OMB Approval Number 2700-0087

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) HEADQUARTERS
AERONAUTICS RESEARCH MISSION DIRECTORATE
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RESEARCH OPPORTUNITIES IN AERONAUTICS – 2009

(ROA-2009)

NASA RESEARCH ANNOUNCEMENT (NRA): NNH09ZEA001N

SOLICITING BASIC AND APPLIED RESEARCH PROPOSALS

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 00.000

ISSUED: April 13, 2009

PROPOSALS DUE
STARTING May 27, 2009
THROUGH April 30, 2010

RESEARCH OPPORTUNITIES IN AERONAUTICS (ROA) – 2009

EXECUTIVE SUMMARY

This NASA Research Announcement (NRA), entitled *RESEARCH OPPORTUNITIES IN AERONAUTICS (ROA) – 2009*, solicits foundational research in support of the Aeronautics Research Mission Directorate (ARMD), National Aeronautics and Space Administration (NASA). This NRA covers a variety of topics in aeronautics fundamental research that are being pursued by NASA personnel. Specific research thrusts are outlined in the Appendices. A major focus of this NRA is to encourage collaboration between other organizations and NASA to help achieve specific goals in a variety of foundational aeronautics research programs.

Details for award scope are provided for each project task area listed in the Appendices. Awards will be made as grants, cooperative agreements or contracts, depending on the nature of the proposing organization and/or program requirements. It is anticipated that the majority of awards will be cooperative agreements or contracts due to the expected collaborative nature of the work specified in the technical appendices. Section D of the *NASA Guidebook for Proposers* provides a discussion regarding funding mechanisms. The typical period of performance for an award is three years, although a few programs may specify shorter or longer (maximum of five years) periods. Note that it is generally NASA's policy to conduct research with non-U.S. organizations on the basis of no exchange of funds. Details of the solicited program elements along with any changes or modifications to any of these guidelines will be specified in the descriptions in the Appendices of this solicitation. Proposal due dates are given in Tables 2 and 3 which are located at the end of this NRA.

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SUMMARY OF SOLICITATION

I. FUNDING OPPORTUNITY DESCRIPTION

(a) Strategic Goals of NASA's Research Program

The National Aeronautics and Space Administration's (NASA) Mission,

> *To pioneer the future in space exploration, scientific discovery, and aeronautics research,*

draws support from NASA's world-class capability for aeronautical research founded on a tradition of expertise in aeronautical engineering and core research areas. The Aeronautics Research Mission Directorate (ARMD) is responsible for achieving NASA Strategic Goal 3E, "Advance knowledge in the fundamental disciplines of aeronautics and develop technologies for safer aircraft and higher capacity airspace systems." The objectives of ARMD are three fold to meet this Goal: (1) take responsibility for the intellectual stewardship of the core competencies (to include facilities) of aeronautics for the Nation in all flight regimes, (2) establish a milestone-based approach to research that enables near-term results while focusing on long-term cutting edge research, and (3) ensure long-term, stable, strategic investment in aeronautics research to benefit both civilian and military applications.

In addition, the ARMD research plans directly support the National Aeronautics R&D Policy and accompanying Executive Order 13419 signed by the President on December 20, 2006 and the National Plan for Aeronautics R&D and Related Infrastructure that was released in December 2007. A Technical Appendix to the National Plan was approved on December 22, 2008, and contains additional technical content on Aeronautics R&D goals and objectives and a preliminary assessment of current relevant Federal Aeronautics R&D activities. Specifically, ARMD conducts high-quality, cutting-edge research that includes foundational research across a breadth of core aeronautics competencies that supports aeronautics and space exploration activities; research in key areas related to the development of advanced aircraft technologies and systems, including those related to aircraft safety, environmental compatibility, and fuel efficiency; and research that supports the Next Generation Air Transportation System (NextGen) in partnership with the Joint Planning and Development Office (JPDO). In addition, ARMD is pursuing a coordinated approach to managing the Nation's research, development, test, and evaluation (RDT&E) infrastructure with other agencies, particularly the DOD. Additional information about ARMD can be found at http://www.aeronautics.nasa.gov.

An important goal of the ARMD NRA is to generate knowledge that can benefit the Nation. Therefore, it is expected that award recipients will publish their work and will

utilize peer-reviewed publications to the greatest practical extent.

Further valuable, in-depth insight into NASA's strategic plan and supporting aeronautical research areas may be found in the following document:

The 2006 NASA Strategic Plan, available at http://www.nasa.gov.

The NASA strategic goal and outcomes for aeronautics from *The 2006 NASA Strategic Plan* are given in Table 1.

(b) NASA's Aeronautics Research Mission Directorate Programs

ARMD addresses the above objectives in four programs: the Fundamental Aeronautics Program, the Aviation Safety Program, the Airspace Systems Program and the Aeronautics Test Program. The Airspace Systems Program will directly address the Air Traffic Management (ATM) research needs of the Next Generation Air Transportation Systems (NextGen) initiative as defined by the Joint Planning and Development Office (JPDO). The Aviation Safety Program will take a proactive approach to safety challenges with new and current vehicles and with operations in the Nation's current and future air transportation system. The Fundamental Aeronautics Program will pursue long-term, cutting edge research in all flight regimes to produce data, knowledge, and design tools that will be applicable across a broad range of air vehicles that fly through any atmosphere at any speed. The Aeronautics Test Program (ATP) is focused on ensuring a healthy suite of facilities and platforms to meet the nations testing needs including the development of new test instrumentation and test technologies.

This NASA Research Announcement (NRA) solicits proposals for all four of these programs: (1) Fundamental Aeronautics Program, (2) Aviation Safety Program, (3) Airspace Systems Program, and (4) Aeronautics Test Program. Appendices A-D provide a detailed description for each of the research programs listed above. In addition, Appendix E contains research topics that are coordinated between two or more programs. Each of these appendices is prefaced with an Overview section that provides an introduction to the research program content that all interested applicants to this NRA are encouraged to read. Proposals in response to this NRA should be submitted to the most relevant aeronautics program elements described in Appendices A-E (see also the *Table of Contents* that prefaces this NRA). Table 2 lists these programs in the order of their calendar deadlines for the submission of proposals, while Table 3 lists them in the order in which they appear in the appendices of this NRA. Questions about each specific program should be directed to the Program Officer(s) identified in the *Summary of Key Information* subsection that concludes each program description.

These appendices also provide clarifications or modifications, if any, to the general guidelines contained in this *Summary of Solicitation* for the individual program elements.

(c) References to Unique NASA Capabilities

NASA's Aeronautics Research Mission Directorate uses a variety of specialized test and high-end computational facilities to achieve its mission. Any need for these specific facilities for the proposed research must be explicitly described in the proposal, including the asset, rationale and justification of the need, how it supports the investigation, and when during the proposed period the resource will be required. As evaluation panels review the intrinsic merit of the proposed investigation, they will be asked to consider the realism and reasonableness of the request for unique NASA capabilities and whether it is an appropriate utilization of a highly constrained asset. Proposals selected for funding will be considered for an allocation of the requested NASA resources needed for their investigation, but availability of the resource to support the fully requested level cannot be guaranteed.

(d) NASA Safety Policy

Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect the public, astronauts and pilots, the NASA workforce (including employees working under NASA award instruments), and high-value equipment and property.

(e) Availability of Funds for Awards

Prospective proposers to this NRA are advised that funds are not in general available for awards for all of its solicited programs at the time of its release. The Government's obligation to make awards is contingent upon the availability of sufficient appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this NRA.

(f) Changes from ROA-2008

Proposers should be aware of the following significant changes in this NRA from ROA-2008.

- Proposers should only submit proposals via NASA's proposal data system, NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) (http://nspires.nasaprs.com). Until further notice, proposers will be unable to submit proposals intended for NASA through Grants.gov.

- Each program element includes a specific description of how it is relevant to the NASA Strategic Plan (see Section I(a)). Therefore it is not necessary for individual proposals to show relevance to NASA's broader goals and objectives. The proposal only needs to demonstrate relevance by discussing how the proposed investigation addresses the goals and objectives of the specific program element. See Section IV(e).

- For proposals submitted via NSPIRES, team member commitments may made via NSPIRES (see Section IV(b)(iv).

- In addition to the listed significant changes, this NRA and the *NASA Guidebook for Proposers* incorporate a large number of additional changes, including both policy changes and changes to proposal submission requirements. Many sections of both documents have been clarified since the release of ROA-2008. All proposers are urged to read this NRA and the 2009 edition of the *NASA Guidebook for Proposers* carefully, since all proposals must comply with their requirements, constraints, and guidelines.

II. AWARD INFORMATION

(a) Funding and Award Policies

The amount of funds expected to be available for new awards for proposals submitted in response to this NRA is given in the *Summary of Key Information* subsection that concludes each program description in the appendices. The number of awards that may be made for each program element is also given in this location. Any deviation from the usual maximum duration for awards of three years will also be noted (some programs may specify only one year for activities of limited scope to as long as five years for extensive, comprehensive studies). While the Summary of Key Information provides estimates for the funding and the number of awards, these amounts may vary greatly depending on merit of the proposals submitted and the funding available at the time of selections.

In all cases, NASA's goal is to initiate new awards within 46 days after the selection of proposals is announced for each program. However, this time period may be longer based on the workload experienced by NASA, the availability of appropriated funds, and any necessary post-selection negotiations with the proposing organization(s) needed for the award(s) in question. Regarding this last item, every proposer is especially encouraged to submit full and detailed explanations of the requested budget (see further below) to help expedite the processing of the award should their proposal be selected.

Awards made through this NRA will be in the form of grants, cooperative agreements, or contracts depending on the nature of the submitting organization and/or the specific requirements for awards given in each program description in the appendices. The type of award to be offered to selected proposers will generally follow the policies in Appendix D.1 of the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook), although in a few cases, only one type of award may be offered as specified in the program description. A NASA awards officer will determine the appropriate award instrument for the selections resulting from this solicitation. Grants and cooperative agreements will be subject to the provisions of the *NASA Grants and Cooperative Agreement Handbook* (hereafter referred to as the *Grants Handbook*, found at http://ec.msfc.nasa.gov/hq/grcover.htm) and Appendix D of the *NASA Guidebook for Proposers*. In the case of any conflict, the *Grants Handbook* takes precedence. Contract awards will be subject to the provisions of the Federal Acquisition Regulations (FAR) and the NASA FAR Supplement (see

http://ec.msfc.nasa.gov/hq/library/v-reg.htm).

Depending upon the Technical, Scientific and Research requirements (i.e., by Project or Thrust Area) ARMD may make Multiple Year Awards under this NRA. Multiple Year Awards will be managed in accordance with Appendix D of the NASA Guidebook for Proposers.

