prototype system integrated into a real (not simulated) CMM. As stated earlier, the system must prove its cost-effectiveness. Several parts (at least two) of demonstrable ubiquity and varying size will be used in the demonstration. The prototype algorithms for pose estimation, part recognition, and CAD file transformation will be integrated into this demonstration and will not be simulated. A prototype

system demonstration for NIST ISD researchers will conclude phase two. Awardees must make a convincing and quantifiable case for the marketability of the Phase 2 system.

8.11.4T Subtopic: Closed-Loop Alignment of an Optical Resonator

The difficulty of manually aligning laser beams into optical resonators is an impediment to the routine application of many new spectroscopic measurements. This is particularly true of high-sensitivity cavity-enhanced laser absorption techniques for measuring gas phase concentration such as those based upon cavity ring-down spectroscopy. Although recent advances in mirror technology and solid-state cw laser systems have motivated the rapid development of these techniques, applications to-date are primarily limited to the custom-built laboratory systems. This is largely because of the difficulty in realizing and maintaining good coupling of laser light into optical cavities.

We seek the development of a generic scheme enabling closed loop control of the length and transverse mode structure of a high-finesse optical resonator (typically as high as $2x10^5$). The resonator will be a linear cavity (5 cm - 150 cm in length) illuminated by a single-mode cw laser beam of line width 100 kHz to 1 MHz. It is expected that the approach will involve active control of at least five degrees of freedom of the optical cavity, e.g., a pair of mirrors with two-axes of tilt and an axial translation of one mirror. An automated scheme for finding and maintaining the relative mirror orientation in such a way that a given transverse mode of the cavity (e.g., the TEM_{00} mode) is excited should be found. Also a locking method for ensuring that the cavity length be remain nominally resonant (on time scales of several hours or more) with a single-frequency cw laser beam is also required.

8.11.5T Subtopic: Omni-directional Traversing Probe for Mapping Flow in High Temperature Reactors

There is a need for an integrated traversing probe system for measuring simultaneously three components of instantaneous velocity and temperature in high temperature corrosive environments containing fuel droplets and soot particles. Although laser based instruments provide such data non-intrusively, these instruments are very expensive. Moreover, the region of interest may not be accessible for optical techniques. Desirable characteristics of the probe include the following: excellent temporal resolution, spatial resolution better than 3 mm, velocities of 0 (stagnation point) and greater (with the capability to handle the directional ambiguity in recirculation zones), capability to provide three components of instantaneous velocity over a wide range, capability to provide turbulent intensity measurements, materials compatible with high temperatures (up to 1600 C or more) and corrosive environments, operational in the presence fuel droplets and particulate matter (soot), ease of calibration, ease of operation, and robustness.

Phase 1 of this research should demonstrate the feasibility of developing and fabricating this omni-directional probe for in-situ spray combustion measurements, while Phase 2 would involve

prototype development and delivery of a system to NIST. It is expected that this system will find immediate commercial applications related to fluid dynamics, combustion, and chemical process industries.

8.11.6T Subtopic: Constitutive Equations for Lightweight Sheet Metal Forming

Increased use of lightweight materials in automobiles is essential to the achievement of PNGV goals for improved performance. The PNGV Manufacturing Team has identified reliable and predictable aluminum forming as one of the top five priorities in vehicle manufacturing needs. Industrial experience with lightweight materials is limited and the use of computer methods (for example, finite element analysis, FEA) to predict forming behavior is being actively pursued by industry to accelerate the transition from traditional alloys. FEA employs constitutive equations to relate stress and strain. However, for the large strains and nonproportional loading paths occurring during and after sheet metal forming, presently employed constitutive equations are inadequate. Advanced equations that more accurately predict the mechanical behavior of metal undergoing large strain plasticity need to incorporate internal state variables. We seek the development of equations incorporating, measurable, physically based state variables (for example, parameters describing dislocation structures). It must be demonstrated that effective techniques exist or can be developed for measurement of these variables and the internal state of deforming metals. Such an approach is likely to be useful in a variety of commercial applications ranging from the determination of residual stress to metal forming.

8.11.7T Subtopic: Software for Weld Sensing and Control

NIST has developed various technologies for sensing and controlling the gas metal arc welding process. These technologies have shown great promise in laboratory tests, but the software must be made more user friendly before the technology can be effectively transferred to industry. We are looking for a company to complete the software developments in preparation for commercialization. The ideal company understands the welding industry, welding software, and control concepts.

Computer programs need to be developed in the areas of: monitoring the weld quality from the current and voltage signals, control of the arc length rom, the current and arc light intensity, and elimination of contact tube melting by monitoring the current and wire feed speed. One or more of these software packages can be selected for development.

Interested parties should be aware that the NIST-developed technologies are covered by the following patents: Sensing of Gas Metal Arc Welding Process Characteristics for Welding Process Control, Prevention of Contact Tube Melting to Arc Welding, Methods for Welding Cryogenic Alloys. The patents are available for non-exclusive commercialization licenses. Non-exclusive, royalty free research licenses are also available and have been previously granted to several parties.

References:

Madigan, R.B., T.P.Quinn, and T.A.Siewert, U..S. Patents 5,221,825, 5,349,156, and 5,514,851, and NISTIR 5037.

8.11.8T Subtopic: X-ray Optics for Spectrometers in X-ray Microanalytical Systems

The Microanalysis Research Group within the Surface and Microanalysis Science Division of the Chemical Science and Technology Laboratory of NIST has need for an x-ray optical component for focused beam analytical systems applied to advanced microanalytical problems, including materials, semiconductor devices, and environmental.

Optics to restrict the spatial extent of acceptance: When analytical x-ray spectrometry is performed in the important new class of environmental scanning electron microscopes, the inevitable spreading of the primary electron beam due to gas scattering severely degrades the spatial resolution. Spatial-filtering optics are needed to restrict the effective view of the semiconductor energy dispersive x-ray spectrometer. The semiconductor energy dispersive x-ray spectrometer is of the conventional type, with an active area of at least 10 square millimeters. Mechanical motion is available to adjust the distance between the spectrometer and the specimen from a closest approach of 5 millimeters to a maximum distance of 10 centimeters. A spatially-filtering x-ray optic which restricts the EDS view of the specimen to a spot with linear dimensions of less than 1 millimeter is desirable, with increasing value placed on even better spatial specificity, e.g., 100 micrometer dimensions would be highly desirable. An alignment method for positioning the filtering optic relative to the spectrometer and specimen should be developed along with the optic itself.

8.12 NIST TOPIC: INTELLIGENT AND DISTRIBUTED CAD

8.12.1T Subtopic: CAD and DMIS Integration of Virtual CMMs

A principal determinant of quality in the manufacturing of discrete-part products is the ability to manufacture and verify the conformity of machined part features. Additionally, measurement traceability requires the assessment of measurement uncertainty for all measurement results. Thus the rapid and efficient generation of both CMM inspection instructions and task specific measurement uncertainty statements is imperative. This solicitation seeks innovative flexible integrated manufacturing concepts to combine CAD based CMM inspection software capable of generating DMIS 3.0 output with virtual CMM simulation software capable of producing task specific uncertainty statements compliant with ANSI/NCSL Z540-2 1997. The result of this effort should yield a seamless software package capable of highly reliable collision free DMIS based CMM instructions and on demand task specific measurement uncertainty statements for any feature or GD&T analysis included in the DMIS output.

Both the CAD directed inspection and the virtual CMM simulation should be capable of modeling real industrial conditions, including (but not limited to) many different types of CMMs, probes, probe heads, sampling strategies, environmental factors, operator effects, and the myriad of errors present in manufacturing and measuring equipment. The software should be based on data that is practically and economically obtainable in an actual factory environment. This includes the ability to generate inspection programs and produce task specific uncertainty statements for parts defined in any of the common CAD or solid model representation currently in industrial use. The system should be capable of operating on standard Win 95/NT type computer platforms.

8.12.2T Subtopic: Green Engineering Concepts for Next Generation Vehicles

Environmental regulations on CFC and HCFC's have put considerable pressure on automotive designers to develop newer designs of air conditioning systems. The use of carbon dioxide as a refrigerant is not new. At the turn of the century most refrigeration systems were carbon dioxide based and more compact freon-based systems eventually replaced them. Currently, there is considerable interest in carbon dioxide based systems. By going to higher pressures, it has made carbon dioxide as a more effective refrigerant. The use of carbon dioxide as a refrigerant would be a great boon to the environment. Carbon dioxide costs 1/ 100th the cost of a non-ozone depleting freon and is readily available everywhere. More importantly, it does not require any great freon capture machinery in an automotive garage. There are other such examples of design for the environment. However, the big issue is the engineering design. Proposals are solicited that will utilize advanced CAD tools (such as network-centric CAD, novel design exploratory tools) for developing designs that will not only be simple, but easy to manufacture taking into consideration the life cycle concerns of the product.

8.12.3T Subtopic: Manufacturing Data Exchange Standards Interoperability Testing Tools

Manufacturers attempting to solve Computer Aided Design (CAD) and Computer Aided Engineering (CAE) interoperability problems through use of the international Standard for the Exchange of Product model data standards (STEP) require objective technical means to assure the compatibility of commercial software applications. Similarly, commercial software vendors, seeking to satisfy their customers, seek the capability to test their STEP implementations during the development cycle. Software deployment pilot programs are an effective means to test implementations to information exchange standards. However, test pilots can not be effective unless tools are available to isolate sources of exchange errors. Once isolated, translator errors and incompatible interpretations of a specification may be rectified in order to improve the capability of the participating implementations.

NIST is soliciting proposals to provide the technical infrastructure tools necessary to support STEP implementation interoperability testing trials and to realize STEP conformance testing services. The focus of this effort is in the following areas:

Computer Aided Design to Computer Aided Manufacturing – Numerical Control (NC) for Machine Tools.

Computer Aided Design to Computer Aided Engineering – Finite Element Analysis (FEA).

The result of this effort shall be reference test case data and test metrics for exchange testing as well as software tools capable of validating that neutral exchange data meets the requirements of the specified standard.

8.13 NIST TOPIC: INFRASTRUCTURE FOR DISTRIBUTED ELECTRONIC COMMERCE

8.13.1T Subtopic: Compact Oscillators with High Stability

There are a number of standards and telecommunications applications requiring oscillator performance that is beyond that achievable with quartz devices, yet cannot justify the large size and high cost of devices such as hydrogen masers, superconducting oscillators, or cooled-sapphire oscillators. As one example, the performance of advanced atomic clocks (optically pumped clocks, fountain clocks and ion clocks) is now well beyond that which can be supported adequately with a quartz device as the local oscillator. In another example, quartz oscillator performance is not adequate for maintaining network synchronization within new generations of cell-phone systems. There is need for improved performance in both the very short term (1 second to 1000 seconds) and the intermediate term (1 hour to several days). The best quartz technology achieves a stability (Allan variance) of about 1×10^{-13} at 1 second and remains flat out to several hundred seconds. The large drift associated with quartz oscillators and conventional rubidium oscillators makes them unsuitable for use in the intermediate and long term. Proposals should emphasize innovative concepts that result in improved short-term stability and dramatically reduced drift that is normally associated with systematic effects.

8.13.2T Subtopic: Secure Agent Toolkit

Mobile software agents, capable of acting autonomously and cooperatively on behalf of individuals and organizations, are well suited for electronic commerce in many areas, including Electronic Market Places, Electronic Auctions, Brokering and Trade-mediating Services, Virtual Trading Institutions, Network-based Tendering and Procurement, Agent-based Negotiation, and Agent-based Contracting. The power of mobile agents in conducting such transactions, however, is offset by privacy and security concerns. These concerns are one of the main obstacles that is limiting the use and adaptation of this new technology. While many security techniques specially adapted for agent security, such as sliding encryption, partial results encapsulation, and path history recording, have been developed recently, their widespread use and availability in the marketplace is absent. The goal of this effort is to develop an innovative toolkit that enables developers employing mobile agent technology to readily incorporate the appropriate and optimal protection techniques into their applications.

8.13.3T Subtopic: Infrastructure for Interoperable MPI (IMPI) Parallel Algorithms

We solicit an algorithm tuner for parallel algorithms written with the Interoperable Message Passing Interface (IMPI) Protocol. The definition of the protocol standard is at <http://impi.nist.gov/IMPI/>.

Inter-client and inter-host communications may be significantly slower than communications between processes on the same host. The IMPI protocol specifies attributes defined on communicators as a way of providing information useful for tuning algorithms. The algorithm tuner should use these communicator attributes to provide a general mechanism to tune a broad spectrum of algorithms in a variety of computational circumstances from networks of heterogeneous workstations to homogeneous shared memory processors to admixtures of these. Ideally, this tuner should be able to tune at run time as well as at compile time.

8.13.4T Subtopic: Network Interface for IP-over-WDM

Wavelength Division Multiplexing (WDM) networks have been widely deployed to meet the increasing bandwidth demand of Internet traffic. A common network architecture to carry the Internet traffic is the Asynchronous Transfer Mode (ATM) network in which Internet Protocol (IP) packets are segmented into ATM cells and multiplexed by the Synchronous Optical Network (SONET) protocol before being transported by the WDM system. The Internet Engineering Task Force (IETF) developed an alternate approach, called Packet over SONET. This alternate approach encapsulates IP packets in Point-to-Point Protocol (PPP) frames before multiplexing by SONET and transmission over WDM. The industry is interested in other techniques to carry IP directly over WDM networks. Examples of such alternatives are the use of the Simple Data Link (SDL) protocol[1] to replace SONET, and the use of an optical subcarrier or separate optical control channel for framing and routing. In addition, innovative wavelength assignment and routing methods could be developed to take full advantage of a WDM network.

The goal of this effort is to design and then produce a network interface card for the Peripheral Component Interconnect (PCI) bus on personal computers, such that a low cost test network could be constructed to conduct experiments and to evaluate performance of various alternatives. The desired capabilities of the interface card include:

1. Transfer data through the PCI bus at its maximum throughput rate.

2. Support external input/output rate up to OC-12 rate, using either optical or electrical interface.

3. Use an onboard processor and memory for packet-header processing and for payload forwarding.

4. Use of a special purpose chip, such as Lucent's TDAT04622[1] to assist framing of packets.

5. Use of NIST Multikron measurement chip[2] for instrumentation.

As an integrated part of the proposal, the software drivers for major components of the card must be developed. Furthermore, a cost comparison needs to be provided on alternatives for an interface to control the external optical components. Specifically, direct optical input/output must be compared against electrical input/output.

References:

<http://www.lucent.com/micro/tic/ds3e3.html>
<http://www.multikron.nist.gov/multikron.html >

8.13.5T Subtopic: Development of Techniques for Automated Security Testing

Security Testing is a complex and expensive process and any technique that will fully/partially automate this process will have great payoff in terms of cost and turnaround time. Since there is no uniformity in the software engineering (SE) process that has been used to develop the delivered software of different vendors, the techniques for automating security testing have to be based on the end products of the SE process. These constitute the software itself, the associated documentation (user & system), the functional specifications, and the design documents (both high level and detailed).

Examples of the developed security testing techniques are: (a) use the detailed design and functional specification documents to develop a formal specification of security properties and testing specifications, and use a suitable code generator tool to convert these formal security test specifications into testable code that can run against the product API; or (b) use of the reverse engineering technique of slicing – where sections of the code relating to a particular security property can be extracted as well as testing code generated as an integral part of this process. Other, innovative techniques to automate the generation of security tests are acceptable and encouraged. Whatever the technique used, it should have the following three characteristics: (1) it should answer the research questions needed to partially/fully automate the process of security test code generation, (2) it should be based on the software vendors' end products and (3) it should be economically justifiable.

8.13.6T Subtopic: Mathematics on the World Wide Web

NIST is making increasing use of the World Wide Web to deliver scientific reference data to the public. Much of this data has significant mathematical content, such as limits, integrals, differential equations, matrices, etc. Current technology for representing and displaying such content in HTML documents is both primitive and inefficient. New and emerging standards, such as XML, MathML, XSL, and OpenMath, promise to greatly improve this situation. However, this will not occur unless stable and robust production-quality tools are available to convert existing content to new Web-based standards, and to effectively display the resulting mathematical content directly in widely available Web browsers. Thus, we seek research and development leading to production-grade tools to do the following:

(a) Convert arbitrary math-intensive LaTeX input files to MathML/OpenMath. Such tools should be configurable by the user, allowing considerable control over the type of markup generated from LaTeX constructs and macros.

(b) Display the full range of MathML/OpenMath files in existing commercial Web browsers.

(c) Allow cut-and-paste of MathML/OpenMath equations from Web browsers into LaTeX documents, computer programs (Fortran, C, and Java), and mathematical computation systems such as Matlab, Maple, and Mathematica.

Such tools are intended for use in the NIST Digital Library of Mathematical Functions project at <http://math.nist.gov/DigitalMathLib/>.

8.13.7T Subtopic: Application-based Intrusion Detection Techniques

The ability to detect signs that an information attack is taking place is crucial for protecting any information resource. Current approaches to intrusion detection identify intrusions by either computing deviations from expected statistical profiles or by performing pattern matching against known methods of attack. These approaches work primarily at the operating system level and at the network level, providing little help with intrusion detection at the level of applications such as the DBMS. In the DBMS, the problem of detection is particularly difficult, since it involves detecting that data inserted or updated in the database is unreasonable or incorrect. To detect attacks against the DBMS, we need techniques that will perform data characterization. To perform this task requires a data modeling methodology that incorporates constraints/rules that specify acceptable data transitions. These constraints may involve data integrity constraints (general and domain specific–including the concept of valid transactions, etc.) as well as data access constraints. The research challenge is to develop a generic methodology that will help in the formulation of a data characterization model that can then be used as the basis for detecting information attacks on the domain specific data repositories under the control of DBMS applications.

8.13.8T Subtopic: Role-Based Authorization Policy Toolkit

Role-based access control (RBAC) is a promising technology for managing and enforcing authorization in large-scale enterprise and cross-enterprise systems. RBAC has received considerable interest from vendors and users. It is supported in a variety of commercial-off-the-shelf (COTS) products. RBAC itself is policy-neutral and can be configured to enforce a wide range of security policies. To use RBAC effectively in large-scale systems, security administrators need to articulate organizational authorization policy by configuring various components of RBAC and mapping these to COTS products. In particular, this requires the design of role hierarchies and constraints such as mutually exclusive roles. There is a need for tools to help security administrators carry out this design and evolve it as the system evolves. The tools must have a strong formal foundation to provide effective security, but also have an easy to use and intuitive visual interface to make them usable without extensive formal training.

The goals of this effort are to:

(a) define a formal role-based language for specifying authorization policy,

(b) demonstrate the richness of this language by specifying a wide range of policies in it,

(c) define and prototype a visual GUI-based language as a front-end to the formal language, and

(d) identify how such a tool would interface with COTS products that it is used to configure.

8.13.9T Subtopic: XML for Workflow Management

The increasing prevalence of virtual enterprises is driving a need to coordinate the efforts of individuals and teams using different computer platforms residing on different local area networks. Such coordination often requires the exchange of complex data objects between distributed applications. The Web has become a popular computing environment for virtual enterprises because it allows users on heterogeneous platforms to use the same applications and access the same data. The emerging XML standard provides a convenient and cost-effective way to define structured data objects that will be shared among distributed tasks and applications on the Web.

NIST is soliciting proposals for the application of XML and Web technology to workflow management systems. The result of this effort shall be the development of a software tool-kit for building Web-based workflow applications employing XML as means for data exchange. The only software required of end users to run workflow applications developed using the tool kit shall be a Web browser that supports XML.

References:

<http://www.w3.org/XML/>.
<http://www.aiim.org/wfmc/>.

8.14 NIST TOPIC: MEASUREMENT AND STANDARDS FOR COMPOSITE MATERIALS

8.14.1T Subtopic: Nondestructive Evaluation of Microstructure in Graphite/Glass Hybrid Composites

Polymer matrix composites reinforced with a combination of both glass and graphite fibers are increasingly finding applications in civil infrastructure and offshore oil applications. These hybrid composites combine the high performance of graphite with the low cost of glass to achieve a very advantageous mix of properties and price. To produce optimum materials, however, the fibers must be combined in the proper way. For example, a high percentage of the fibers in the highly loaded regions of a part should be graphite while regions with low loading should be high in glass fibers. Details of how the fibers are mixed, orientation of the fibers, and void content are also important. Since there materials are relatively new, little is known about application of nondestructive evaluation (NDE) to determine structural features like fiber mix, fiber content, fiber orientation, voids, etc. A variety of NDE techniques might be applicable to this problem including radiography, thermoelastic measurement, microwave techniques, and eddy current methods. The awardee is expected to assess the state-of-the-art in NDE techniques as applied to this problem and select the approach with the greatest potential. The feasibility of this technique should then be demonstrated with tests on selected hybrid materials.

8.14.2T Subtopic: Tensometer for Measurement of Stress Developed During Polymerization

The goal of the SBIR proposal will be to produce a prototype tensometer for measuring stress developed in a composite resin during its photo-initiated polymerization. Stress developed due to polymerization shrinkage is a major concern in photonics, as well as dental composites.

8.15 NIST TOPIC: MEASUREMENT AND STANDARDS FOR MEMBRANE MATERIALS

8.15.1T Subtopic: Reference Materials and Resolution Test Patterns for Characterizing Scanning Near-field Optical Microscopes

Near field scanning optical microscopy (NSOM) is a powerful technique for nanoscale optical characterization of materials. NSOM makes use of the properties of a sub-wavelength optical probe to exceed the diffraction limit in optical microscopy. Images are constructed by scanning the probe over a surface at distances much smaller than a wavelength of light. Contrast is

generated by way of a number of different interactions of the sample and probe, including such traditional optical contrast mechanisms as absorption, reflection, fluorescence, and polarization, and also new contrast mechanisms that are unique to NSOM, including dielectric contrast.

Probes currently in use for this purpose include single mode glass optical fibers drawn to a fine point (about 50 nm) and usually partially coated with aluminum, and small metallic scatterers. Probes can be used either for collection of light or for illumination of the sample. Resolution in NSOM depends on the size and efficiency of the probes, and is intimately tied to the contrast mechanism used. No standard techniques or materials exist for determining the resolution and characterizing the contrast mechanism of these probes.

NIST is seeking suitable reference materials and resolution test patterns to determine the resolution, and characterize the contrast mechanisms of near-field probes. Suitable materials will have nanoscale optical features that have little or no topography, and will be useful for characterizing probes that are used in reflection, absorption, polarization, fluorescence, or dielectric contrast.

8.15.2T Subtopic: Application of Radionuclides to Nanoscale Porosity Characterization

Filters and membranes with extremely small pore sizes (tens or hundreds of Angstroms) have been used extensively in biomedical and physical fields of research and have potential use in a variety of applications including high selectivity in the separation and purification of waste water and air. In biomedicine, filters of various materials are utilized during purification and concentration steps through such diverse applications as particulate removal, dialysis and degassing. In tribology and material sciences, membranes have found a vital role in both liquid and gas phase filtration. In fact, potential applications of particularly small pored membranes (smaller than ten Angstroms) would have direct use in the studies of finite size effects and catalysis. Pore sizes of five to 10 Angstroms would be useful in gas filtrations where diatomic gas molecules (between 0.75 and 5.5 Angstroms in diameter) need to be filtered from molecular clusters of greater diameter. Additional applications would arise once suitable methods for porosity characterization are developed. Unfortunately, at this time, the determination and standardization of very small pore diameters is limited by a lack of appropriate tracers.