(b) Successor Proposals and Resubmissions

Generally, Principal Investigators holding previous awards selected through any of the programs offered through earlier NRAs are welcome to submit "successor" proposals that seek to continue a previously funded line of research (see Section 1.5 of the *NASA Guidebook for Proposers*; see Section IV(a) below for location reference). However, in order to ensure equitable treatment of all submitted proposals, NASA does not extend any special consideration to such successor proposals in terms of preferential handling, review, or priority for selection. Note that the instructions regarding successor proposals in the *NASA Guidebook for Proposers* have changed from past years. Proposers are strongly encouraged to review them.

Applicable proposals that were submitted but not selected for any previous NASA solicitation(s) may be submitted either in a revised or original form. Such submissions will be treated as a new proposal and will be subjected to a full peer review.

Funds provided as a result of instruments awarded under this NRA can not be applied as contributions under Space Act Agreements that NASA may execute in support of related programs.

III. ELIGIBILITY INFORMATION

(a) Eligibility of Applicants

Participation in this program is open to all categories of U.S. and non-U.S. organizations, including educational institutions, industry, and not-for-profit institutions. Historically Black Colleges and Universities (HBCUs), Other Minority Universities (OMUs), small disadvantaged businesses (SDBs), veteran-owned small businesses, service disabled veteran-owned small businesses, HUBZone small businesses, and women-owned small businesses (WOSBs) are encouraged to apply. Participation by eligible non-U.S. organizations in this program is welcome but subject to NASA's policy of no exchange of funds, in which each government supports its own national participants and accounts for associated costs (further information on foreign participation is provided in Section 1.6 of the *NASA Guidebook for Proposers*; see Section IV(a) below for location reference).

Other government agencies, Federally Funded Research and Development Centers (FFRDCs), and NASA Centers are not eligible to submit proposals under this NRA or participate as team members under proposals submitted by eligible entities. NASA Centers will be involved to the extent they are carrying out responsibilities in connection

with cooperative agreement or contracts. Additional information on collaboration opportunities may be found in appendices (A-E). Questions regarding NASA roles under cooperative agreements should be sent to the designated Point of Contact listed in the appropriate technical appendix (A-E).

(b) Number of Proposals and Teaming Arrangements

There is no restriction on the number of proposals that an organization may submit to this solicitation or on the teaming arrangements for any one proposal. However, each proposal must be a separate, stand-alone, complete document for evaluation purposes. The NRA is structured in a way that facilitates responses to individual subtopic areas. However, some project areas provide special instructions for addressing more than one subtopic in a single proposal. The proposer is responsible for reviewing any additional information that may be provided in project area instructions.

(c) Cost Sharing or Matching

If an institution of higher education or other not-for-profit organization is selected to receive a grant or cooperative agreement, cost sharing is not required, although NASA can accept cost sharing if it is voluntarily offered (see the *Grants Handbook*, Section B, Provision 1260.123, "Cost Sharing or Matching"). If a commercial organization is selected to receive a grant or cooperative agreement, cost sharing is typically required unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required but may be offered voluntarily (see also Section D, Provision 1274.204, of the *Grants Handbook*). See also Section V(a) below.

IV. Proposal and Submission Information

(a) Proposal Instructions and Requirements

All information needed to respond to this solicitation is contained in this ROA NRA and in the companion document entitled *Guidebook for Proposers Responding to a NASA Research Announcement* (hereafter referred to as the *NASA Guidebook for Proposers*) located at http://www.hq.nasa.gov/office/procurement/nraguidebook. By reference, the 2009 edition of the *NASA Guidebook for Proposers* is incorporated into this NRA, and proposers are responsible for understanding and complying with its procedures for the successful, timely preparation and submission of their proposals. Proposals that do not conform to its standards may be declared noncompliant and rejected without review.

The introductory material, as well as the appendices, of the *NASA Guidebook for Proposers* provide additional information about the entire NRA process, including NASA policies for the solicitation of proposals, guidelines for writing complete and effective proposals, and NASA's general policies and procedures for the review and selection of proposals and for issuing and managing the awards to the institutions that submitted selected proposals.

Questions regarding this NRA or its program elements should be directed to the cognizant Program Officer listed in the program element's description. Clarifications or questions and answers will be posted on the relevant program element(s)'s web page(s).

A group of *Frequently Asked Questions* provides additional miscellaneous information about a variety of the NASA proposal and award processes, policies, and procedures. The *Frequently Asked Questions* with general applicability to the majority or all of the solicitation are posted on the ARMD ROA page on NSPIRES. In addition, each Project Element may post additional *Frequently Asked Questions* in their respective pages on NSPIRES.

(b) Content and Form of the Proposal Submission

(i) Electronic Proposal Submission

All proposals submitted in response to this ROA NRA must be submitted in a fully electronic form. No hard copy of the proposal will be accepted. Electronic proposals must be submitted by one of the officials at the proposal principal investigator's organization who is authorized to make such a submission; electronic submission by the authorized organization representative (AOR) serves for the proposal as the required original signature by an authorized official of the proposing organization.

Proposers may submit proposals in response to this ROA NRA via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES), the NASA proposal data system (http://nspires.nasaprs.com; see Section IV(b)(iv) below). Until further notice, proposers will be unable to submit proposals intended for NASA through Grants.gov.

Note carefully the following requirements for submission of an electronic proposal.

- Every organization that intends to submit a proposal to NASA in response to this NRA, including educational institutions, industry, and not-for-profit institutions, must be registered in NSPIRES. Registration must be performed by an organization's electronic business point-of-contact (EBPOC) in the Central Contractor Registry (CCR).
- Any organization requesting NASA funds through the proposed investigation must be listed on the Proposal Cover Page. NASA will not fund organizations that do not appear on the Proposal Cover Page.
- Each individual team member (e.g., PI, co-investigators, etc.), including all personnel named on the proposal's electronic cover page, must be individually registered in NSPIRES.
- Each individual team member (e.g., PI, co-investigators, etc.), including all personnel named on the proposal's electronic cover page, must specify an organizational affiliation. The organizational affiliation specified must be the organization through which the team member is participating in the proposed investigation. If the individual has multiple affiliations, then this organization may be different from the individual's primary employer or preferred mailing address.

Generically, an electronic proposal consists of one or more electronic forms, including an

electronic cover page and one or more attachments. The attachments contain all sections of the proposal, including the science/technical/management section, as well as all required and allowed appendices; see Section IV(b)(ii) below for further requirements.

Submission of electronic proposals via NSPIRES requires several coordinated actions from the proposing organization. In particular, when the PI has completed entry of the data requested in the required electronic forms and attachment of the allowed PDF attachments, including the science/technical/management section, an official at the PI's organization who is authorized to make such a submission, referred to as the authorized organization representative (AOR), must submit the electronic proposal (forms plus attachments). Coordination between the PI and his/her AOR on the final editing and submission of the proposal materials is facilitated through their respective accounts in NSPIRES. Note that if one individual is acting in both the PI and AOR roles, he/ she must ensure that all steps in the process are taken, including submitting the proposal from the organization.

(ii) Proposal Format and Contents

All proposals submitted in response to this NRA must include the appropriate required electronic forms that are available through the NSPIRES proposal submission system.

The science/technical/management section and other required sections of the proposal must be submitted as searchable, unlocked PDF files that are attached to the electronic submission using one of the proposal submission systems. Proposers must comply with any format requirements specified in this NRA and in the *NASA Guidebook for Proposers* (e.g. Section 2.3 of the *NASA Guidebook for Proposers*). Only appendices/attachments that are specifically requested in either this NRA or in the *NASA Guidebook for Proposers* will be permitted; proposals containing unsolicited appendices/attachments may be declared noncompliant. Section 2 of the *NASA Guidebook for Proposers* provides detailed discussions of the content and organization of proposals suitable for all program elements in this NRA, as well as the default page limits of a proposal's constituent parts.

Note that some of the program elements in the Appendices of this NRA may specify different page limits for the main body of the proposal; if so, these page limits will be prominently given in the *Summary of Key Information* subsection that concludes each program element description. In the event the information in this NRA is different from or contradictory to the information in the *NASA Guidebook for Proposers,* the information in this NRA takes precedence.

A detailed Work Plan delineating how the Recipient/Awardee will accomplish the Goals and Objectives of the proposed Program, Thrust or Project Area (including applied Research Methodologies, Processes, and Resources, etc.) shall be included as part of the proposal. The Work Plan shall be evaluated in accordance with the requirements set forth in each of the applicable Appendices. For entities seeking contracts, a Statement of Work (SOW) should be included as part of the proposal for the award of a contract. The SOW should include the following in the order listed: (1) Scope (2) Objectives (3) SOW

tasks organized in a Work Breakdown Structure (WBS) (4) Program Schedule & Milestones (5) Measurable metrics, and (6) deliverables, which should be defined and described under the applicable task / WBS portion of the SOW. The SOW does not count against the page limit and should be inserted at the end of the proposal.

If a commercial organization seeks an award of a cooperative agreement that will involve cost sharing (see Section III (c)) or if milestone payments are anticipated, it is requested that a schedule of milestone payments be included in the proposal. The schedule should include a description of the milestone as a performance benchmark as well as the associated amount of funds to be paid or transferred upon successful completion of the milestone. The schedule does not count against the page limit of the proposal (See 1274.204(d) and 1274.908 of the *Grants Handbook).*

Important note on creating PDF files for upload: It is essential that all PDF files generated and submitted meet NASA requirements. This will ensure that the submitted files can be ingested by NSPIRES. At a minimum, it is the responsibility of the proposer to: (1) ensure that all PDF files are unlocked and that edit permission is enabled – this is necessary to allow NSPIRES to concatenate submitted files into a single PDF document; and (2) ensure that all fonts are embedded in the PDF file and that only Type 1 or TrueType fonts are used. In addition, any proposer who creates files using TeX or LaTeX is required to first create a DVI file and then convert the DVI file to Postscript and then to PDF. See http://nspires.nasaprs.com/tutorials/PDF_Guidelines.pdf for more information on creating PDF documents that are compliant with NSPIRES. PDF files that do not meet NASA requirements cannot be ingested by the NSPIRES system; such files may be declared noncompliant and not submitted to peer review for evaluation.

(iii) Additional ROA Requirement for Budget Format

The uniform policy concerning the review of proposals submitted in response to this ROA NRA against the cost evaluation criterion is described in Appendix C of the *NASA Guidebook for Proposers*. External peer reviewers will provide recommendations on the budget summary and budget justification for cost realism and cost reasonableness to ensure that the proposed technical work is feasible. NASA program personnel will conduct the complete evaluation of cost including the detailed budget and budget justification for all relevant factors including cost realism, cost reasonableness, total cost and comparison of the proposed cost to available funds.