The sizes of the radioactive molecules must be accurately measured through possible experimental techniques such as High Resolution Transmission Electron Microscopy (HRTEM), Scanning Tunneling Microscopy (STM), and neutron diffraction. Tracing radiolabelled molecules with various detection systems (phosphor plate imaging, MultiPhoton Detection, autoradiography, etc.) as they flow across a porous membrane would allow characterization of pore sizes in the molecular range to an accuracy of tenths of angstroms, by determining the maximum sized molecules that will successfully pass through the membrane. It is possible to simultaneously introduce several different sized molecules into a porous system if they are doped with isotopes of different emission character yielding a “multicolored” system. The use

of several radioisotopes emitting different energies or having different half-lives linked to molecules of various sizes would make a “multicolored” system where size-dependent transmission and blockage could be observed simultaneously. The successful production and subsequent application of such multicolored radioactive molecules to membrane studies would constitute a significant advance in the field of porosity characterization.

This work complements the Physics Lab research programs involving several aspects of nuclear medicine, including investigations of novel delivery and purification methods of radiopharmaceuticals on the nanoscale level. Research at NIST has focused on the production, purification and standardization of various radioactive isotopes with direct applications in nuclear medicine on a macroscale level. This research will lead to alternate purification systems, to be used *in vitro* and *in vivo*, of various radioisotopes used in medical imaging, diagnosis, and, potentially, cancer treatment.

8.16 NIST TOPIC: MICROELECTRONICS MANUFACTURING INFRASTRUCTURE

8.16.1T Subtopic: Co-axial Atomic Force Microscope Probes for Electrical Measurements

A number of scanning probe microscopes combine an atomic force microscope (AFM) with an electrical measurement. These include the Scanning Capacitance Microscope (SCM), the Scanning Microwave Microscope (SMWM), and the Electrostatic Force Microscope (EFM). These techniques depend on a conducting AFM cantilever probe tip. The spatial resolution of these microscopes is limited by the electrical field spreading from the curved terminal tip and the sidewalls of the tip. This effect becomes more pronounced at higher measurement frequencies. One approach to improving the spatial resolution would be to use coaxial tips so that the tip sidewalls are electrically shielded from the sample.

We are seeking proposals to develop novel approaches to fabricate co-axially shielded AFM cantilever probe tips suitable for high-frequency electrical measurements (to 20 GHz). The desired probe structure consists of an inner conductor terminating in an ultra sharp tip, a dielectric insulating layer surrounding the inner conductor, and an outer, grounded shield conductor. Both conducting parts of the probe must be accessible to outside electrical conduct. Probes suitable for both contact and non-contact mode of AFM operation are of interest. The tips must be highly conductive (metallic) and ultra sharp. Tip radii to less than 5 nm are of interest. The sharpest part of the tip should be resistant to wear in contact mode and perhaps strengthened by the surrounding co-axial insulator. To achieve significant shielding the outer conductor must extend close to the terminal tip. The most significant electric field spreading occurs from the last 100 nm of tip sidewall. The proposed cantilever tips should be suitable for use in commercial AFM/SCM/EFM systems. Processes capable of economical batch production are preferred to single probe fabrication methods.

A successful Phase 1 contract will require: (1) design of a cantilevered, coaxial, conducting AFM tip with improved spatial resolution for high-frequency electrical measurements that has been validated through simulation and measurement; (2) demonstration of the critical fabrication processes necessary to produce these tips; and (3) production of a prototype tip.

8.16.2T Subtopic: In-Situ, Closed-Loop Control of Semiconductor Epitaxial Deposition

A major challenge to the implementation of in-situ growth probes for semiconductor manufacturing is the development of technology to take the output of in-situ monitors and sensors to control important growth parameters in an active, real-time manner. An additional constraint on intelligent epitaxial control deals with the algorithms required to combine inputs from more than one sensor to control the same growth parameter.

The development of these technologies for this national critical technology will help ensure the growth capabilities required for next-generation optoelectronic and semiconductor applications. These commercial applications include the manufacturing of high speed hetero-bipolar transistors (HBTs) as well as psuedomorphic high electron mobility transistors (pHEMTs) for wireless applications in addition to lasers for optical transceivers. The content of the proposal should detail a technical strategy for developing a process that will take output from a particular growth parameter (e.g., temperature, composition, beam flux, lattice parameter) and use this output, in a closed loop fashion, to control a critical parameter of the deposition process. This parameter could be sample temperature, source flux, effusion cell temperature, or gas flow rates for MOCVD and/or MBE processes. The technical strategy should contain clear provisions for demonstrating the final structure quality with, and without, in-situ closed loop control.

References:

Roth, J.A., T.J. de Lyon, and M.E. Adel, presented at Diagnostic Techniques for Semiconductor Materials Processing Symposium, Boston MA Nov. 29 – Dec. 2, 1995.

Johnson, S.R., C. Lavoie, T. Tiedje, and J.A. MacKenzie, J. Vac. Sci. Technol., B11, 1007, 1993.

8.16.3T Subtopic: Materials and Device Technologies for Next Generation MMIC Devices for Wireless Applications

Microwave and millimeter wave integrated circuits (MMICs) are of increasing importance in wireless communication systems. Current trends are toward low cost, high density, multilevel and multifunctional integration. Research on testing and measurement techniques, as well as material and fabrication technologies, are being directed to meet these challenges.

This subtopic covers several areas of interest to MMIC device manufacturers: innovations to improve the quality of material supplies to Gallium Arsenide (GaAs) Fabs, as well as manufacturing challenges for hetero-bipolar transistors (HBTs) and psuedomorphic high electron mobility transistors (pHEMTs). Technologies to reduce turn-on voltages, improve power-added-efficiency, high linearity, and high output powers, are appropriate proposal topics. Because the turn on voltage is fundamentally limited by the base material energy bandgap for HBTs, proposals that deal with improving the epilayer quality through pre-growth, real time, and post growth methods are expected to make significant contributions.

Other areas include materials issues to improve the reliability of HBTs and pHEMTs and 3-D GaAs MMIC technology for high frequency applications.

References:

Das, N.K. and H.L. Bertoni, editors, "Directions for the Next Generation of MMIC Devices and Systems," Edited by, Plenum Press, New York, 1997.

McQuiddy, D. N. et al., "Monolithic Microwave Integrated Circuits: A Historical Perspective," IEEE Trans. Microwave Theory Tech., Special Centennial Issue, 32: 991, 1984.

8.16.4T Subtopic: Radiometric Temperature Measurement Facility for Electronic Processing

Accurate temperature measurement and control of semiconductor materials undergoing high temperature (800 K to 1400 K) processes are critical for achieving desired electronic properties. Radiometric (optical) methods of temperature measurement are the preferred sensing approach allowing easy optical access to the target without complications to the process environment, comprised of the target (wafer) and surrounding chamber. Two essential and demanding requirements of the thermal processor are uniform heating (within 0.25 K) and temperature uncertainties less than 2 K (3 standard deviations). Features of practical thermal reactors (and test facilities) that confound meeting these requirements include uncertainty in the target optical properties, optical properties and geometric arrangement of the surroundings, temperature distributions over the target and surrounding surfaces, stray radiation from heating lamps, and heat leakage from contact sensors used for calibration/test purposes. Radiometric sensors useful for these applications include spot-type, scanning, and optical-fiber/light-pipe radiometers. Using the new NIST thin-film thermocouple technology, target temperatures can be determined with uncertainty less than 1 K traceable to the International Temperature Scale (ITS-90). For further background, respondents are referred to the Material Research Society series Rapid Thermal and Integrated Processing, Volumes 1 to 7.

NIST has undertaken the responsibility for developing test methods and standards for temperature measurement in rapid-thermal processing environments. Proposals are sought for development of a test facility to evaluate innovative radiometric temperature measurement

methods in these environments. The simulated environment will include the target material, process chamber (hot or cold) wall, and guard surfaces. The planned project should demonstrate methods to address the central problem of calibrating radiometers referenced to thin-film thermocouples with consideration to uniform and controlled-heating of the wafer, to characterization of the radiation environment, including target emissivity effects and non-isothermal surroundings, and to determination of the temperature distribution across the target. It is anticipated that the test facility for temperature measurement will be constructed and delivered in Phase 2.

8.16.5T Subtopic: Advanced Ion Beam Methods for Nanotechnology

Ion beams are used in various subdisciplines of nanotechnology, including: microelectronics (implantation, lithography, mask repair, failure diagnostics, etc.), biotechnology (production of nano-scale pores for drug delivery, biosensors, etc.), and photonics (production of flat panel displays, diode lasers, optical waveguides, etc). NIST is seeking proposals for innovative ways to produce and apply exotic ion beams for use in the general area of nanotechnology. Work should be geared towards new methods rather than incremental improvements in established techniques. Proposed research should contain a component which considers how increasing the charge on an individual ion to very high values would influence the results.

References:

Sealy, B. J., P. L. F. Hemment, "Ion Beam Techniques in Microelectronics." Nucl. Instrum. Meth. Phys. Res. B, 89, 298, 1994.

Reber, N., et al, "Thermal Switching of Grafted Single Ion Tracks." Nucl. Instrum. Meth. Phys. Res. B, 105, 275, 1995.

Polman, A., et al., "Ion Beam Synthesis of Planar Opto-electronic Devices." Nucl. Instrum. Meth. Phys. Res. B, 106, 393, 1995.

Gillaspy, J.D., D. C. Parks, and L. P. Ratliff, "Masked Ion Beam Lithography with Highly Charged Ions." J. Vac. Sci. Technol. B, 16, 3294, 1998.

8.16.6T Subtopic: Measurement of Trace Alpha-Radiation in Polymeric Microchip Material

Electrical breakdowns in microchips have been observed for over 10 years. Alpha particle emissions from materials used in the assembly and packaging were determined as the sources that triggered many of these effects. The problem is even more critical in the latest, denser generation of microchips that incorporate polymeric materials into the chip itself. The Semiconductor Industry Association in its 1997 National Technology Roadmap for Semiconductors has expressed that a measurement of the trace radioactivity in this type of

materials is a prerequisite to the improving of wafer bumping and the development of new flip chip technologies. This program will be a part of the NIST wide effort to meet the highest priority measurement needs of the semiconductor industry.

The microchip manufacturer has questioned estimates by the polymer manufacturer of the degree of contamination. A reliable methodology is needed to provide certified measurements of this type of materials for alpha particles emitted per unit volume per day. Proposals are being sought to develop an innovative and cost-effective technology capable of measuring alpha activities at or below the environmental level. The potential impact of a solution to this problem could be very large commercially and would provide a means to test procedures that would greatly improve the quality and reliability of microchips.

8.16.7T Subtopic: High Speed Magnetic Materials For GMR/SDT Applications

This solicitation seeks to develop fast switching magnetic materials used in Giant Magnetoresistive (GMR) and/or Spin Dependent Tunneling (SDT) applications. In the past several years, the speed of fast electronics has been driven into deep sub-nanosecond regime, yet the speed of the magnetic materials used in GMR and SDT applications are limited to less than a few nanoseconds under normal conditions. In order to keep pace with the fast electronics in making fast GMR and SDT devices, the magnetic materials used in these devices have to be greatly improved in terms of speed while maintaining other attractive properties. Although soft ferrite and garnet magnetic materials have been successfully used for microwave applications, they have yet to find their way in producing high quality GMR and/or SDT materials. New and innovative approaches are sought to achieve high speed switching of magnetic materials in GMR and SDT applications, either by using new magnetic materials in these structures or by innovative techniques to achieve sub-nanosecond switching speed. Proposers need to address the compatibility of these new magnetic materials with other layers in GMR and SDT structures. Serious proposers should address all the fundamental resonance frequencies of the magnetic materials, and ways to either make them higher, make use of them in a controlled way, or avoid them totally. The final results after the Phase 2 will be GMR or SDT structures with comparable static properties as the state of the art but with a switching speed of less than 1 nanosecond. Potential applications for the high-speed magnetic materials in GMR and SDT materials are magnetic field sensors, isolators, magnetoresistive random access memory chips, and hard-disk read heads, each of which have large commercial markets.