In order to allow this division of review responsibilities, NASA will provide limited but sufficient proposal budget information to the peer review (work effort and personnel, other direct costs including procurements and subawards/subcontracts) while reserving certain proposal budget details for NASA's use (costs of direct labor, indirect costs, total costs).

Therefore, ARMD places additional requirements on the submission of proposals in response to this ROA NRA. Where the requirements in this NRA conflict with requirements and instructions found elsewhere (e.g., in the *NASA Guidebook for Proposers* or NSPIRES instructions), the requirements in this NRA have precedence. It is

important that all proposers responding to this ROA NRA follow these additional instructions carefully to enable an appropriate evaluation of their proposals.

In addition to the budget summary information provided in the NSPIRES Cover Page forms, all proposers are required to include more detailed budgets and budget justifications, including detailed subcontract/subaward budgets, in a format of their own choosing in the *Budget Justification.* For this NRA, this additional budget must be divided into three parts, the "*Budget Justification: Narrative*" and the "*Budget Justification: Details*," both as described in Section 2.3.10 of the *NASA Guidebook for Proposers*, and the "*Total Budget*," a requirement specific to this ROA NRA.

The *Budget Justification: Narrative* includes the *Table of Proposed Work Effort* and the description of facilities and equipment, as well as the rationale and basis of estimate for all components of cost including procurements, travel (destination, purpose and number of travelers), publication costs, and all subawards/subcontracts. The *Table of Proposed Work Effort* must include the names and/or titles of all personnel (including postdoctoral fellows and graduate students) necessary to perform the proposed investigation regardless of whether these individuals require funding from the current proposal. The number of person-months each person is expected to devote to the project must be given for each year. The *Budget Justification: Details* must include the detailed proposed budget including all of the Other Direct Costs and Other Applicable Costs specified in the *NASA Guidebook for Proposers*. For this NRA, the *Budget Justification: Narrative* and the *Budget Justification: Details* should not specify the cost of Direct Labor or any Administrative Costs (e.g., overhead).

While the appropriate award instrument will be determined by the Government, offerors must indicate the assumed type of award used during budget preparation. Offerors must indicate whether a grant, cooperative agreement or contract is presumed, and the type of contract proposed (i.e. cost plus fixed fee, cost sharing, fixed price, etc.). Note that some topics may specify an expected award type.

The *Total Budget* file must specify the complete set of cost components including all costs discussed in the *Budget Narrative* and *Budget Details*, as well as the Total Estimated Cost, cost of Direct Labor, and Administrative Costs (overhead). The *Total Budget* document will not be provided to the non-government peer review, but will be used by NASA in the evaluation of total cost and comparison of the proposed cost to available funds. Proposers may also choose to include any data they consider to be sensitive financial information in the *Total Budget* file required by this Section of the ROA NRA. However, if any such information is excluded from the *Budget Justification: Narrative* and *Details* sections, a note should be included in the applicable section of the *Budget Justification: Narrative* or *Details* section to clarify where the information is located in the *Total Budget* file.

The required *Budget Justification: Narrative* and *Details* section of the proposal may be incorporated into the proposal document as these will be provided to the peer review (for submission via NSPIRES, the *Budget Justification: Narrative* and *Details* must be

incorporated into the single proposal PDF file). Proposers to the ROA must provide the *Total Budget* in a file called "totalbudget.pdf," which is uploaded as a separate attachment.

Note that failure to provide sufficient budget justification and data in the *Budget Narrative* (including the *Table of Proposed Work Effort*) and the *Budget Details*, recognizing that the peer review will not have access to the Total Estimated Cost, the cost of Direct Labor, and Administrative Costs (e.g., overhead), will prevent the peer review from appropriately evaluating the cost realism of the proposed effort. A finding by the peer review of "insufficient information to properly evaluate cost realism" will be considered a weakness of the proposal. Inconsistent budget information between these budget descriptions will also be considered a weakness of the proposal.

(iv) Submission of Proposals via NSPIRES, the NASA Proposal Data System

Proposals may be submitted electronically via NASA's master proposal data base system, the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). In order to submit a proposal via NSPIRES, this NRA requires that the proposer register key data concerning the intended submission with NSPIRES; NSPIRES is accessed at http://nspires.nasaprs.com. Potential applicants are urged to access this site well in advance of the proposal due date(s) of interest to familiarize themselves with its structure and enter the requested identifier information.

It is especially important to note that every individual named on the proposal's electronic *Cover Page* form (see below) as a proposing team member in any role, including co-investigators and collaborators, must be registered in NSPIRES and that such individuals must perform this registration themselves; no one may register a second party, even the Principal Investigator of a proposal in which that person is committed to participate. This data site is secure and all information entered is strictly for NASA's use only.

New change in ROA-09: All team members identified on the NSPIRES proposal cover page may indicate their commitment to the proposed work via NSPIRES.

- Each team member will receive an email from NSPIRES indicating that he/she has been added to the proposal and should log in to NSPIRES. Once logged in, the team member should follow the link in the "Reminders and Notifications" section of his NSPIRES homepage, titled "Need Co-I and/or Collaborator Statement of Commitment For: Proposal to Solicitation <<solicitation number>>." On the "Team Member Statement of Commitment -Confirmation" page, the team member should read the commitment language, click the "Accept" button, and then click "OK".

- PI's may monitor the status of team member commitments by examining the "Commitment Confirmed" column on the Team Member page of the NSPIRES proposal cover page record.

- If desired, statements of commitment from team members may be provided as letters attached to the proposal application

All proposals submitted via NSPIRES in response to this NRA must include a required electronic *Cover Page* form that is accessed at http://nspires.nasaprs.com. This form is comprised of several distinct sections: a *Cover Page* that contains the identifier information for the proposing institution and personnel; a *Proposal Summary* that provides an overview of the proposed investigation that is suitable for release through a publicly accessible archive should the proposal be selected; and a *Budget Summary* of the proposed research effort. Unless specified in the program description itself, no other forms are required for proposal submission via NSPIRES. See the *NASA Guidebook for Proposers*, Sections 2 and 3, for further details.

The required elements of the proposal, including the science/technical/management section, must be submitted as one or more PDF documents that are attached to the *Cover Page* using the tools in NSPIRES. It is possible that the complete proposal is submitted as a single, searchable, unlocked PDF document, that contains the complete proposal, including the science/ technical/ management section and budget justification (but not the *Total Budget*), assembled in the order provided in the NASA Guidebook for Proposers (see Section 2.3) and uploaded using the tools in NSPIRES. The Total Budget must be uploaded as a separate attachment in a file named "totalbudget.pdf". One advantage of submitting the proposal as one PDF document as described above is that it is easier for the proposer to create a table of contents that will be correct. If separate files are uploaded, there may be slight differences in page numbering due to the concatenation process. Any mismatch with the table of contents caused by this process does not impact the evaluation of the proposal.

NSPIRES will provide a list of all elements that make up an electronic proposal, and the system will conduct an element check to identify any item(s) that is (are) apparently missing or incomplete.

Proposers are encouraged to begin their submission process early. Tutorials and other NSPIRES help topics may be accessed through the NSPIRES online help site at http://nspires.nasaprs.com/external/help.do. For any questions that cannot be resolved with the available on-line help menus, requests for assistance may be directed by E-mail to nspires-help@nasaprs.com or by telephone to (202) 479-9376, Monday through Friday, 8:00 a.m. – 6:00 p.m. Eastern Time.

(v) Submission of Proposals via Grants.gov

Until further notice, proposers will be unable to submit proposals intended for NASA through Grants.gov.

(vi) Notice of Intent to Propose

For most of the programs advertised through this solicitation, a brief Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this solicitation. The information contained in an NOI is used to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. To be of maximum value, NOIs should be submitted by the proposal principal

investigator to NSPIRES, NASA's master proposal data system located at http://nspires.nasaprs.com, by the dates given in Tables 2 or 3 below for each program in the Appendices. Note that NOIs may be submitted within NSPIRES directly by the proposal principal investigator; no action by an organization's AOR is required to submit an NOI.

Interested proposers must register with NSPIRES before it can be accessed for use; see Section IV(b)(i) above. Since NOIs submitted after the deadline may still be useful to NASA, late NOIs may be submitted by E-mail as directed in Section 3.1 of the *NASA Guidebook for Proposers.*

(vii) Conflict of Interest Check Information

In order to ensure that all proposal evaluations are conducted as fairly as possible, it is important to ascertain whether prospective reviewers may have conflicts of interest that might affect their capacity to function with impartiality. To facilitate the process of identifying potential conflicts of interest, it is necessary to collect information about the organizations participating in each proposal. A NASA program-specific form will be used to collect this information. This form will be part of a submission to the NSPIRES system.

(c) Proposal Submission Dates, Time, and Location

For each program in Appendices A through E of this NRA, the electronic proposal must be submitted in its entirety by 11:59 p.m. Eastern Time on the appropriate proposal due date given in Tables 2 or 3 below. All proposals must be submitted electronically using NSPIRES (see Sections IV(b)(i–v), above).

Proposals that are late will be handled in accordance with NASA's policy as given in Section (g) of Appendix B of the *NASA Guidebook for Proposers* (also see Sections 3.2 and F.23). Proposals received after the due date may be returned without review. If a late proposal is returned, it is entirely at the discretion of the proposer whether or not to resubmit it in response to a subsequent appropriate solicitation. It is not possible to submit a late proposal electronically via NSPIRES unless the electronic Cover Page was initially created prior to the proposal due date.

(d) Proposal Funding Restrictions

In addition to the funding restrictions and requirements given in the Guidebook for Proposers and the Grants Handbook, the following restrictions are applicable to this ROA NRA.

- The estimated funding and number of proposals anticipated to be funded, as shown in the *Summary of Key Information* at the end of each program element, are subject to the availability of appropriated funds, as well as the submission of a sufficient number of proposals of adequate merit.

- The construction of facilities is not an allowed activity for any of the programs solicited in this NRA unless specifically stated. For further information on the allowability of costs, refer to the cost principles cited in the *Grants Handbook*, Section 1260.127.
- Typically travel, including foreign travel, is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for publicizing its results at appropriate professional meetings.
- Profit for commercial organizations is not allowable under grant or cooperative agreement awards but is allowable under contract awards.
- U.S. research award recipients may directly purchase supplies and/or services from non-U.S. sources that do not constitute research, but award funds may not be used to fund research carried out by non-U.S. organizations. However, subject to export control restrictions, a foreign national may receive remuneration through a NASA award for the conduct of research while employed either full or part time by a U.S. organization (see Section 1.6 of the *NASA Guidebook for Proposers*).