8.16.8T Subtopic: Integrated Bias for GMR Devices

This solicitation seeks new innovations and improved techniques for fabricating low power magnetic sensors and read heads. Giant Magnetoresistive (GMR) materials are being used in the recording industry, in nonvolatile memory applications, and for magnetic field sensors. Their method of operation often includes the application of a biasing magnetic field, produced by a permanent magnet or current through a coil. Power consumption may be limited by the use of external or on-chip coils to produce the necessary magnetic biasing fields. Permanent

magnets offer one solution, but often increase the size and are problematic in placement. This solicitation would seek novel low power methods for biasing and operating GMR and related spin-dependent-tunneling devices. Useful approaches may include new methods of incorporating external permanent magnets, or innovative techniques of integrated thin-film biasing. Techniques could include, but are not limited to, novel uses of exchange biasing, orange peel coupling, or demagnetization effects such that would be affected by shape, size and orientations of the devices. The work could benefit many applications which use GMR materials or spin-dependent tunneling such as low field sensors, arrays of sensors, and recording read heads.

Reference:

Tondra, M., J. Daughton, D. Wang, and A. Fink, "Pico-Tesla Field Sensor Design Using Spin Dependent Tunneling Devices", J. Appl. Phys. 83, 6698, 1998.

8.16.9T Subtopic: Improved Magneto-Optical Indicator Films

The magneto-optical indicator film (MOIF) imaging technique is a non-destructive method for real-time characterization of magnetic domain structure for a wide range of technologically important magnetic materials such as spin-valves, ultrathin multilayers, and granular systems. The MOIF film is placed on top of a magnetic sample and has its magnetization altered by the magneto-static field of the sample under study. In this way, the domain structure of the sample under study is imaged in a polarizing microscope through the interaction of the polarized light with the MOIF film. The MOIF method is expected to become a standard non-destructive quality control imaging technique for the next generation of magnetic materials for sensors and storage devices. Proposals are solicited for the development of improved magneto-optical indicator films, including , but not limited to, transparent Bi-substituted yttrium-iron garnet single-crystal films (thickness 1-3 micrometers, Faraday rotation > 100,000 deg/cm) grown on a gadolinium-gallium garnet substrate with a high reflectivity underlayer. The influence of different element substitutions should be studied to enable different magnetic saturation values and coercivities to be fabricated.

Reference:

Gornakov, V.S., V.I. Nikitenko, L.H. Bennett, H.J. Brown, M.J. Donahue, W.F. Egelhoff, R.D. McMichael and A.J. Shapiro. "Experimental Study of Magnetization Reversal Processes in Nonsymmetric Valve." J. Appl. Phys. 81. (8) 5215.

8.16.10T Subtopic: High Speed/Low Power Magnetic Field Sensing Devices

This solicitation seeks to develop devices with fast response and low power consumption for a variety of magnetic field and electric current sensing applications, including nondestructive evaluation, magnetic remote sensing, telecommunications and more. The specific

requirements are 1 nanosecond or less response time, 1mW or lower power consumption, 100mV or above output signal with a low voltage source of 1V, a size of SO8 or smaller packaging, and operational at room temperatures or above. The eventual fabrication of the devices should be compatible with mainstream mass production, preferably using microelectronic processing. All types of new and innovative approaches which meet the above requirements are sought. One possible approach is the spin dependent tunneling devices using magnetic materials capable of high speed switching. Serious proposers should address both the fundamental properties for the materials as well as overall performance of the devices considering all aspects of the material/geometry/process designs, to present a coherent strategy in order for the device to meet the requirements.

References:

Moodera, J. S., L. R. Kinder, T. M. Wong, and R. Meservey, "Large Magnetoresistance at Room Temperature in Ferromagnetic Thin Film Tunnel Junctions," Phys. Rev. Lett. 74, 3273, 1995.

Daughton, J. M., "GMR Applications," JMMM, 192, pp 334-342, 1999.

Tehrani, S., J. M. Slaughter, E. Chen, etc. "Progress and Outlook for MRAM Technology," InterMag-99, paper GA-02.

8.16.11T Subtopic: Enhanced Specular Scattering to Optimize GMR Spin Valves

This solicitation seeks new innovations and improved techniques for enhancing specular electron scattering in giant magnetoresistance (GMR) spin valves. GMR materials are critical to hard-disk read heads for the recording industry and are becoming critical to many other applications for materials sensitive to magnetic fields, such as nonvolatile memory and sensors. Magnetoresistance ratios in GMR structures can potentially be increased through achieving specular scattering of conduction electrons at the outside surfaces of the structure. Innovative deposition techniques and/or the use of new thin film materials are sought which will enhance this effect and greatly enhance device signals by a factor of from two to five. Successful development will lead to improved magnetic field sensors, nonvolatile memory, read heads, and isolators, which are in total, multi-billion dollar commercial markets.

References:

Daughton, J. M. "Magnetoresistive Memory Technology", Thin Solid Films, 216 pp 162-168,1992.

Egelhoff, W. F. Jr., P. J. Chen, C. J. Powell, M. D. Stiles, R. D. McMichael, J. H. Judy, K. Takano, A. Berkowitz, and J. M. Daughton, "Specular Electron Scattering In GMR Spin Valves", IEEE Trans. Mag. 33, 3580,1998.

8.17 NIST TOPIC: MICROFABRICATION AND MICROMACHINING

8.17.1T Subtopic: Probes for Combined Near-field Scanning Optical and Atomic Force Microscopy

Near field scanning optical microscopy (NSOM) is a powerful technique for nanoscale optical characterization of materials. NSOM makes use of the properties of a sub-wavelength optical probe to exceed the diffraction limit in optical microscopy. Images are constructed by scanning the probe over a surface at distances much smaller than a wavelength of light. Contrast is generated by way of a number of different interactions of the sample and probe, including such traditional optical contrast mechanisms as absorption, reflection, fluorescence, and polarization, and also new contrast mechanisms that are unique to NSOM, including dielectric contrast.

Probes currently in use for this purpose include single mode glass optical fibers drawn to a fine point (about 50 nm) and usually partially coated with aluminum, and small metallic scatterers.

NIST is seeking aperture, waveguide (coaxial), or combination aperture/scatterer NSOM probes in a form that is compatible with atomic force microscopy (AFM). These probes should be useable as contact, noncontact, shear-force, or intermittent contact AFM probes, but should have the additional feature of a small subwavelength aperture or tapered waveguide structure for guiding and confining light. Waveguide or aperture probes with a small scatterer at the tip will also be considered.

8.18 NIST TOPIC: PHOTONICS MANUFACTURING

8.18.1T: Subtopic: In Situ, Noncontact Temperature Measurements of Compound Semiconductors During Epitaxial Growth/Processing

Accurate temperature control during compound semiconductor epitaxy is important for process reproducibility. During epitaxial growth of compound semiconductors by molecular beam epitaxy (MBE), the substrate temperature is usually measured with a single wavelength infrared pyrometer. Two-wavelength pyrometric systems are also commercially available. However, the lowest accurate temperature for most infrared pyrometers is 450EC. There are epitaxial regimes where this temperature range is not sufficient, such as low temperature growth of GaAs (LT-GaAs) that requires substrate temperatures between 150EC and 450EC. Furthermore, the emissivity of the growing sample changes as thin films are deposited since these films often cause interference patterns at the wavelength that the infrared pyrometer uses. Additional problems at low temperatures are caused by the transparency of the substrate at low temperatures. We are requesting proposals that demonstrate noncontact techniques that can accurately measure the temperature of a compound semiconductor wafer during epitaxial growth/processing. The preferred technique should be capable of measuring temperature from 150EC to 1000EC. The required accuracy is ±3EC and the required

precision is ±1EC. It is expected that follow-on Phase 2 work will demonstrate a prototype measurement system either at NIST or comparable facilities.

8.18.2T Subtopic: Actively Quenched IR Avalanche Photodiode

High efficiency stable photon counting devices are important for many areas of research ranging from optical metrology, low level sensing, cryptography, and communication. All of these areas have needs in the infrared where high quality detection is difficult to find. NIST is soliciting proposals to develop actively quenched compact photon counting modules for the spectral region from 1 to 1.5 microns or beyond with peak efficiencies of at least 50%. Such a unit would be similar to the Si APD based devices, which have recently become available, but would likely use Ge or InGaAs avalanche photodiodes.

The unit would employ an actively quenched bias circuit to reduce the avalanche recovery time, making counting rates of 1 MHz possible. The active area should be no smaller than 0.2 mm and have a dark count rate not exceeding 1 Khz. The units may use compact self-contained thermoelectric cooling to produce low dark counting rates.

8.18.3T Subtopic: Design and Construction of High-quality Brewster-angle Polarizers for the Infrared

Broadband polarizers with extinction ratios (defined as the ratio of transmittance of the unwanted polarization state to the correct state) of less than 10^{-5} over a wavelength region of 1 µm to 50 µm are important devices for extending the well-established metrology techniques of visible and near-infrared ellipsometry and polarimetry to longer wavelengths. In order to be most useful with available infrared spectrometers and detectors, a polarizer must exhibit reasonably high throughput (> 0.1), low scattering, and minimal beam deviation (< 0.1 mrad). To be compatible with commercial Fourier-transform infrared (FT-IR) spectrometers, polarizers must have a clear aperture of up to 75 mm.

Currently the only broadband polarizer designs capable of such low extinction ratio over the infrared spectrum employ Brewster-angle reflections from several dielectric plates. One such design using 4 Ge plates has been implemented at NIST. However, these devices have a clear aperture of only 10 mm, exhibit beam deviation of ~ 2 mrad, and have extinction ratios several orders of magnitude above theoretically predicted values. The construction of larger devices with lower beam deviation requires innovations in high-precision machining of lightweight materials, and/or robust optical alignment techniques. Also, improvements in the achieved extinction ratios will require not only highly accurate alignment, but also investigations of the effects of surface quality of the dielectric plates as well as the disposition of light transmitted into the plates. Proposals are solicited for design and construction approaches for such polarizers that would result in high-quality commercially viable products. Phase 1 results would be expected to include a mechanical design and construction plan, as well as delivery of a pair of prototype polarizers to NIST for testing and evaluation.

Reference:

Dummer, D.J., S.G. Kaplan, L. M. Hanssen, A.S. Pine, and Y. Zong, "High-quality Brewster's Angle Polarizer for Broadband Infrared Application," Appl. Opt. **37**, 1194-1204, 1998.

8.19 NIST TOPIC: SUPPORTING TECHNOLOGIES FOR SEMICONDUCTOR LITHOGRAPHY

8.19.1T: Subtopic: Detectors for Deep Ultraviolet Excimer Laser Photolithography Dose Metrology

NIST has developed primary standard laser calorimeters for KrF and ArF excimer laser energy measurements and offers laser power and energy calibration services at laser wavelengths of 248 and 193 nm based on these standards. Primary standard laser calorimeters at 157 nm, for use with F_2 excimer laser measurements, are currently under development. In order to meet the demands of the semiconductor community for improved overall accuracy, NIST is developing improved transfer standards for deep ultraviolet (DUV) excimer laser energy and dose (energy density) measurements. At this time, the overall uncertainty for laser dose measurements at the wafer plane of a typical photolithographic tool is 5%. In order to improve throughput and process latitude control, semiconductor manufacturers would prefer an overall uncertainty of less than 1%. This goal is not achievable without improved transfer standards.

Ideal transfer standard characteristics include large dynamic range, linearity for continuous and pulsed radiation, uniform angular and spatial response, and long-term stability of response with extended DUV exposure. In particular, there is an urgent need for stable detectors for use at 157 nm since to date, none have been identified. These detectors are sought for a multitude of applications, including, but not limited to, wafer plane monitoring, laser pulse energy control, and materials testing. Presently, pyroelectric and solid-state detectors are used as DUV transfer standards. While pyroelectric detectors have good long-term stability, they generally suffer from low dynamic range and poor spatial uniformity. Typically solid-state detectors, such as silicon photodiodes, have good dynamic range. However, they suffer from inferior angular response, poor long-term stability with DUV exposure, and cannot provide a direct measurement of excimer laser power or energy without attenuation. Proposals are sought for the development of standards quality DUV detectors that satisfy all of above requirements.

8.19.2T Subtopic: Stable, Narrow-Band Photodiodes for Extreme UV Lithography

The coming generations of lithography systems for use in the manufacture of semiconductor components will push the state of the art to shorter and shorter wavelengths. Precise measurements of the radiation dose delivered to the sample are crucial to the manufacturing process. Present detector technologies are not well suited for this application. The primary

issues are the broad-band responsivity and degradation of responsivity by the radiation of interest.

The development of radiation-hardened, narrow-band, stable photodiodes would be of great importance to the semiconductor manufacturing industry. Such detectors should respond only in a spectral band of about 2.5 nm FWHM around the central wavelength. Out-of-band rejection should be at least a factor of 100. For an individual detector, the bandpass should be centered at one of the wavelengths for which lithography systems are being developed: 11 nm and 13 nm. Stability of the detector responsivity when exposed to 500mJ/cm^2 at these wavelengths is of great importance. As with any radiometric detector, spatial uniformity, temporal stability, and low internal noise are important characteristics that must be considered in the development of the photodiode. NIST personnel and facilities are available to assist in the radiometric characterization of developed detectors.

8.19.3T Subtopic: Ultraviolet Detectors and Optical Components

Proposals are sought for development of new UV detectors and optical components. These devices and components are needed because NIST has requirements to calibrate UV irradiance and radiance detectors in the spectral range from 100 to 400 nm for lithographic, environmental, UV processing, and space applications. These applications require UV detectors that are uniform in responsivity across the detector area and stable with time and UV dose. Also desirable are solar blind and position sensitive (array) detectors.

UV optical components, such as cutoff filters, diffusers, and optical fibers that resist degradation under high or prolonged UV exposure are also needed. Commercially available components have poor uniformity, stability, and UV damage resistance, making it difficult to maintain calibrated instruments and transfer standards.

8.20 NIST TOPIC: INTEGRATION OF MANUFACTURING APPLICATIONS

8.20.1T Subtopic: Next Generation Process Exchange Tools and Applications

As manufacturing companies move toward increased integration, there is a growing need to share process information in addition to product data. Software applications range from those that simply portray processes graphically to tools that enable simulation, planning, analysis, scheduling, and/or control of processes. In collaboration with industry and academia, NIST is developing a Process Specification Language (PSL) that will be common to all manufacturing applications, generic enough to be decoupled from any given application, and robust enough to be able to represent the necessary process information for any given application. Additionally, the PSL will be sufficiently well defined to enable the exchange of process information among the established applications.

NIST is requesting proposals for computer-based tools to facilitate the use of the PSL for process modeling and process information exchange. Proposals should target the specification and design of generic PSL-based development and integration tools or extensions to manufacturing application software. Solutions could involve the development of translators or wrappers for exchange, or tools for creating and editing PSL presentations.

References:

Internet site: <http://www.nist.gov/psl/>.

Schlenoff, C., A. Knutilla,, S. Ray, "Unified Process Specification Language: Requirements for Modeling Process." NISTIR 5910, National Institute of Standards and Technology, Gaithersburg, MD, 1996.

Knutilla, A., C. Schlenoff,, S. Ray,, "Process Specification Language: Analysis of Process Representations." NISTIR 6160, National Institute of Standards and Technology, Gaithersburg, MD, 1998.

8.20.2T Subtopic: Computational Tools to Support Intelligent and Distributed CAD

Design of complex engineering systems is increasingly becoming a collaborative task among designers or design teams that are physically, geographically and temporally distributed. The complexity of modern products means that a single designer can no longer manage the complete effort. Designers are no longer merely exchanging geometric data, but more general knowledge about design and design process, including specifications, design rules, constraints, rationale, and more. As design becomes increasingly knowledge-intensive and collaborative, the need for intelligent CAD tools to support the representation and use of knowledge among distributed designers becomes more critical. The objective of this solicitation is a development of computational tools to support intelligent and distributed CAD (IDCAD), or more specifically, frameworks for distributed design that will improve the ability to represent, capture and reuse design knowledge, and to enable design integration across time and space. Examples of challenges associated with IDCAD include but are not limited to knowledge-based CAD, knowledge capture and sharing, supply chain management, Internet-based communication, novel design agents, etc. An emphasis will be placed on tools that are either compatible with hardware/ software platforms used by small to medium enterprises, or accessible from such platforms (e. g., via the Internet).

8.20.3T Subtopic: Ontological Engineering Applied to Manufacturing System Integration Research

The Manufacturing Engineering Laboratory is soliciting proposals for the application of the principles behind ontological engineering towards the area of manufacturing systems integration and/or research. The result of this effort will either be: (1) mechanisms, infrastructures, and/or methodology tools with an ontological underpinning that will facilitate the interoperability of manufacturing systems; or (2) the application of ontological principles towards the creation of an electronic notebook, as described below. Within the former area, these principles may be applied to information that is to be shared among manufacturing applications, including, but not limited to, process, resource, product, and design information. Special emphasis will be given to proposals that are applicable to multiple types of information.

The implementation of an ontology-based electronic notebook system (option 2) should allow researchers to collaborate, build, and review domain-specific ontologies and knowledge bases. The implemented system should demonstrate its applicability to a collaborative engineering or manufacturing setting. Each ontology and associated knowledge base(s) [the data] is inherently domain-specific. However the electronic notebook system itself should be domain independent. The system must be based on knowledge representation and interchange formats, which permit interaction and possible integration with other such knowledge systems, e. g. KQML and KIF. The use of agent technology is recommended to coordinate and integrate cooperating researchers' electronic notebook entries, and to facilitate integration with other knowledge systems. The user interface(s) should be platform-independent, and other system components should be platform portable. It is expected that a proposed system should leverage prior work in the field of electronic notebooks.

In the context of this proposal, an ontology is an explicit treatment of some topic. It is a formal and declarative representation, which includes the vocabulary (or names) for the terms in that subject area and the logical statements that describe what the terms mean and how they can or cannot be related to each other. Ontologies, therefore, provide a formal means for representing and communicating knowledge about some topic and a set of relationships that hold among the terms. Without these formal and concise definitions of attributes, relations, and concepts, usually built upon some type of foundational theory, integration of manufacturing applications runs the risk of misinterpretation of those concepts, which can lead to problems with interoperability and exchange.

References:

Knowledge Sharing Effort, Internet site: <http://www.cs.umbc.edu/kse/>.

Ontolingua Server Project, Internet site:
<http://ksi.cpsc.ucalgary.ca/KAW/KAW96/farquhar/farquhar.html>.

Plan Ontology Project, Internet site: <http://www.aiai.ed.ac.uk/~bat/ontology.html>.

Process Interchange Format, Internet site: <http://ccs.mit.edu/pif/>.

Toronto Virtual Enterprise Project, Internet site:
<http://www.ie.utoronto.ca/EIL/tove/ontoTOC.html>.

8.20.4T Subtopic: Testability of Complex Manufacturing Software Systems

Software systems used in manufacturing enterprises are large and highly complex. Manufacturers must integrate these software systems such that they dynamically interact with one another using standards interfaces. Those involved in these integration efforts are frustrated by the lack of practical testing methods for these interacting software systems, by the ineffectiveness of existing testing tools, and by the lack of consideration for testing that standards-developers employ when developing standards in this domain.

NIST is soliciting proposals to identify and develop tools and techniques for specifying, locating faults in, and testing conformance of interaction-driven manufacturing systems as well as developing methods for designing integration specifications with improved testability. The results of this effort shall be the development of prototype testing methods, leveraging existing ITL methods where appropriate, and the development of corresponding software tools. Proposers should identify characteristics of “testable” implementations and devise specification methods applicable to integration specification developers.

8.20.5T Subtopic: Manufacturing Process Characterization Models

There is an increasing need by industry to have the capabilities of their manufacturing processes accessible to them directly through the tools they use to plan and execute their processes. Capabilities refer to information such as achievable tolerances, surface roughnesses, etc. Having this information will allow companies to be more informed as to the capabilities they can reasonably expect from their processes and therefore make appropriate decisions as to what types of specifications are achievable in their products.

In order for this vision to occur, at least two challenges exist. The first is the existence of process characterization models to capture the manufacturing process capabilities. These characterization models will be based upon well proven theories and techniques, including analytically derived relationships, dynamic equations, empirical correlations, and statistical inferencing. The second is the existence of tools that have the ability to incorporate these models into their underlying representation for purposes of display and decision making.

NIST is requesting proposals for the second of these challenges, namely, the development or enhancement of tools that have the ability to incorporate models characterizing manufacturing

processes. The proposer will work closely with NIST staff who are developing the actual characterization models.

The work described above will be part of a larger effort to develop standard specifications and characterizations of manufacturing process information that allow companies to better document, understand, and optimize their processes as well as to facilitate the exchange of process information among different functions within their organization and among the various partnering organizations.

8.21 NIST TOPIC: GENERAL

8.21.1T Subtopic: Inductive Reference Samples for Thin Film Magnetometry

Reference samples for thin film magnetometers are necessary in both manufacturing and basic research applications. The market for these samples is extensive, including magnetic storage manufacturers, government labs, and academia. The cost savings from decreased product failure and increased measurement accuracy will be realized especially in the magnetic recording manufacturing industry. The proposal should include concepts for design and fabrication of both active and passive inductive reference samples on large silicon wafers (~3" and higher diameter). This will include a plan for modeling the coupling of rectangular coils and the self-inductance of the pickup loops. In addition, a timeline for the production of the samples should be included, with the option of utilization of the clean-room facilities at NIST, Boulder. The samples should be robust enough to be used as a reference sample in a manufacturing environment, and applicable to magnetometers such as inductive B-H loopers and possibly vibrating sample magnetometers. These samples will help to meet NIST's mission by providing reference samples while traceable magnetic thin films samples are developed.

8.21.2T Subtopic: Precision Optical Current Sensor

As new power meter standards and current metering technologies appear, NIST must be prepared to evaluate these technologies and advance our ac and dc current metrology systems. One new technology for current measurement that is near production is the optical fiber current sensor. These sensors have high dynamic range, large frequency bandwidth, high isolation to nearby currents, high isolation to the power line potential, and low power output. New measurement systems are being developed at NIST to properly calibrate these sensors.

NIST requires an optical current sensing check standard. The primary component of this system is an optical current sensor that has an uncertainty of less than 10 ppm for currents in the range of 1 A to 10 kA. The optical current sensor should respond to a second parameter, such as rotation, in a known fashion for scale factor and linearity calibration of the sensor. The sensor should have both digital and analog outputs.

8.21.3T Subtopic: Linear Magneto-Resistive Array for Imaging Data Storage Media

Forensic and data storage analysis tools typically image magnetic media with tools such as ferro-fluids, scanning SQUID pickup loops, magnetic force microscopes, and scanning magneto-resistive (MR) microscopy. These techniques are typically non-linear, slow, and limited in field of view and dynamic range. Considerable time and effort can be saved by developing a technique with many elements in parallel. The MR technology is the most promising in terms of cost-effectiveness, sensitivity, and high data rates when integrating many elements in parallel. These elements are in wide-spread use as data storage sensors in high density applications such as hard disk drives (hdd) and digital storage tape drives (td). Currently, single elements are typically used in hdd heads, while heads with multiple elements (up to 32) are used in td's. The successful proposal for this work will describe the integration of many elements into a read head that can image a 2.8 mm wide area with 5 micron resolution and a 16 kHz sample rate per element. The elements can be multiplexed and the packaging should include a scheme for making contact to the read head.