(e) Proposal Requirements for Relevance

Proposals for all NASA sponsored research programs are usually evaluated on three criteria: intrinsic merit, relevance to NASA's objectives, and cost realism and reasonableness (see Appendix C of the NASA Guidebook for Proposers). These criteria may be modified in the Appendix of this NRA. Each program element includes a specific description of how it is relevant to the NASA Strategic Plan. Therefore, unless otherwise stated in the program element, it is not necessary for individual proposals to show relevance to NASA's broader goals and objectives. The proposal should instead focus on demonstrating relevance by discussing how the proposed investigation addresses the goals and objectives of the specific program element.

Note that this NRA references the strategic goals and objectives in the 2006 NASA Strategic Plan (see Section I(a) and Table 1).

V. PROPOSAL REVIEW INFORMATION

(a) Evaluation Criteria

Evaluation by peers of the proposing personnel will be used to assess each proposal's intrinsic scientific and technical merit, its relevance to NASA's stated objectives, and its cost realism and reasonableness. See Appendix C.2 of the *NASA Guidebook for Proposers* for further discussion of these criteria and their relative weights. Some of the projects in the attached Appendices contain additional or tailored evaluation criteria. The criteria identified in the Appendices take precedence over this and other sections of the NRA. The evaluation factors include factors evaluated by peer reviewers, as well as factors evaluated by NASA program personnel. Note the following specific points:

- Some of the programs discussed in the Appendices will provide specific factors, based on the solicited research objectives, which will be considered when

evaluating a proposal's technical merits and/or its relevance to program objectives.

- As discussed in Section IV(e) above, relevance will be judged in part by the proposal's focus on specific objectives for the ARMD program element.
- Opinions on a proposal's cost may be recommended by peer review (for cost realism and cost reasonableness), but NASA personnel will conduct the complete cost evaluation (for cost realism, cost reasonableness, total cost and comparison to available funds). Proposers must follow the budget format requirements in Section IV(b)(iii).
- The selection official may take program balance into account when selecting proposals for funding.
- Cost sharing is generally not considered as part of the evaluation (see Section III(c) above). However, cost sharing may become a factor at the time of selection when deciding between proposals of otherwise equal technical merits.

(b) Review and Selection Processes

Review of proposals submitted to this NRA will be consistent with the general policies and provisions given in Sections C.1 through C.4 of Appendix C of the *NASA Guidebook for Proposers*, and selection procedures will be consistent with the provisions of Section C.5 of that document.

Unless otherwise specified, the Program Director responsible for a thrust area is the final Selecting Official. In cases where a conflict of interest exists, the Selecting Official will be designated by the Associate Administrator for Aeronautics.

(c) Partial Awards and Participation with Others

NASA may elect to offer selection of only a portion of a proposed investigation, usually at a level of support reduced from that requested in the original proposal or may also offer tentative selections in which NASA requests investigators to team in a joint investigation. Additionally, NASA may decide to award an effort for less than the full period of the proposal. In either case, the proposer will be given the opportunity to accept or decline such selection. If the proposer accepts such an offer, a revised budget and statement of work may be required before funding action on the proposal can be initiated. If the proposer declines the offer of a partial selection, or participation in a joint investigation, the offer of selection may be withdrawn in its entirety by NASA.

(d) Selection Announcement and Award Dates

NASA's stated goal is to announce selections as soon as possible. However, NASA does not usually announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in the budget process for NASA usually results in a delay of the selection date(s). After 150 days past the proposal due date for which a proposal was submitted, proposers may contact the responsible Program Officer listed at the conclusion of that program description in the appendices for the status of the selection activity.

Those proposers not selected will be notified by postal or electronic mail and offered a debriefing consistent with the policy in Section C.6 of the *NASA Guidebook for Proposers*.

(e) Process for Appeals

(i) Ombudsman Program

The NASA Procurement Ombudsman Program is available under this NRA as a procedure for addressing concerns and disagreements. The clause at NASA FAR Supplement (NFS) 1852.215-84 ("Ombudsman") is incorporated into this NRA. The cognizant ombudsman is

Director, Contract Management Division
Office of Procurement
NASA Headquarters
Washington, DC 20546
Telephone: 202-358-0445.

(ii) Protests

Only prospective offerors seeking contract awards under this NRA have the right to file a protest, either at the Government Accountability Office (GAO) or with the Agency, as defined in FAR 33.101. The provisions at FAR 52.233-2 ("Service of Protest") and NFS 1852.233-70 ("Protests to NASA") are incorporated into this NRA. Under both of these provisions, the designated official for receipt of protests to the Agency and copies of protests filed with the GAO is

Assistant Administrator for Procurement
Office of Procurement
NASA Headquarters
Washington, DC 20546.

VI. AWARD ADMINISTRATION INFORMATION

(a) Notice of Award

Notification of both the selected, as well as the nonselected proposers, will be consistent with the policy given in Section C.5.3 of the *NASA Guidebook for Proposers.* For selected proposers, the offeror's business office will be contacted by a NASA Awards Officer, who is the only official authorized to obligate the Government. For a grant or cooperative agreement, any costs incurred by the offeror in anticipation of an award will be subject to the policies and regulations of the *Grants Handbook* (see Section B, Part 1260.125(e)).

(b) Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or national policy requirements, nor do the awards that will be made involve any special terms and

conditions that differ from NASA's general terms and conditions as given in the *Grants Handbook and the NASA Guidebook for Proposers*. Please note that it is expected that proposers will comply with Homeland Security Presidential Directive/ HSPD-12. HSPD-12 applicability will be determined during negotiation for award for selected proposals.

(c) Award Reporting Requirements

The reporting requirements for awards made through this NRA will be consistent with Exhibit G of the *Grants Handbook*. Any additional requirements will be specified in the program description.

VII. Points of Contact for Further Information

General questions and comments about the policies of this NRA may be directed to:

Jay Dryer
Senior Technical Advisor, NASA Headquarters, Aeronautics Research Directorate
E-mail: NASA-roa@nasa.gov

Note: Proposals shall not be submitted to this E-mail address. Proposals shall be submitted electronically as described in Section IV above.

Specific questions about a given program element in this NRA should only be directed to the Program Officer(s) listed in the *Summary of Key Information* subsection that concludes each program description.

No communication concerning this NRA may be made to any other NASA official other than those specifically listed in this NRA.

Inquiries about accessing or using the NASA proposal data base located at http://nspires.nasaprs.com should be directed by an E-mail that includes a telephone number to nspires-help@nasaprs.com or by calling (202) 479-9376. This help center is staffed Monday through Friday, 8:00 a.m. – 6:00 p.m. Eastern Time.

VIII. Ancillary Information

(a) Announcement of Updates/Amendments to Solicitation

It is possible that additional programmatic information for any of its programs may develop before their proposal due dates. If so, such information will be added as a formal amendment to this NRA as posted at its homepage at http://nspires.nasaprs.com. It is the responsibility of the prospective proposer to check this NRA's homepage for updates concerning the program(s) of interest.

Any clarifications or questions and answers that are published will be posted either with the summary ROA NRA information or on the relevant program element(s)'s web

page(s) at http://nspires.nasaprs.com.

(b) Electronic Submission of Proposal Information

On-time electronic submission over the World Wide Web is required for every proposal. While every effort is made to ensure the reliability and accessibility of this Web site and to maintain a help center via E-mail and telephone, difficulty may arise at any point on the Internet, including the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with this site and to submit the required proposal materials well in advance of the deadline(s) of the program(s) of interest. Difficulty in registering with or using a proposal submission system is not, in and of itself, a sufficient reason for NASA to consider a proposal that is submitted after the proposal due date (see Section IV(c)).

IX. CONCLUDING STATEMENT

Through this ROA NRA, NASA encourages the participation of the aeronautics communities in its Aeronautics Research Mission Directorate research and technology programs. Comments about this NRA are welcome and may be directed to the point of contact for general questions and comments identified in Section VII above.

Tony Strazisar
Director (Acting)
Fundamental Aeronautics Program

Amy Pritchett
Director
Aviation Safety Program

John Cavolowsky
Director (Acting)
Airspace Systems Program

Mike George
Director
Aeronautics Test Program

Jaiwon Shin
Associate Administrator
Aeronautics Research Mission Directorate

TABLE 1. NASA STRATEGIC GOALS AND OUTCOMES[2]

TABLE 1A. NASA'S STRATEGIC GOALS

Strategic Goal 1: Fly the Shuttle as safely as possible until its retirement, not later than 2010.

Strategic Goal 2: Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.

Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

- Strategic Sub-goal 3A Study Earth from space to advance scientific understanding and meet societal needs.
- Strategic Sub-goal 3B Understand the Sun and its effects on Earth and the solar system.
- Strategic Sub-goal 3C Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.
- Strategic Sub-goal 3D Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.
- Strategic Sub-goal 3E Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.
- Strategic Sub-goal 3F Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.

Strategic Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

Strategic Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

[2] From *The 2006 NASA Strategic Plan*, available in February 2006 at http://www.nasa.gov.

TABLE 1B. NASA'S STRATEGIC OUTCOMES

Strategic Sub-goal 3E — Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

NASA Outcomes:

3E.1 By 2016, identify and develop tools, methods and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).

3E.2 By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements for the Next Generation Air Transportation System.

3E.3 By 2016, develop multidisciplinary design, analysis, and optimization capabilities for use in trade studies of new technologies, enabling better quantification of vehicle performance in all flight regimes and within a variety of transportation system architectures.

3E.4 Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.

TABLE 2. SOLICITED RESEARCH PROGRAMS (IN ORDER OF PROPOSAL DUE DATES)

APPENDIX	PROGRAM	NOI DUE DATE	PROPOSAL DUE DATE
B-3	Integrated Intelligent Flight Deck Project (IIFDT1)	4/29/09	5/28/09 (see Note 1 below)
B-4	Integrated Vehicle Health Management Project (IVHM1)	4/29/09	5/28/09
C-2	NextGen Airspace Project (AS1)	6/16/09	7/16/09

Note: It is expected that additional project areas will be added in future amendments.

Note 1: For the Integrated Intelligent Flight Deck Technologies Project (IIFDT1), the due date for the first round of evaluations is May 28, 2009. To be considered in the first round of evaluations, proposals must be received by 11:59 p.m. Eastern Time on the due date as described in Section IV(c). It is expected that the majority, and perhaps all, of the available funds will be allocated during this first round of evaluations. However, the topics in this section will remain open until July 27, 2009 in case funding still remains after the first round of evaluations. A note will be posted on the ROA page on NSPIRES if funds are expended and no further reviews are expected. Proposers who decide to wait until after the first round of evaluations do so at their own risk.

TABLE 3. SOLICITED RESEARCH PROGRAMS (IN ORDER OF APPENDICES A–E)

APPENDIX	PROGRAM	NOI DUE DATE	PROPOSAL DUE DATE
B-3	Integrated Intelligent Flight Deck Project (IIFDT1)	4/29/09	5/28/09 (see Note 1 below)
B-4	Integrated Vehicle Health Management Project (IVHM1)	4/29/09	5/28/09
C-2	NextGen Airspace Project (AS1)	6/16/09	7/16/09

Note: It is expected that additional project areas will be added in future amendments.