8.21.4T Subtopic: In-situ Readout of Thermocouple Voltages for Rotating Stages

In-situ temperature control of substrates during vacuum deposition and sample processing is critical in many industrial applications. For large samples, it is often also necessary to spin multiple samples on planetary gears in order to assure uniform properties of materials over large areas and achieve high throughput of product. However, there is no current technique available to simultaneously rotate the sample and read the voltage of a thermocouple attached directly to the sample. In these applications integration of the thermocouple into the sample holder will increase product yields and decrease processing times. The focus and ultimate purpose of this program is to develop an inductive-to-magneto-resistive coupling for the thermocouple that allows the signal to be acquired with no direct wire connections to the rotary stage. The coupling can be accomplished by allowing the thermocouple to drive a coil that rotates the sample stage. A stationary coil or magneto-resistive (MR) element can be used to sense the current induced in the moving coil. Successful proposals will address the dimensions and design of the readout coils, a matched pickup element, and will also address the problems of RF noise and the need for a reference junction on the rotating stage.

8.21.5TCC Subtopic: Low-Cost, High Performance Passive Components, Low ESR Capacitors, Ultra Capacitors and Low Loss Transistors for Automobile Hybrid Drive System

In an automobile hybrid drive system, methods to reduce the losses in the inverter must be addressed to ensure that the addition of an electric drive does not reduce the vehicle range. Studies completed indicate that the effectiveness of the hybrid drive system drops significantly as the system efficiency begins to decrease. Therefore, the principal focus of this low-cost, high-performance effort is on the following:

(a) Improved Low-Cost Dielectric Materials: This effort should focus on improved dielectric materials for increased capacitance in significantly smaller packages for lower frequency, filter capacitor applications. Emphasis should also include low-cost, high-temperature, low equivalent series resistance, and high RMS current capability.

(b) Improved Capacitors with high temperature, high storage, high current capabilities, and low equivalent series resistance.

(c) Improved Current and Voltage Sensors with high temperature capabilities, and are integrated into the transistor package.

(d) Lower Switching and Conduction Loss Power Transistors that reduce the need for high performance cooling systems.

8.21.6T Subtopic: Vibration Calibration System

In primary standards laboratories and some secondary standards laboratories, various absolute methods, usually reciprocity or optical interferometric techniques, calibrate vibration sensors and vibration exciters (shakers). In industry, routine calibrations of vibration sensors are usually made by comparison to a sensor or exciter that has received a primary calibration. The uncertainty of such secondary calibrations is often considerably larger than the uncertainty attainable in primary calibrations, due to numerous factors involving both the transfer standard and the other equipment and instrumentation used in the industrial laboratory. Although in many applications smaller uncertainties are needed, the expense and complexity of equipment that enables primary calibrations of vibration sensors is such that it generally is not practical for industrial laboratories to use such equipment.

NIST invites proposals to develop a new generation of vibration calibration systems that can provide high-accuracy calibrations of vibration sensors at reasonable cost and minimal complexity. The goal during Phase 1 would be to evaluate alternative design approaches, develop a preliminary system design, and carry out sufficient analyses to enable prediction of the performance of that Design. During Phase 2, the contractor would refine the system design, build a prototype system, validate its performance, and make the prototype system available to NIST for further evaluation. During Phase 3, the contractor would use non-SBIR capital to develop a vibration calibration system for commercial sale.

While NIST does not want to place any constraints on the design approach, Phase 1 proposals will be evaluated with regard to the extent that they provide built-in capability for absolute measurement of vibration, adequately address typical exciter problems such as harmonic distortion, internal resonances, and cross-axis motion, and show promise for later development of a rugged, reliable, affordable, easy-to-use, and accurate vibration calibration system that can be used routinely by government and industry. It is suggested, but not required, that the initial system be focused on the frequency range from 3 Hz to 3 kHz, which covers the large majority

of industrial needs. The contractor is encouraged to exploit the use of modern materials, control methods, and data acquisition and analysis techniques and to be reasonably specific in the Phase 1 proposal about the (tentative) design approach to be taken.

8.21.7T Subtopic: Standards for Routine Validation of NIR Instrument Performance

Near Infrared Spectroscopy (NIR) is increasingly used for many diverse analytical chemistry applications. The technique is routinely used in process chemistry, agricultural chemistry, the petroleum industry and pharmaceutical industry. Its minimal sample preparation requirements, its real time analytical capabilities, and its ease of use have ensured the technique's acceptance in many quality control and analytical laboratories. Expenditures for NIR instruments and method development amounted to over a billion dollars last year, three times the amount spent on the related, but more mature, Mid-Infrared spectroscopy techniques. Because the method relies exclusively on multivariate statistical methods to correlate chemical concentration with NIR spectra, it is necessary to perform wavelength validation and calibrations daily. To address the needs of the NIR community, NIST has developed SRM 2035, a NIR transmission wavelength calibration standard. Because of the wide variety of NIR applications, and lack of a standard sampling technique, both the geometric form (25-mm diameter optic) and temperature requirements of SRM 2035 severely limits the use of this standard *at the point of measurement* for the daily validation of instrument performance. The standard is best suited for use in a desiccated and temperature-controlled spectrometer. This is a clear departure from the outdoor, ambient temperature environment where many process control instruments are used.

We propose to offer an SBIR opportunity to address this secondary standards need, since NIST lacks the resources to pursue it internally. The SBIR recipient will investigate a number of inorganic and organic materials with the goal of finding a suitable secondary standard material for routine daily validation checks of the wavelength axis of commercial NIR spectrometers. Initially, applications in the pharmaceutical industry should be targeted, as it is the most heavily regulated, and for the most part its applications involve powdered or compressed powdered materials. The materials investigated should be measured using state-of-the-art fiber probe technology, as this is the most common measurement technique utilized in the NIR industry. The materials identified for the secondary standard should have well defined peak shapes in the 1 to 2 micron spectral region, and the peak locations should be relatively insensitive to temperature variations. These materials should also be relatively inexpensive, environmentally and physiologically benign, and expendable. The materials chosen must be available commercially in sufficient purity to ensure spectral consistency between batches and vendors. Once suitable candidate materials are identified, NIST can evaluate them as potential secondary standards for NIR applications.

The desired deliverables for Phase 1 studies are:

1. Spectral library of compounds studied for wavelength validation standards. (NIST will provide a starting list). Each spectrometer used will be calibrated using NIST SRM 2035 and must meet system lifecycle validation requirements as expected for current Good Manufacturing Practices in the pharmaceutical industry.

2. List of most likely candidates for application to pharmaceutical applications.

3. Temperature coefficients of peaks of candidates and peak locations using NIST supplied peak location algorithms.

4. Report on the potential use and market acceptance of such a standard for NIR applications in the pharmaceutical industry.

Reference:

SRM 2035, NIR Transmission Wavelength Standard from 10,300 cm^{-1} to 5,130 cm <http://ois.nist.gov/srmcatalog/certificates/srm-2035.htm >.

8.21.8T Subtopic: Fast-Scanning FTIR Spectrometer for Measurements In Spray Flames

The nonintrusive measurements of multiple gas species concentrations, soot volume fraction, and temperatures of soot, droplets characteristics (size and number density) in spray combustion systems will be needed to better understand the combustion of liquid fuels. While separate diagnostics have been developed for many of these measurements, most are difficult to use, expensive, and not readily adaptable to industrial processes. Fourier Transform Infrared (FTIR) spectroscopy has shown potential as a means of obtaining this data set using a single instrument. Measurements of gas concentrations are based on the absorption of radiation from an infrared source. Temperatures can be obtained from gas band shapes in absorption or in emission. Temperatures can also be obtained from a combination of emission and absorption measurements. Particle or drop size can be obtained from wavelength dependent scattering. Tomographic reconstruction of spectra for multiple lines-of-sight can be used to obtain spatially resolved spectra, from which analysis of temperature and concentration may be performed. FTIR spectroscopy systems have been used in the past to make measurements in diffusion flames. However, particle transit noise is a significant issue for multi-phase systems at slow scanning speeds. A fast-scanning (3 scan/s at 1 cm^{-1}), low-noise, mid-IR, FTIR system is sought for characterization of spray flames. Simultaneous quantification is required for both major and minor combustion byproducts, droplet sizes less than 150 µm, droplet number densities less than 10^6 particles/cm^3, and soot number concentrations less than 10^9 particles/cm^3.

Phase 1 of this research should demonstrate the feasibility of a fast-scanning FTIR spectrometer system for in-situ spray combustion measurements, while Phase 2 would involve prototype development and delivery of a system to NIST. It is expected that a fast-scanning FTIR instrument will find immediate commercial applications related to the power generation and chemical industries.

8.21.9T Subtopic: Time-Resolved Planar Velocity Diagnostics for Spray Flames

Detailed characterization of droplet transport in turbulent spray flames is important for effective control of fuel/air mixing processes, droplet evaporation and combustion. Knowledge of the droplet dispersion, penetration, and spatial patternation depends crucially on measurement of the spatial distributions of both the droplet and surrounding air velocity. State-of-the art laser diagnostic techniques provide the simultaneous measurement of individual droplet size and velocity, and air velocity components, but at spatially discrete positions within the flame. Planar laser-based diagnostic techniques, such as with planar imaging velocimetry (PIV), can provide two-dimensional, in-flight droplet and air velocity information, but the repetition rates (typically 10-40 pulses/s) are too slow to capture the spray flame dynamics. A high-speed, high-magnification laser-based optical system is sought for 2-D visualization of droplet and air velocity in different cross-sectional planes of the flame. The two-dimensional droplet and air velocity vector fields should be measured without directional ambiguity. Determination of droplet and air velocities, and time-dependent aspects of the flow is also required with repetition rates of better than 4 kHz (with better than a 2 µs pulse duration). Image analysis capabilities must provide post processing of the velocity components, as well as their cross correlations. Image recording and analysis capabilities should also be carried out with a PC-based system.

Phase 1 of this laser/optical diagnostic should demonstrate the feasibility of the proposed approach. The objective of Phase 2 is the delivery of a functioning system to NIST. It is expected that this new measurement capability will find immediate commercial applications for fluid dynamics, and combustion-related industries.

8.21.10T Subtopic: Synthesis and Characterization of Semiconductor Nanocrystals: Standards for Fluorescence Intensity in Medical Devices and Medical Diagnostics

Fluorescence is a core transducing technology employed in many measurement devices for analytical chemistry, medical diagnostics and biotechnology. Different classes of fluorescent ligands and labels exist (organics, rare earths, fluorescent proteins), however many suffer the common problem of photobleaching on illumination. Furthermore, spectral characteristics are limited by the chemistry of these diverse compounds. Linking chemistry is therefore quite different for each individual color. By contrast, novel semiconductor-based materials (fluorescent semiconductor nanocrystals) offer significant advantages over conventional fluorescent tag compounds in these two important areas. First, semiconductor nanocrystals do

not fade appreciably upon illumination. Second, their excitation and emission wavelengths are a function of crystal size, which can be manipulated experimentally. Since the chemistry of differently sized (hence differently colored) nanocrystals is similar, a universal linking chemistry can be developed to apply to this entire class of compounds irrespective of color, making applications far less complex and more practical. Much has proven feasible on a research basis, however development and refinement of research procedures will be necessary to move these from scientific curiosities to practical products for various medial and diagnostic applications.

Limitations facing nanocrystal scale up for commercial applications include small batch size and uniformity of each production run. In addition, for use as tags on biological molecules, the efficiency of linking these labels to nucleic acids and protein should be optimized for commercial applications. If such challenges were met, nanocrystal labels could have significant impact in biotechnology and diagnostics.

With such improvements, nanocrystals might represent attractive new materials from which NIST fluorescence intensity and wavelength standards could be developed.

8.21.11T Subtopic: The Development of Critical Renewable Validation Materials for Molecular Diagnosis

Our knowledge of the human genome and the roles that the approximately 70,000 genes play in genetic disease and cancer have grown tremendously over the past 10 years, largely due to advances in molecular biology and the Human Genome Project. Molecular testing for disease status is currently conducted for over 50 genes, and this number is increasing rapidly. Standard reference materials, assay controls, and proficiency testing materials have been sought by the molecular diagnostic community for the past few years; this need became the focus of a NIST Workshop entitled "Standards for Nucleic Acid Diagnostic Applications" held in 1998. NIST's development of reference materials requires the availability of stabilized specimens or the establishment of cell lines containing specific genetic characteristics suitable for molecular diagnostic measurements. The availability and a centralized repository of such biomaterials will be critical for the development of disease-specific national standards. A successful program will establish a system for the creation, validation and storage of biomaterials related to human diseases for which such standards needs exist, such as cystic fibrosis and fragile x disease.