Note 1: For the Integrated Intelligent Flight Deck Technologies Project (IIFDT1), the due date for the first round of evaluations is May 28, 2009. To be considered in the first round of evaluations, proposals must be received by 11:59 p.m. Eastern Time on the due date as described in Section IV(c). It is expected that the majority, and perhaps all, of the available funds will be allocated during this first round of evaluations. However, the topics in this section will remain open until July 27, 2009 in case funding still remains after the first round of evaluations. A note will be posted on the ROA page on NSPIRES if funds are expended and no further reviews are expected. Proposers who decide to wait until after the first round of evaluations do so at their own risk.

APPENDIX A: Fundamental Aeronautics Program

A.1 Program Overview

The top-level goal of the Fundamental Aeronautics Program is to develop system-level, multi-disciplinary capabilities for both civilian and military applications. The program also provides long-term investment in research to support and sustain expert competency in critical core areas of aeronautics technology.

The Fundamental Aeronautics Program encompasses research and technology spanning four (4) flight regimes: Subsonic Fixed Wing, Subsonic Rotary Wing, Supersonics and Hypersonics. It also supports NASA's Vision for Space Exploration by providing key aeronautical capabilities that can be adapted for high-speed vehicles exiting and entering the atmosphere of our planet as well as operating throughout the atmospheres of other planetary bodies such as Mars.

The work in the Fundamental Aeronautics Program directly benefits the public through the development of techniques and concepts for both subsonic and supersonic vehicles that are cleaner, quieter, and more energy efficient. Research efforts in revolutionary configurations, lighter and stiffer materials, improved propulsion systems, and advanced concepts for high-lift and drag reduction all target the efficiency and environmental compatibility of future air vehicles. NASA's Vision for Space Exploration will benefit from fundamental technology advances that can impact our ability to both access space and survive the planetary entry, descent, and landing phase. The program also helps the country develop and maintain excellence in the aeronautics workforce by providing significant research opportunities in all of its projects.

A major emphasis of the Fundamental Aeronautics Program is on the mastery and intellectual stewardship of key core competencies of Aeronautics for the Nation across all flight regimes. However, NASA will principally conduct long-term research that is both focused and integrated across disciplines in areas that are appropriate to our unique capabilities. NASA will invest broadly and deeply producing knowledge, technology, and tools that are applicable across a broad range of air vehicles.

NASA has defined four distinct levels to describe its approach to Fundamental Aeronautics technology development: (1) conduct foundational research to further our fundamental understanding of the underlying physics and our ability to model that physics, (2) leverage the foundational research to develop technologies and analytical tools focused on discipline-based solutions, (3) integrate methods and technologies to develop multi-disciplinary solutions, and (4) solve the aeronautics challenges for a broad range of air vehicles with system-level optimization, assessment and technology integration.

Interaction with the aeronautics community aligns with the four levels: (1) NASA will advance the state of knowledge of the underlying physics and its modeling by partnering with universities and companies engaged in foundational research, (2) NASA will investigate discipline-related challenges and will interact with the aeronautics community

through published reports and direct technology transfer, (3) NASA will develop multi-disciplinary methods and technologies, and disseminate them in published reports and direct technology transfer, and (4) NASA will collaborate with industry by means of non-reimbursable cooperative agreements to address system-level challenges at the pre-competitive level.

The awards from this NRA will support U.S. leadership in aerospace through its commitment to identify and advance innovative ideas, concepts, technologies, and approaches to the aeronautics challenges described below for each of the four Fundamental Aeronautics thrust areas.

Milestone references are provided in the sections below under the heading "NASA Milestones" so that it is possible to see how the NRA topics fit into the NASA Fundamental Aeronautics research plan. These milestones are listed on project roadmaps that are available on the ARMD website (www.aeronautics.nasa.gov, under the Programs link).

A.2: Subsonic Fixed Wing

1. Project Overview

A major focus of the Subsonic Fixed Wing (SFW) project is to develop improved prediction methods and technologies for lower noise, lower emissions, and higher performance for subsonic aircraft. Increased performance requires increased energy efficiency and operability for advanced airframe and engine systems and subsystems. The ten-year strategy includes providing novel test methods and validated prediction tools that can be used to improve system trades for advanced concepts that are capable of meeting long-term noise, emissions, and performance targets. The following objectives address the overall project goals.

- Improvements in prediction tools and new experimental methods that provide fundamental properties and establish validation data
- Noise prediction and reduction technologies for airframe and propulsion systems
- Emissions reduction technologies, alternative fuels, and particulate measurement methods
- Improved vehicle performance through design and development of lightweight, multifunctional and durable structural components, high lift aerodynamics, and higher bypass ratio engines with efficient power plants.

Table 1 summarizes the vehicle technology goals for future generation aircraft and represents the "corners" of the trade space. It is desirable to identify technology and vehicle solutions that simultaneously meet the goals for noise, emissions, and energy usage (fuel burn).

Table 1 – NASA's Technology Goals for Future Subsonic Vehicles

CORNERS OF THE TRADE SPACE	N+1 (2015 EIS) Generation Conventional Tube and Wing (relative to B737/CFM56)	N+2 (2020 IOC) Generation Unconventional Hybrid Wing Body (relative to B777/GE90)	N+3 (2030-2035 EIS) Advanced Aircraft Concepts (relative to user defined reference)
Noise (cum below Stage 4)	- 32 dB	- 42 dB	55 LDN at average airport boundary
LTO NOx Emissions (below CAEP 6)	-60%	-75%	better than -75%
Performance: Aircraft Fuel Burn	-33%***	-40%***	better than -70%
Performance: Field Length	-33%	-50%	exploit metro-plex* concepts

*** An additional reduction of 10 percent may be possible through improved operational capability
* Concepts that enable optimal use of runways at mutiple airports within the metropolitan areas
EIS = Entry Into Service; IOC = Initial Operating Capability

2. Description of Solicited Research

The Subsonic Fixed Wing Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3. Summary of Key Information

Expected program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the Summary of Solicitation of this NRA and Chapter 3 of the NASA *Guidebook for Proposers - 2009*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected award type	TBD
Funding opportunity number	TBD
NASA points of contact (POC)	Email questions to: Subsonicfixedwing@grc.nasa.gov Written responses will be posted on the solicitation website. Principal Investigator: Fay Collier Project Scientist: Rich Wahls/Jim Heidmann NRA Manager: Kim Pham Procurement POC: Melissa Merrill

A.3: Subsonic Rotary Wing

1. Project Overview

The challenge of the Subsonic Rotary Wing project of the NASA Fundamental Aeronautics program is to develop validated physics-based multidisciplinary design and analysis tools for rotorcraft, integrated with technology development, enabling rotorcraft with advanced capabilities to fly as designed for any mission. Meeting this challenge will require innovative technologies and methods, with an emphasis on integrated, multidisciplinary, first-principle computational tools specifically applicable to the unique problems of rotary wing aircraft.

The focus of the Subsonic Rotary Wing project of the Fundamental Aeronautics program is the civil utility of rotorcraft. Several facets will be addressed at the fundamental research level: efficiency, including aerodynamic performance and structural weight; productivity, which requires high speed, large payload, long range, and good maneuverability; and environmental acceptance, particularly noise and handling qualities. Without intending to predict where the design process will lead when truly effective design and analysis tools are available, some very promising (and very challenging) configurations can be identified to drive the required fundamental research. The challenges faced in rotary wing aviation are among the most complex and demanding of any configuration: highly complex, three-dimensional rotor and fuselage structures, unsteady flows in speed regimes from low subsonic to high transonic, dynamically-stalled components, harsh operating environments, highly-loaded propulsion systems, and a vehicle that is statically unstable. The Subsonic Rotary Wing project will focus its research effort in the most persistent technical challenge areas in order to produce advances in prediction tool capability and technology.

The Subsonic Rotary Wing project will utilize this NASA Research Announcement (NRA) to leverage in-house foundational research with academic institutions, non-profit organizations and industry performing foundational and applied research to address technology needs that are focused on unique aspects of rotorcraft configurations.

2. Description of Solicited Research

The Subsonic Rotary Wing Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3. Summary of Key Information

Expected budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the Summary of Solicitation of this NRA.
Detailed instructions for the preparation and submission of proposals	See the NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009 at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the Summary of Solicitation of this NRA and Chapter 3 of the NASA Guidebook for Proposers-2009.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected type of award	TBD
Funding opportunity number	TBD
NASA point of contact concerning this program	Principal Investigator:Susan A. Gorton, Susan.A.Gorton@nasa.gov Procurement POC: Kelly Kaplan, Kelly.G.Kaplan@nasa.gov

A.4: Supersonics

1. Project Overview

The Supersonics Project is aligned with the ARMD principles of maintaining intellectual stewardship of aeronautical core competencies for the nation in the supersonic flight regime and of focusing research in areas that are appropriate to NASA's unique capabilities. The Supersonics Project is a broad-based effort designed to develop knowledge, capabilities and technologies that support vehicles that fly in the supersonic speed regime. A major focus of this effort is eliminating the efficiency, environmental and performance barriers to practical supersonic cruise vehicles. This effort is divided into elements that focus on foundational, discipline, multidiscipline and integrated system level challenges. The project's internal investment at the NASA Aero Centers is primarily focused at the discipline and multidiscipline levels. The project also invests a significant portion of its allocated budget in NASA Research Announcement (NRA) solicitations. The objective of the NRA investment is to stimulate innovation in integrated propulsion/airframe concepts and to create an environment for collaboration among NASA researchers, commercial organizations, and academia. This investment is primarily focused at foundational level research, but has also been used to aid the project in developing integrated systems concepts. These concepts can be used to both conduct trade studies to determine the requirements for future supersonic aircraft and to assess the effectiveness of the project's work content at overcoming the barriers to supersonic flight. NASA has proposed an initial set of requirements for supersonic aircraft anticipated to enter service in 2012-2015 ("N+1"), 2018-2020 ("N+2") and 2030 ("N+3") time period (see table 1).

In conjunction with an award from a recent NRA, the Supersonics Project is pursuing the development of an "N+2" vehicle concept and is conducting trade studies to investigate its mission and technology requirements. In addition, the Supersonics Project is in the NRA award process for a similar effort directed at the "N+3" class of vehicles.

A key element of the Supersonics Project is systems level validation testing, which leverages the substantial investments made by the project (both internally and through the NRA). The system level validation will provide proven capabilities that will be able to address the efficiency, environmental and performance challenges of future supersonic aircraft.