8.21.12T Subtopic: Solar-Blind, Large-Area, Semiconductor Photodiode for the Far Ultraviolet

The National Institute of Standards and Technology (NIST) has been a source for radiometric transfer standard detectors for the extreme ultraviolet (EUV) spectral region for many years. Recent developments have made possible the use of radiation-hardened silicon semiconductor photodiodes in this program. It is felt that the quality of transfer standard detectors could be improved by the development of additional semiconductor photodiodes that are insensitive to

radiation with a wavelength longer than about 400 nm. Radiometric use requires that the photodiode be underfilled, so a large active area is required, typically 1 cm by 1 cm. These photodiodes would be used by NIST primarily in the 3 nm to 254 nm spectral region.

Important parameters for NIST transfer standard photodiodes include a high degree of spatial uniformity, temporal stability, a low level of internal noise, and freedom from damage by radiation in the extreme ultraviolet/soft x-ray region. NIST personnel and facilities are available to assist in the radiometric characterization of photodiodes developed under this proposal.

8.21.13T Subtopic: Development of a A "Turn-key", Broadly Tunable Source for Terahertz Spectroscopy Applications

In the past decade, there has been an increased interest in the far-infrared (Terahertz) region of the electromagnetic spectrum. This interest is due, in part, to the development of new techniques for the generation of Terahertz radiation, such as backward-wave oscillators, solid-state photomixers and CO_2-laser pumped far-infrared lasers. To date, these applications have involved one-of-a-kind laboratory instruments. However, it is desirable to have a general purpose instrument capable of delivering broadly-tunable, spectrally-discreet, radiation throughout the Terahertz spectral region (0.5 to 3 Thz). Applications for such an instrument include remote sensing, materials characterization, process monitoring, laboratory spectroscopy and heterodyne detection. Ideally, the source would have low-noise, the potential for continuous tunability, and an output power greater than 1µW. Such a device would fill the commercial instrumentation void between the microwave and mid-infrared spectral regions. Special consideration will be given to compact systems small enough for use in space-based and field applications.

References:

Lewen, F., E. Michael, R. Gendriesch, J. Stutzki, and G. Winnewisser, "Terahertz Laser Sideband Spectroscopy with Backward Wave Oscillators", J. Mol. Spectrosc., **183** 207-209, 1997.

Pine, A. S., R. D. Suenram, E. R. Brown and K. A. McIntosh, "A Terahertz Photomixing Spectrometer: Application to SO_2 Self Broadening", J. Mol. Spectrosc., **175** 37-47, 1996.

8.21.14T Subtopic: Trap Detectors for Wavelengths Longer than 1 µm

Proposals are solicited to develop optical radiation trapping detectors and improved measuring electronics for transfer standard radiometers. The requirements are: (1) developing multiple input reflection detector arrangements of large detection area (minimum diameter of 5 mm); (2) making high spatial response uniformity for the detector input; (3) performing a noise floor of equal to or less than 50 $nW/Hz^{1/2}$; (4) minimizing spectral reflectance to less than 1%; (5) eliminating spectral transmittance loss; and (6) designing the electrical and radiometric

properties of the radiometer to achieve less than 0.1 % non-linearity within a three decade or greater radiant power range.

Radiometers based on multiple input reflection offers unique advantages because of their high spatial response uniformity. An on-going project at NIST is to develop transfer-standard infrared radiometers for which these highly uniform detectors with matched electronic circuits would be essential components. These radiometers will have high accuracy and stability.

8.21.15T Subtopic: Superconducting Quadrupole Magnet Windings, Suitable for Studies of Trapping Ultracold Neutrons

NIST has a long tradition of studying materials and testing fundamental interactions using thermal and cold neutron beams. Recently, scientists have successfully created and magnetically confined ultracold neutrons (neutrons with velocities less than 10 m/s) in a three-dimensional quadrupole type magnetic trap with a trapping field of 1.0 T. The trapping region is cylindrical in shape, approximately 30 cm long and a diameter of 5 cm.

The limiting factor on the trapping of ultracold neutrons is the technology of "air-core" quadrupole magnets (a combination of limitations of the trapping field and trap size). The field strength is presently limited by the winding technology of the quadrupole coils and not by the critical current of the wire. Development of improved techniques for winding coils is essential in obtaining a higher number of trapped neutrons. In addition, improved procedures for winding racetrack-shaped coils should result in a larger diameter (and longer length) trap, resulting in a higher number of trapped ultracold neutrons.

The objective of proposals on the subtopic should be to develop techniques for the winding and assembly of superconducting quadrupole magnetic coils with high fields and large diameter bores. The ultimate goal is to develop a quadrupole assembly of large diameter (> 10 cm), long length (> 60 cm) and high magnetic field strength (> 2.0 T).

In addition to the benefits to neutron research, the development of these coils will be of interest to scientists involved in the research of magnetic trapping and cooling of atoms and molecules, including the production of very large bose condensates.

8.21.16T Subtopic: Miniaturized Detectors for Brachytherapy Dosimetry

Dosimetry measurements on brachytherapy sources in tissue-equivalent media are very difficult to make accurately because of the very high dose-rate gradients in the vicinity of the sources. Conventional detectors in use today include small-volume ionization chambers, thermoluminescence dosimeters (TLDs), solid state devices (diodes and diamond detectors), plastic scintillators, and radiation-sensitive films. Current technology limits on detector sizes are on the order of 0.5 to 1 mm, usually in one dimension only. Thinner materials must be supported on thicker, often non-tissue equivalent substrates. Sensitivity is usually attained only

at the expense of added volume in the other two detector dimensions, compromising resolution in these dimensions. Requirements for new detectors include sizes of 0.5 mm or less in all three dimensions, the ability to operate under water, tissue equivalence in their radiation absorption and scattering properties for electrons from 100 keV to 4 MeV and photons from 10 keV to 1 MeV, and sensitivity sufficient to detect clearly an absorbed dose rate of 1 mGy/s, or, for passive devices, absorbed doses of 1 mGy. Therapy with small sources has recently seen great interest and activity, such as in prostate cancer treatment and intravascular treatment. A successful miniature dosimetry system could be a widely used tool to plan and assess the absorbed dose delivered in many radiation therapy applications.

References:

Chiu-Tsao, S.-T. and L.L. Anderson, "Thermoluminescent Dosimetry for 103Pd (Model 200) in Solid Water Phantom," Med. Phys. 18, 449-452, 1991.

Fluehs, D., M. Heintz, F. Indenkampen, C. Wieczorek, H. Kolanski and U. Quast, "Direct Reading Measurement of Absorbed Dose with Plastic Scintillators--the General Concept and Applications to Ophthalmic Plaque Dosimetry," Med. Phys. 23, 427-434, 1996.

Soares, C.G., D.G. Halpern and C.-K. Wang, "Calibration and Characterization of Beta-particle Sources for Intravascular Brachytherapy," Med. Phys. 25, 339-346, 1998.

8.21.17T Subtopic: Imaging Systems for Beta Activity Sources

A program for the traceability of various radionuclides of paramount importance to the US Army (for monitoring of decommissioning and decontamination efforts as well as environmental remediation) has been under way for over a year. Following a successful program involving the development of large-area alpha standards for use in calibrating monitoring equipment used in the field, other facilities, counting systems and nuclides (particularly the beta emitting tritium) are to be evaluated. To this end, imaging techniques to be used in the development of standards (for calibration and homogeneity testing) are to be developed. The accuracy of the results are important from not only a health physics and regulatory viewpoint, but from an economic one. The results of these tests are used to determine if equipment in which the radionuclide is incorporated needs to be replaced due to leakage of the material. Results from the first radionuclide investigated, ^{63}Ni, indicated a number of problems leading to under-reporting of removable activity from leak-test smears. These problems have been addressed and another set of samples will be sent to participating laboratories. Tritium swipe samples have been sent to the various laboratories and the results are being evaluated. Future plans call for traceability intercomparisons for ^{241}Am, ^{60}Co and ^{137}Cs. The calibration of the beta-emitting standards to be used in this program will lead to methods of correcting beta particle counting for backscattering from the backing material. This is of interest to source manufacturers and their customers since most regulations are written in terms of activity rather than 2B emission rates.

An effort has been proposed for the development of counting systems and calibration of large-area tritium sources for the calibration of surface monitors. Development and/or modification of the large-area gas flow proportional counter for the absolute counting of tritium large-area sources, which will involve modifications to enable the counter to be used at a gas pressure above atmospheric pressure (to eliminate pressure effects on the counting of the low energy beta particles emitted by tritium) is the first step and is currently under development. An imaging system, which must have a spatial resolution of at least 0.1 mm, and have sensitivity sufficient to detect clearly an activity level at or below 100 Bq for low-energy betas, is required for source imaging.

References:

Berger, M. J. "Counting Yields for Beta and Alpha Particle Sources," NIST Special Publication, 1999.

Miyahara, J. "The Imaging Plate: a New Radiation Image Sensor," Chemistry Today, 29-36, October 1989.

8.21.18T Subtopic: Modeling of Optical Radiometric Calibration System

All primary as well as secondary calibration laboratories in both government and industry involved in optical radiometric characterization of sources and detectors need to build the facility minimizing all sources of uncertainty as much as possible from the initial design itself. Currently there is no software tool that would model the individual components and their integrated setup to help design the calibration system and develop the measurement equations. NIST data on the optical properties of materials and coatings and its internal reports on reducing diffraction and other uncertainties both by design and simulation could be comprehensively put together into a software package that would be of great use throughout the world. Such a software package would also bring to practice NIST recommendations on the symbols, terms and uncertainty analysis for radiometry and build uniformity of procedure.

We would like to obtain proposals for developing software that models the following: effective emissivity of blackbodies at various temperatures for various cavity designs of various materials and coatings; integrating spheres; absorption characteristics and response characteristics of cryogenic and ambient cavity radiometers of various designs; diffraction at limiting and non limiting apertures and optical components; 2-dimensional and 3-dimensional radiation transfer in respective paraxial systems and imaging catoptric systems. The software would also model integrated optical setup for radiometric calibration and be able to predict irradiance at any point in the optical beam path.

Reference:

Wyatt et.al., “Recommended Practice; Symbols, Terms, Units and Uncertainty Analysis for Radiometric Sensor Calibration”, NIST Handbook 152, National Institute of Standards and Technology, Gaithersburg, MD, 1998.

8.21.19T Subtopic: Flourescence Standards

Proposals are solicited for the development of novel materials for fluorescence standards for biological, chemical and physical applications. U. S. industry has moved to fluorescence for measuring responses in a variety of technical, scientific and medical tests. The heightened awareness of industry and regulators for quality and standardization in measurements (ISO 9000 and ISO 25) has resulted in an increasing call for NIST to provide secondary standards for fluorescence directly traceable to the national radiometric scales. For example, the Council of Optical Radiation Measurements (CORM) Sixth Report (1995) identified the measurement of fluorescence and the development of a reference instrument by NIST as a top national need. In anticipation of the availability of such standards, the National Committee for Clinical Laboratory Standards (NCCLS) has proposed the creation of a standing subcommittee to facilitate the introduction of fluorescent intensity standards (FIS) in clinical applications.

While highly quantitative, fluorescence tags currently in use suffer from rapid degradation of their optical properties and often require unique excitation sources. If stable fluorophores with different spectral distributions having the ability to be excited with a common source could be developed, they could be used for a wide range of applications, for example in multispectral imaging applications of biological samples.

8.21.20T Subtopic: Steels with Very Consistent Impact Toughness

NIST sells standard reference materials for the verification of the performance of impact test machines. These specimens are of the standard 10 by 10 mm cross section prescribed by ASTM Standard E23, and are heat treated to produce energies near 18 J, 100 J and 200 J. The two lower energy specimens have been manufactured in recent years from AISI 4340 steel, and the higher energy specimen has been manufactured from a maraging steel. All specimen energies produce batches of specimens with coefficients of variation near 3 %.