2. Description of Solicited Research

The Supersonics Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3. Summary of Key Information

Expected annual program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected award type	TBD
Funding opportunity number	TBD
NASA points of contact	Email questions to: FA_Supersonics@nasa.gov Written responses will be posted on-line. Peter G. Coen - Principal Investigator Dr. Louis Povinelli - Project Scientist Kestutis C. Civinskas - Project Manager Dr.Tom Wallett – Project NRA Manager Procurement POC: Merrill, Melissa, melissa.a.merrill@nasa.gov

A.5: Hypersonics

1. Project Overview

The Hypersonics Project is investing a substantial portion of its allocated budget through NRA solicitations. Objectives of this investment include the support of core research to enable the Hypersonics Project to achieve its goals and the development of a new pool of experts in the requisite technology areas. The vision of the investment is directly aligned with the Fundamental Aeronautics Program principle that "we will dedicate ourselves to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation in all flight regimes."

Two mission classes are of interest to the Hypersonics Project: Highly Reliable Reusable Launch Systems (HRRLS) and High Mass Mars Entry Systems (HMMES). These missions were chosen to focus technology and tool development efforts in support of NASA's Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

The HRRLS mission was chosen to build on work started in NASA's Next Generation Launch Technology (NGLT) Program to provide new vehicle architectures and technologies to dramatically increase the reliability of future launch vehicles. The design of reusable entry vehicles that provide low-cost access to space is challenging in several technology areas. The severe heating environment encountered during hypersonic flight dictates the shape of the vehicle. Boundary-layer transition and turbulence at hypersonic speeds are especially significant because of the large differences in heating rates between laminar and turbulent flows. The interaction of bow shock and wing shock (shock-shock interaction) leads to local enhancement of heating at the impingement point. Therefore, the accurate definition of the hypersonic environment is of paramount importance, placing great emphasis on computational tools and high-temperature experimental measurement capabilities. Since these vehicles fly from the Earth's surface at low speeds and enter space and re-enter the atmosphere at hypersonic speeds, the vehicle performance, controllability, and energy management across the entire Mach range is another significant challenge requiring rapid and accurate computational tools. The development of hypersonic-unique air breathing propulsion systems, and the integration of the propulsion system with the airframe further impact vehicle performance and controllability and drive the need for an integrated physics-based design methodology. The hypersonic heating environment coupled with the emphasis on reusability, creates additional technology challenges for materials, material coatings, and structures that are low weight with high thermal-shock resistance yet also possess long-life and durability.

Technologies that enable these systems will require advancements in foundational knowledge and development of discipline-level tools for accurate analysis and design. These tools are integrated to achieve the system-level goal of the Hypersonics Project to develop predictive capabilities using physics-based multi-disciplinary analysis, design optimization, and uncertainty quantification tools and technologies.

2. Description of Solicited Research

The Hypersonics Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3.0 Summary of Key Information

Expected annual program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the Summary of Solicitation of this NRA.
Detailed instructions for the preparation and submission of proposals	See the NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009 at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the Summary of Solicitation of this NRA and Chapter 3 of the NASA Guidebook for Proposers.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected type of award	TBD
Funding opportunity number	TBD
NASA points of contact	Neil Cheatwood, FA-Hypersonics Project Scientist Karl Vaden, NRA Implementation Manager hypersonics@lists.nasa.gov Procurement POC: Kelly Kaplan, Kelly.G.Kaplan@nasa.gov

APPENDIX B: Aviation Safety Program

B.1 Program Overview

The Aviation Safety Program is dedicated to the mastery and intellectual stewardship of the core competencies of safety in aeronautics for the Nation. Furthermore, the program builds upon the unique safety-related research capabilities of NASA to improve the safety of current and future aircraft and aviation operations, and to overcome safety limits that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen). Currently the U.S. Air Transportation System is widely recognized as among the safest in the world, enabled by the vigilance of industry and government working together. However, looking at the projected increases in air traffic and future system capabilities, this vigilance must continue for the U.S. to meet both public expectations for safety and full realization of the NextGen. To meet these challenges, the Aviation Safety Program will focus on developing cutting-edge technologies to improve the intrinsic safety attributes of current and future aircraft and of NextGen operations. Concurrently, these technologies can be leveraged to support space exploration activities, such as enabling self-reliant and intelligent systems necessary for the long-duration travel requirements of future space vehicles.

The Aviation Safety Program will provide safety related concepts, tools, and technologies that will help ensure the safety of the U.S. Air Transportation System as it transitions to meet the future needs of the NextGen. These needs include: the anticipated increases in air traffic; increased reliance on automation; increased diversity of vehicles; and increased complexity in the system. The long range goals of the research include: reduced occurrence of in-flight failures; onboard systems capable of self-correcting anomalies; improved crew workload allocation and situation awareness; verification and validation of complex, flight-critical systems, and advanced flight controls to ensure flight safety during adverse flight conditions. In addition, the Aviation Safety Program technologies can be leveraged to improve the resilience of future space vehicles against the hazards of long duration space travel as well as operations in harsh and/or remote environments. These technology developments are aligned with NASA's Strategic Goals and with the National Aeronautics Research and Development Policy.

The awards as a result of this NRA will improve safety through its commitment to identify and advance innovative ideas, concepts, technologies, and approaches to the challenges described below for each of the four Aviation Safety Program’s thrust areas. For more information, please see http://www.aeronautics.nasa.gov/programs_avsafe.htm.

Evaluation Criteria and Basis for Award

The evaluation criteria in Appendix B, part (i) and Appendix C, paragraph C.2 of the “Guidebook for Proposers Responding to a NASA Research Announcement (NRA), January 2009” are superseded by the following.

In general, the topics stated within this NRA announcement must be addressed clearly and must present the development and research techniques that will be applied to accomplish the relevant issues. In addition, the cost to the Government of each major task should be clearly stated. Proposals that do not comply may be rejected for award. Proposals may be awarded in full, or only specific tasks may be selected for award.

In addition, the nature and extent of the required tasks for the government and for the proposal team must be outlined. NASA's involvement may include collaborative relations, access to a NASA site or equipment, sharing NASA facilities and personnel, NASA's mentoring/advising of graduate students, and/or hosting students/faculty for various periods of time. If access to a NASA site or equipment, and/or sharing NASA facilities and personnel is required, the proposals must identify the specific requirements and proposed schedule. While NASA cannot guarantee the availability of requested facilities, we will work with the offeror to try to accommodate requests.

The evaluation of the proposals should be based on the following factors, in the relative order of importance:

(1) Technical merit (50%)

- Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts. Credibility of technical approach, including a clear assessment of primary risks and a means to address them.
- Proposer's capabilities, related experience, facilities, techniques, or unique combinations of these, which are integral factors for achieving proposal objectives. Includes principal investigator and key personnel critical in achieving proposal objectives.
- Overall evaluation against the state of the art.

(2) Relevance to NASA's objectives (30%)

- Clear relevance of the proposed work and significance of contribution to one or more of the technical areas listed.

(3) Effectiveness of the proposed work plan (15%)

- Comprehensiveness of work plan, effective use of resources, management approach, and proposed schedule for meeting the objectives.

- Measurable metrics toward achieving the proposer's goal should be provided, with at least one metric per year. Proof-of-concept demonstrations are encouraged. Proposals shall be rated higher based on the aggressiveness of each of these metrics; achieving these metrics will likely be a factor in deciding which awarded proposals continue in future years.

- A clear statement of intellectual property, in which work performed under this agreement is expected to be publicly available at the conclusion of this

agreement. It is our intent to share all knowledge developed under this solicitation, thus, any restrictions to that objective will cause a lower score in this area.

(4) Proposed Cost (weight: 5%)

- Evaluation of the cost of a proposed effort should include the realism and reasonableness of the proposed cost, and the comparison of that proposed cost to available funds.

Review and Selection Process

Each Principal Investigator will serve as the chair of their review team and make recommendations for selections to the Selecting Official. A review panel will evaluate the scientific and technical merit of the proposals and rate them using the subjective ratings listed in the rating method mentioned in the above section. The review panel members will be selected on the basis of their expertise in the fields represented by the proposals and may include representatives from academia and other government agencies. Academic members will be required to sign non-conflict-of-interests and non-disclosure statements prior to receipt of any proposal submissions.

The review panel will submit the ratings to the source selection official, which has the final authority for selecting the specific proposals for negotiation. The final selection decision will consider the Panel ratings as well as project priorities, project balance, and available funding. Awards will be cooperative agreements, grants, or contracts, as decided by the source selection official with recommendations from the review team.

APPENDIX B.2 AIRCRAFT AGING & DURABILITY (AAD)

1. Project Overview

The AAD Project is part of the Aviation Safety Program. The goal of the AAD Project is to perform foundational research in aging science that will ultimately enable system-level integrated methods for the detection, prediction and mitigation/management of aging-related hazards for future civilian and military aircraft. The Project is organized relative to these three theme areas:

- Detect – locate and characterize fully damage or degradation of materials and structures
- Predict – life and strength predictions accounting for accumulated damage associated with long-term exposure to thermal/mechanical/environmental loads
- Mitigate – concepts to prevent, contain, or manage degradation associated with aging

The focus of AAD is on aging and damage processes in new aircraft designs and 'young' aircraft, rather than life extension of legacy vehicles. There is an emphasis on new and emerging material systems/fabrication techniques and the potential hazards associated with aging-related degradation. The scope and technical content for the AAD Project was developed to accomplish two objectives: (1) deliver technology to address specific end-user problems and (2) develop fundamental technology (not isolated to a single application) to enable integrated tools.

The first objective was addressed by establishing a set of Challenge Problems (CP) to define representative physical problems to be addressed by the project. Challenge Problems have been defined for eight application problems:

- CP-01: Damage Methodology for Metallic Airframe Structures
- CP-02: Structural Integrity of Integral Metallic Structure
- CP-03: Durability and Structural Integrity of Composite Skin-Stringer Fuselage Structure
- CP-04: Durable Bonded Joints
- CP-05: Durability of Engine Fan Containment Structure
- CP-06: Durability of Engine Superalloy Disks
- CP-07: Durability of Engine Hot Section
- CP-08: Wiring Degradation and Faults

To accomplish the second objective, fundamental technology development not isolated to a single application, AAD has defined a four-level approach to technology development and integration, and will conduct research across each of these levels to address evolving safety challenges. At Level 1, foundational research will be conducted in sensing and diagnostic technologies; physics-based modeling; continuum-based models and computational methods; material science (metals, ceramics, composites); and characterization/validation test techniques; to further the fundamental understanding of the underlying physics and develop an ability to model that physics. At Level 2, the foundational research is leveraged to develop NDE Systems; Structural Integrity tools;

Lifing methods; and Mitigation concepts, by producing technologies and analytical tools focused on discipline-based solutions. At Level 3, methods and technologies are developed to balance solutions across disciplines. Detect capability is enhanced by coupling NDE and structural integrity analysis, Predict capability is enhanced by applying NDE to improve model input and provide improved remaining life and strength predictions, and Mitigate is enhanced by applying predictive models to develop advanced mitigation concepts. At Level 4, results from Levels 1 through 3 activities are built upon to integrate Detect, Predict, and Mitigate capabilities for system-level performance, and system-level experiments are conducted for validation. A summary of the Project's technical plan is available at: http://www.aeronautics.nasa.gov/programs_avsp.htm

NASA will focus its core competencies and resources on NASA-appropriate research areas at all levels, and with partners, on the levels that are appropriate to each partner. The AAD Project will work with partners from other government agencies, industry, and universities to fills the gaps that NASA research cannot address. This solicitation is intended to fill such gaps at Level 1 and 2. The proposed research efforts are an integral component of the overall project content and have been defined to contribute to specific Challenge Problem and Theme-based technology needs.