We are looking for alternate steels or treatments that can produce reference specimens with even lower coefficients of variation. The first goal is to improve the consistency of the current energy ranges, then to consider other ranges, such as 300 J. We desire a report of coefficient of variation data for various candidate steels and recommended processing procedures.

Reference:

ASTM Standard E23 "Standard Methods for Notched Bar Impact Testing of Metallic Materials.”

8.21.21T Subtopic: Two Dimensional Detection of Neutrons with High Spacial Resolution, High Dynamic Range and Low Noise

The NIST Center for Neutron Research operates a 20 MW research reactor including a cold neutron source. The reactor provides a peak thermal core flux of 4×10^{14} neutrons cm^{-2} s^{-1} for use in materials and science research. Approximately 15 instruments use the cold neutron source and another six use thermal neutrons.

New concepts are sought to advance the state-of-the-art in instrumentation using either thermal or cold neutrons, Of particular interest are novel methods for two-dimensional detection of neutrons. Detectors are sought that can achieve some or all of the following: (1) high spacial resolution (1000 x 1000 channels or greater); (2) a low intrinsic noise level; (3) can discriminate neutrons from gamma rays; and (4) offer linear response for signals varying over 4 to 5 orders of magnitude.

8.21.22T Subtopic: Ultra High Efficiency Solid State Soft X-Ray Detectors for Low Z Fluorescence

NIST seeks the design and construction of ultra high efficiency Si(Li) and high purity Ge energy dispersive detectors with ultra-thin surface dead-layers for the purpose of improving x-ray detection sensitivity at energies below 1 keV. The expectation would be to reduce the surface dead-layer from the present industry standard of 100 to 300 nm towards a goal of 10nm or less. Such an improvement could increase the detection sensitivity of x-rays at 200 eV by a factor of 5 with a Si(Li) detector and a factor of 100 with high purity Ge. This would significantly enhance soft x-ray fluorescence sensitivity in our synchrotron based x-ray absorption measurements of low Z materials. Other potential detector improvements could include: (1) development of high transmission IR shields and vacuum windows, and (2) alternative front-end electronic assemblies to reduce electronic noise and increase signal recognition sensitivity and energy resolution at energies below 1 keV. The successful development of ultra high efficiency solid state detectors would be a very significant advance in the quantitative analysis of "light elements" performed in electron micro probes in many analytical and research laboratories in the United States.

8.21.23T Subtopic: Focusing Optics for High-Energy X-rays

NIST has a project that uses high-energy x-rays (50 to 320 keV) to measure different physical properties in materials, in particular strain, texture, and local atom arrangement. The instrument presently uses a simple pinhole geometry to collimate polychromatic x-rays for measurements. To gain measured x-ray intensity for most applications, it is advantageous to focus the beam and to have a parallel x-ray beam geometry. Currently, x-ray optics for higher (> 50 keV) energies are being developed for synchrotron radiation. We would like to adapt and /or develop optics optimized for our laboratory x-ray diffraction equipment for monochromatic and possibly polychromatic x-rays in the range 50 to 320 keV.

8.21.24T Subtopic: Laser Light Source for Illuminating Specularly Reflecting Droplets

A visible light source is required to illuminate the droplets in spray plumes generated by metal atomizers, metal spray deposition equipment, plasma spray coating systems, etc. The particles and droplets generated by these processors are generally 5 to 100 Fm in diameter and travel at velocities up to several hundred m/s. The specularly reflective surface of these “droplets” renders point source and collimated light unsuitable for the required “reflected-light” imaging of surface structure. This light source will be synchronized with a high-speed movie camera (10,000 fps) where each frame will be exposed with one or more short duration (<100 ns), flash illuminated image through “telescopic/macro” optics. Copper Vapor (CV) lasers with external sync oscillators capable of 15 to 20 watts of light output with a fiber optic couple to a beam expander and Lambertian scattering plate should provide sufficient brightness and dispersion for this application. Other laser or white light sources would be considered if the wavelength, pulse duration, and repetition rate were suitable for high-speed film exposure.

8.21.25T Subtopic: Software and DAQ System for High Temperature DTA

Researchers at NIST require a data acquisition (DAQ) system and control software with a graphical user interface (GUI) to operate a high temperature controlled atmosphere furnace. This system will consist of a PC computer running the most recent release of Microsoft® Windows™ operating system and DAQ hardware that provides suitable voltage input and output channels to measure and control the temperature and pressures within the furnace system. The primary function of this system is the acquisition of heating and cooling data from materials specimens (metallic, intermetallic, ceramic, etc.) and the performance of differential thermal analysis (DTA) of high temperature phase transitions (up to 2700 K). The preferred GUI is LabVIEW® by National Instruments® with sufficient flexibility to allow the operator to program a variety of heating and cooling profiles, acquire the temperature data from the specimens, determine the phase transition boundaries, and save the information in file formats suitable for inclusion in word processing software such as Microsoft® Word™ and spreadsheet software such as Microsoft® Excel. NIST will entertain proposals that address the major elements of this measurement problem within the described framework. Ideally, the system would be an innovative adaptation of tried and proven technology, so that it is immediately ready to secure the required data and has potential for commercial marketability.

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Proposal to the Department of Commerce
COVER PAGE

PROGRAM SBIR - SMALL BUSINESS INNOVATION RESEARCH	This firm and/or Principal Investigator ___ has ___ has not submitted proposals for essentially equivalent work under other federal program solicitations, or ___ has ___ has not received other federal awards for essentially equivalent work.
SOLICITATION NO.: DOC 2000-1	CLOSING DATE January 12, 2000
NAME OF SUBMITTING FIRM	
ADDRESS OF FIRM (INCLUDING SIP CODE + 4)	
TITLE OF PROPOSED PROJECT	
REQUESTED AMOUNT $	PROPOSED DURATION 6 months
SOLICITATION SUBTOPIC NO.	SOLICITATION SUBTOPIC TITLE

THE ABOVE ORGANIZATION CERTIFIES THAT:	YES	NO
1. It is a small business firm as defined on page 3.		
2. The primary employment of the principal investigator will be with the firm at the time of award and during the conduct of the		
3. A minimum of two-thirds of research will be performed by this firm in Phase 1.		
4. It Qualifies as a minority and disadvantaged small business as defined on page 3. Circle one: 1- Native American 2-Asian American 3-African American 4-Pacific Islander 5-White 6-No Response		
5. It qualifies as a woman-owned small business as defined on page 4.		
6. It will permit the government to disclose the title and technical abstract page, plus the name, address and telephone number of the corporate official if the proposal does not result in an award to parties that may be interested in contacting you for further information or possible investment.		

PRINCIPAL INVESTIGATOR/ PROJECT DIRECTOR	CORPORATE OFFICIAL (BUSINESS)	OTHER INFORMATION
NAME	NAME	YEAR FIRM FOUNDED
SIGNATURE	SIGNATURE	NUMBER OF EMPLOYEES Avg. Previous 12 mos. _____ Currently _____
TITLE	TITLE	HAS THIS PROPOSAL BEEN SUBMITTED TO ANOTHER AGENCY? Yes _____ No _____
DATE TELEPHONE NO. + AREA CODE	DATE TELEPHONE NO. + AREA CODE	IF YES, WHAT AGENCY?
E-MAIL:	E-MAIL:	

PROPRIETARY NOTICE

For any purpose other than to evaluate the proposal, this data shall not be disclosed outside of the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a funding agreement is awarded to this proposer as a result of or in connection with this submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data source without restriction. The data in this proposal subject to this restriction is contained on separate proprietary page(s).

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9.0 SUBMISSION FORMS

Department of Commerce
Small Business Innovation Research Program
PROJECT SUMMARY

NAME OF FIRM	AMOUNT REQUESTED
ADDRESS	PHONE # FAX#
PRINCIPAL INVESTIGATOR (NAME AND TITLE)	
TITLE OF PROJECT	
SOLICITATION SUBTOPIC NO.	SOLICITATION SUBTOPIC TITLE
TECHNICAL ABSTRACT (LIMIT TO 200 WORDS)	
KEYWORDS	
POTENTIAL COMMERCIAL APPLICATIONS OF THE RESEARCH	

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SBIR PROPOSAL SUMMARY BUDGET

FIRM:	PROPOSAL NUMBER: (Leave Blank)
PRINCIPAL INVESTIGATOR:	
	TOTAL PRICE
DIRECT LABOR:	$
OVERHEAD RATE: 0.00%	$
OTHER DIRECT COSTS:	$
MATERIALS:	$
GENERAL AND ADMINISTRATIVE (G&A): 0.00%	$
PROFIT: 0.00% TOTAL PRICE PROPOSED:	$_____ $_____
TYPED NAME AND TITLE:	SIGNATURE:
THIS PROPOSAL IS SUBMITTED IN RESPONSE TO DOC SBIR PROGRAM SOLICITATION 2000-1 AND REFLECTS OUR BEST ESTIMATES AS OF THIS DATE. **DATE SUBMITTED:**_____	

BUDGET INSTRUCTIONS

The offeror is to submit a cost estimate with detailed information for each element, consistent with the offeror's cost accounting system. This does not eliminate the need to fully document and justify the amounts requested in each category. Such documentation should be contained, as appropriate, on a budget explanation page immediately preceding the budget in the proposal.

1. Principal Investigator (PI).

The PI must be with the small business concern at the time of contract award and during the period of performance of the research effort. Additionally, more than half of the PI's time must be spent with the small business firm during the contract performance.

2. Direct Labor.

All personnel (including PI) must be listed individually, with the projected number of hours and hourly wage.

3. Overhead Rate.

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable overhead rate may be requested, which will be subject to approval by DOC.

4. Other Direct Costs.

List all other direct costs which are not described above (i.e. consultants, subcontractor, travel, and equipment purchases). Each of the above needs a detailed explanation and elaboration of its relation to the project.

5. Materials.

The materials and supplies required for the project must be identified. There is also a need to specify type, quantity, unit cost, and total estimated cost of these materials and supplies.

6. General & Administration (G&A).

Specify current rate and base. Use current rate already negotiated with a Federal agency, if available. If no rate has been negotiated, a reasonable G&A rate may be requested, which will be subject to approval by DOC.

7. Profit.

The small business may request a reasonable profit (about 7 percent of costs is the average proposed).

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CHECKLIST OF REQUIREMENTS

Please review this checklist carefully to assure that your proposal meets the DOC SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. **Seven copies of the proposal must be received at DOC by Noon EST January 12, 2000.**

_____ 1. The proposal is **25 PAGES OR LESS** in length.

_____ 2. The proposal is limited to only **ONE** of the subtopics in Section 8.

_____ 3. The proposal budget is for **$75,000 or LESS** (or $50,000 or less for those topics designated as "SG"). No more than one-third of the budget goes to consultants and/or subcontractors.

_____ 4. The abstract contains **no proprietary information** and does **not exceed** space provided on the Project Summary.

_____ 5. The proposal contains only pages of 21.6cm X 27.9cm size (8 ½" X 11").

_____ 6. The proposal contains **an easy-to-read font (fixed pitch of 12 or fewer characters per inch or proportional font of point size 10 or larger) with no more than 6 lines per inch,** except as a legend on reduced drawings, but not tables.

_____ 7. The **COVER PAGE** has been completed and is **PAGE 1** of the proposal.

_____ 8. The **PROJECT SUMMARY** has been completed and is **PAGE 2** of the proposal.

_____ 9. The **TECHNICAL CONTENT** of the proposal begins on **PAGE 3** and includes the items identified in **SECTION 3.3.3** of the solicitation.

_____ 10. The **SBIR PROPOSAL SUMMARY BUDGET** has been completed and is the **LAST PAGE** of the proposal.

_____ 11. The P.I. is employed by the company.

NOTE: Proposers are cautioned to be careful of unforeseen delays that can cause late arrival of proposals at DOC, with the result that they may be returned without evaluation.

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