2. Description of Solicited Research

The Aircraft Aging and Durability Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3. Summary of Key Information

Expected annual program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers-2009*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspire-shelp@nasaprs.com or (202) 479-9376)
Expected Type of Award	TBD
Funding opportunity number	TBD
NASA point of contact concerning this program	Richard D. Young, Principal Investigator, (757) 864-2894, Rick.Young@nasa.gov K. Elliott Cramer, Project Scientist, (757) 864-7945, K.E.Cramer@nasa.gov NRA Manager: Tami Croom Procurement POC: Tim Cannella, timothy.p.cannella@nasa.gov (until May 22, 2009) Roberta Keeter, Roberta.i.keeter@nasa.gov (after May 22, 2009)

APPENDIX B.3 Integrated Intelligent Flight Deck Technologies (IIFDT)

1. Project Overview

The goal of the IIFDT project is to develop tools, methods, principles, guidelines, and technologies for revolutionary flight deck systems that enable transformations toward safer operations. This includes developing novel methods of piloting aircraft, enabled by the rigorous, systematic design of new technologies and operating procedures. In doing so, IIFDT seeks to expand our ability to predict and create the comprehensive set of developments (technologies, procedures, and specifications for crew training) demanded for truly novel concepts of operation, such as those proposed for the Next Generation Air Transportation System (NextGen).

Two challenges that have historically hindered our ability to effectively predict and design for the effective support of human performance are (1) understanding (and accounting for) the inter-relationships not only within a specific system, but also with external systems and the operating environment; and (2) understanding (and accounting for) the context dependency of the behaviors, including specific activities that can be beneficial in one situation but detrimental in another. IIFDT research takes an inter-disciplinary approach that builds on coordinated insights into human performance and technological capability. This approach is especially important given the project's focus on designing for safety because choices of mitigating risk via a mix of technology, procedures, or training can have long-term and profound impacts on many aspects of aviation operations.

To enable the design of truly novel concepts of operation for flight deck systems, IIFDT develops rigorous, predictive, generalizable methods and models for designing technologies and operating procedures, and for capturing assumptions and requirements for crew training. The resulting methods and models should be suitable for use by all within the aviation community to promote the systematic consideration of human and technology performance and other safety concerns throughout both the procedure and technology design communities. One goal of this NRA is to support the development of these methods and models.

As aircraft and airspace systems become more complex, the complexity of flight deck systems and procedures increase correspondingly. Solutions to identified problems or issues are commonly addressed by adding new systems or functions. Each addition can reduce the coherence of flight deck operations, increase the risk of undesired side-effects, and push more information and tasking to the pilot. Increasing information also creates new challenges regarding data sharing and dissemination among the crew, aircraft systems, and other decision makers such as air traffic controllers. IIFDT seeks to provide a transformed view of piloting operations that establishes a coherent basis for designing technologies and procedures, and that considers both human performance and technological capability. Simultaneously, the project seeks revolutionary advancements in avionics technology capability and performance in selected areas where new demands

for flight-critical high-integrity capabilities are required, such as external hazard detection.

NASA is dedicated to pushing state of the art in flight deck systems by investigating transformative integrated display concepts, decision support functions, on-board/off-board information management, high-integrity external hazard detection, and effective mechanisms for human-automation interaction that enable safer flight deck systems in the future. These systems need to be robust and flexible to accommodate a wide range of operating conditions and classes of envisioned operations. Their design will be based on systematic (often formal) methods for analyzing for human and machine performance and human-system-integration issues and for identifying design requirements such as required technology-based functional behaviors and information/sensing requirements.

Description of Solicited Research

IIFDT is seeking proposals addressing multiple topics described below. Associated with each topic are a set of research objectives. It is highly desired that proposals address all objectives for a given topic. Proposals spanning only selected objectives are acceptable; however, the proposed budget should scale accordingly.

These Topics all support NASA Strategic Sub-goal 3E:

> Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

TOPIC NUMBER: IIFDT-1.1

DISCIPLINE AREAS: Enabling Avionics

RESEARCH TOPIC: Airborne forward looking interferometry for detecting terminal area hazards

MILESTONES SUPPORTED:

- IIFD.SS.1.2 Complete feasibility studies of forward-looking interferometric (FLI) sensing including terminal area ground and flight testing to quantify performance prediction uncertainty and to provide data to advance the development of hazard detection capabilities (3rd Quarter, FY2010)
- IIFD.EA.1.1 Develop and verify an initial Integrated Alerting and Notification (IAN) system model design suitable for design capture and evaluation against requirements (2nd Quarter, FY2010)
- IIFD.EA.1.2 Develop and validate flight deck system information model to aid in understanding complex information redundancies and relationships (4th Quarter, FY2010)

IIFD.EA.1.3 Evaluate IAN system model for determining context and hazard state (4th Quarter, FY2012)

IIFD.EA.2.1 Evaluation of the IAN model with a Caution Warning Alert (CWA) function incorporated (1st Quarter, FY2011)

DESCRIPTION:
IIFDT is investigating innovative, practical, affordable, and effective airborne forward-looking sensor systems to reliably detect weather and other external hazards to aircraft, particularly in the terminal area. These new and improved sensors and sensing capabilities are intended to overcome technology hurdles associated with detection and measurement capabilities for the Next Generation air transportation system (NextGen) environment. Because of the anticipated traffic densities and an assumption of all-weather capacity at these densities, sensing capability must be improved to ensure and enable high-integrity detection performance. Specifically, in the NextGen terminal area, there will be increased exposure (and risk) to hazards such as: wake vortices, icing conditions, reduced visibility, runway contamination, winds (wind shear and crosswinds), air/ground traffic, other features in the external environment (e.g. terrain, towers, wildlife, and construction equipment), and orographic turbulence. This list is not intended to be exhaustive, but is given in order of priority for the purposes of this announcement.

The products of IIFDT sensors research are intended to enable tactical detection of aviation hazards and estimation of hazard severity at a sufficient range to provide adequate warning time to allow avoidance maneuvers (manual or automatic) or crew procedures to mitigate hazard exposure. Research includes both the investigation of forward-looking sensor technologies, and the characterization of the physics of hazards that may make them amenable to detection, especially as observed by multiple sensors; thereby allowing discrimination of hazardous from benign phenomena. Research also includes the development of a cockpit information management system that will receive data from a variety of sources, including onboard systems and sensors, communications/datalink services, and the pilot interface. This information system concept is referred to in IIFDT as the Integrated Alerting and Notification system (IAN). The IAN will process incoming information, monitor for the development of hazardous situations, and support the pilot, through an appropriate pilot interface, in making informed decisions with regard to hazard avoidance. As sensor research progresses beyond the feasibility stage to higher levels of technology development and maturity, the work will be coordinated with the development of the IAN concept. This will facilitate the development of instrument requirements, experimentation regarding the role of the sensor in the flight deck system, the development of commensurate alerting methods, and the investigation of the effect on, and the value of, the sensor to safe and efficient operations.

Previous feasibility studies (West, 2008) have shown promise for forward-looking interferometer (FLI) technology. (West, 2008) describes an aircraft-mounted Michelson Fourier transform imaging infrared spectrometer (FTS) concept capable of measuring conditions ahead of an aircraft for the purpose of detecting or mitigating hazards. This FLI concept has been evaluated for its potential to address multiple hazards including

clear air turbulence (CAT), volcanic ash, wake vortices, reduced visibility, dry wind shear, icing during all phases of flight (takeoff, cruise, and landing), and runway contamination. This solicitation seeks to extend the earlier investigations by achieving the following objectives:

1. Development and flight testing of a prototype FLI instrument
2. Validation of model-based instrument and hazard simulation results by comparing predicted performance against empirical data
3. Development of improved sensor models and hazard metrics
4. Development of requirements for an operational airborne sensor
5. Evaluation of FLI application/performance against operational scenarios representative of the NextGen terminal area environment.

Successful proposals will include FLI/FTS data collection experiments, potentially in conjunction with collection of data from other complimentary airborne sensor technologies including, but not limited to, radar systems (possibly polarimetric and/or multi-frequency), RF radiometers, and Lidar systems. Including such complimentary sensing technologies in field testing of FLI/FTS is strongly encouraged as they may provide points of comparison for evaluating aspects of FLI performance. These data may also be useful in determining causes of unexpected performance and/or disagreements with modeled predictions.

Collection of airborne FLI measurements along with complimentary data is critical. In earlier FLI investigations, ground-based measurements were collected instead of airborne measurements; however, the ground-based measurement geometry is not ideal for studying the concept of airborne radiometric detection because the radiometric background and atmospheric transparency are quite different from a ground-based observer as opposed to at flight altitudes. In addition, the ground-based measurements did not correspond directly to simulation/modeling results which were created and analyzed for the airborne environment. The goal of this research is to perform airborne tests as empirical demonstrations of hazard detection and ranging, along with collection of complimentary data. These flights are expected to result in a large number of data sets for further algorithm development, model verification, and performance evaluation. Further analysis of previously collected data sets and additional ground-based measurements for sensor characterization and comparisons may also be of value.

Added value will be placed on investigations that involve interaction and/or collaboration with IIFDT researchers (either in-house or other partners) and other related research activities. This might include, for example, participation in field experiments being conducted in related IIFDT research (or by other program elements or agencies).

EXPECTED OUTCOME:

A minimum outcome comprises oral reports and delivered presentation materials, including a kickoff presentation, an interim presentation, and an oral report coincident with the delivery of a final written report documenting results of assessment and analyses for each year of the research studies. Sensor and atmospheric phenomenology models or

databases, as well as software tools developed during the study should be delivered. Informal monthly email status reports shall delivered to support programmatic reporting requirements. A high value will be placed on results that include useful instrument models, instrument requirements, verification and validation tests, and hazard algorithms that relate hazard level to specific aircraft states and physical properties of hazardous phenomena.

Year 1: The investigation shall include, at a minimum, FLI airborne and/or ground-based measurements of two or more selected potentially hazardous phenomena, along with data from at least one independent observation for each phenomenon. This data will support continued development and validation of sensor and hazard simulations. Investigations should also include consideration of merging of FLI data with data from other sensors to give a more complete hazard picture. Results will include the development of (initial) requirements for an airborne instrument, a proposed instrument configuration, identification of major technical hurdles to building an operational FLI, and a projected role for the sensor in support of terminal area operations.

Year 2: Investigations will advance instrument development on two fronts: attacking technical hurdles to a practical instrument; and additional investigation into the operational role of a FLI instrument. This may include additional airborne and/or ground-based data collection and will include expanding hazard detection and evaluation capability via (multi-sensor, if feasible) algorithms to estimate hazard intensity and the threat posed to the aircraft. Performance predictions (probability of detection, missed detection rates, probability of false alarm) will be developed to further understanding of the role of a FLI instrument. This will include the development of a simulation model for an airborne FLI and algorithms for detection that can be included in an Integrated Alerting and Notification (IAN) model developed in other IIFDT research efforts. Completion of these objectives requires cooperation and interfacing with NASA researchers responsible for developing and applying the IAN concept.

Year 3: Continue investigation of technical hurdles to a practical FLI instrument and develop details for the instrument requirements and the role of an FLI in the cockpit system. The instrument model and hazard algorithms will be further developed and incorporated in the IAN model, and scenario-based experiments conducted to examine the impact on terminal-area operations. Completion of these objectives requires cooperation and interfacing with NASA researchers developing and applying the IAN concept as well as those developing and applying flight deck display and decision support tools.

DURATION AND ESTIMATED FUNDING:
NASA anticipates investing approximately $1050K in this topic over the next three years, at $350K/year for proposals spanning all objectives. Proposals spanning only selected objectives should scale the proposed budget accordingly. NASA anticipates awarding contracts for this topic that will be structured with three one year phases (i.e., a one-year based, plus two one-year options). Proposals submitted under this topic must cover all

phases. The decision at the end of each phase on whether to continue to the next phase will be based on:

- NASA's judgment of the progress made each year relative to quantifiable metrics defined in the proposal and agreed to by the NASA Technical Monitor at the onset of the agreement.
- NASA's judgment of the impact the findings will have on the goals of the IIFDT project.
- NASA's judgment of the ability to further develop and validate identified sensing concepts with other IIFDT technology concepts.
- The availability of resources to support the proposed work for subsequent years.

Proposals shall include a schedule with milestones that support the evaluation of progress and highlight the achievement of goals. Decision points are acceptable as milestones.

POTENTIAL NASA RESOURCES: NA.

REFERENCES:
The references listed here are intended to be illustrative only; and do not represent the comprehensive set of previous research that should be considered when proposing to this topic. NASA is seeking truly novel, innovative, approaches to the objectives described in this topic and proposers should not feel compelled to use these past works as a basis for the proposed effort. However, these works are considered significant and are recommended reading materials when considering new FLI sensing methods.

(West, 2008) "Applications of a Forward-Looking Interferometer for the On-board Detection of Aviation Weather Hazards", West, Leanne; Gimmestad, Gary; Smith, William; Kireev, Stanislav; Cornman, Larry B.; Schaffner, Philip R.; Tsoucalas, George, NASA/TP-2008-215536, NASA, October 2008, available at http://ntrs.nasa.gov, document ID 20080045836.

(Gimmestad, 2007) "Airborne Forward Looking Interferometer Turbulence Investigation," Gimmestad, G., et. al., document ID AIAA 2007-78, Proceedings of the 45th AIAA Aerospace Sciences Meeting and Exhibit, 8 - 11 January 2007, Reno, NV

TOPIC NUMBER: IIFDT-2.1

DISCIPLINE AREAS: Robust Automation-Human Systems (RAHS) and Operator Performance

RESEARCH TOPIC: Examination of Innovative Flight Deck Automation Technologies in the NextGen Operational Environment

MILESTONES SUPPORTED:

IIFD.RAHS.1.1 Hypothesized solution concept within specified application domain for flight deck system function allocation and human-automation interactions during 4-D trajectory-based operations

IIFD.RAHS.1.2 Evaluation of RAHS solution concept in relevant environment

IIFD.OP.2 Methods for fostering appropriate use of automation and complex information sources

IIFD.OP.3 Methods for supporting communication and collaboration among multiple intelligent agents

DESCRIPTION:

Flight deck automation strategies must consider trajectory clearance data requirements, negotiation protocols, alerting systems, and compliance and monitoring in order to safely operate within the future Next Generation Air Transportation System (NextGen) (Barhydt & Adams, 2006). The NextGen environment allows for the mix of aircraft equipage and performance capability, which poses particular challenges in the complex and compressed terminal airspace (Federal Aviation Administration, 2006). In addition, the design of automation tools and procedures in this arena requires an understanding of integrated alerting and off-nominal events.

The NextGen operational concept also requires a transformation of the roles and responsibilities of flight deck system agents (i.e. either human or automated). There will be a delegation of varying levels of responsibility to the flight deck for managing separation and generating/negotiating 4D trajectories relative to weather, environmental considerations, and other ATM constraints. Research in the area of human-computer interaction indicates the importance of appropriate function allocation between the automation and the human operator (Abbott & Rogers, 1993; Sheridan, 2000; Cook & Corbridge, 2000). The integration and coordination of human-automation functions, roles, and responsibilities must allow for accuracy, precision, timeliness, and effective interaction between the human operator and the automation; this will be critical to aviation system safety. In addition, the allocation of functions between humans and automation may change depending on situation and smooth transitions must be assured. The design of current flight deck automation frequently establishes numerous different operating modes that can lead to confusion for the pilot during flight and create opportunities for human error (Funk, et al 1998; (Federal Aviation Administration, 1996; Sarter & Woods, 1995). During off-nominal events, automation complexity may lead to problems that hinder graceful degradation and the ability to detect anomalies and mitigate their consequences.

The focus of this research effort is to explore new and innovative technologies for pilot/flight crew automation for aircraft functions (e.g., navigation, communication, and surveillance) necessary for the NextGen operating environment, particularly in the terminal area. The design and evaluation tasks will examine the potential of a “clean slate” approach to developing flight deck automation with the goal of improving aircraft performance as well as ‘designing-out’ human factors issues with existing automation

(e.g., latent errors, mode and state confusion, cumbersome interface design). Approaches may include the use of both analytical- and simulation-based design and evaluation tools.

The overall objective of this topic is to define and describe the appropriate role for flight deck automation for flight in the NextGen operating environment, with commensurate interaction mechanisms, automated functions, and methods for ensuring effective performance during off-nominal events. A "clean-slate" approach should be considered so that existing flight deck technologies or procedures do not constrain the design. In addition, the human-automation interface and allocation of roles and tasks as they pertain to effective human-automation interaction should be described and assessed. The NextGen terminal area environment and, in particular, super-density operational applications should be the focus of the developed functional descriptions and human-computer interaction assessments.

The following are specific objectives:

(1) Identify and describe the information requirements and flight deck functions necessary to respond to the NextGen operational environment as described in the most recent version of the JPDO NextGen documentation. Roles for automation should be described that guide effective allocation of functions between the operators and the automation in the early stages of design, and that denote capabilities of automation such as required responses to off-nominal events. Particular emphasis should be placed upon those operational applications that are designated for the terminal area (e.g., very-closely-spaced parallel approaches; merging and spacing in the terminal area; weather routing in the terminal area, etc.).

(2) Develop a novel automation design for the flight deck that enables the implementation of these particular NextGen functions. This design should be demonstrated by applications in the terminal area environment but should also be compatible with designing for robust automation use and safe flight in all flight domains. Primary consideration should be given to the flexibility of the automation technology and the ability of the joint human-automation system to respond to non-normal or off-nominal events (including failures of the automation).

(3) Using the newly developed flightdeck automation design method, describe how it would be used for one or two sample terminal area applications within NextGen. Descriptions should include the roles of the automation and human, automation functions, and an analysis of task and cognitive demands in its use. As with Objective 2, primary consideration should be given to the flexibility of the automation technology and the ability to respond to non-normal or off-nominal events.

(4) Develop and describe the human-computer interaction guidelines that are necessary in order to develop and implement flight deck automation technologies and procedures for the NextGen environment – building upon previous research in human/machine guidelines (Palmer, et al, 1994; Schutte 1999; Schutte, et al 1999; Sheridan, 2000.). Functional allocation principles and information assessment should be addressed, as well as issues associated with effective conflicts in authority

and responsibility between human and automation agents, with information management, and with off-nominal events and graceful degradation.

(5) Conduct an assessment of these automation designs to determine their ability to address the necessary human-computer interactions guidelines and principles as outlined within the research. Methods used may include analytical modeling or simulation techniques. The assessment should utilize a representative set of NextGen-based scenarios. Such scenarios may be provided by NASA via coordination with a separate, and ongoing, IIFDT activity.

EXPECTED OUTCOME:
An analysis of NextGen operational implications for flight deck automation development, design, functionality, and use is expected. Particular emphasis should be placed upon the NextGen terminal area applications (e.g., very-closely spaced parallel approaches; merging and spacing). An assessment of the flight deck automation technologies and procedures is also expected.

Proposals that include innovative approaches to flight deck automation solutions are encouraged. Added value is placed on research that considers the effects of off-nominal events (including automation failures). Offerors are strongly encouraged to propose team arrangements to provide the best combination of skills to provide a comprehensive, interdisciplinary evaluation of flight deck automation and human-computer interaction.

Over the course of the effort, a minimum outcome comprises informal monthly status reports (e.g. via email or telephone), oral reports (and delivered presentation materials) to include, at a minimum, a kickoff presentation and final presentation with the delivery of a final written report addressing the aforementioned objective(s). The final report shall be prepared in the format suitable for publication as a NASA Contract Report (CR) – although actual publication may follow the completion of the work. Guidelines for preparing NASA CRs will be provided to winning offerors. Publication(s) in other, peer-reviewed, venues are highly valued and may be able to supersede the CR requirement. Winning offerors will also be asked to participate in a project-specific Technical Interchange Meeting to report and share results of the activity with other partners on the IIFDT team. As a minimum, the budget for travel shall provide for two such NASA technical meetings during the year at NASA-selected sites in the continental United States.

DURATION:
NASA anticipates investing approximately $500K in this topic over the next 18 months for proposals spanning all objectives. Proposals spanning only selected objectives should scale the proposed budget accordingly. Proposals shall include a schedule with milestones that support the evaluation of progress and highlight the achievement of goals. Decision points are acceptable as milestones.

POTENTIAL NASA RESOURCES: NA.

REFERENCES:

The references listed here are intended to be illustrative only; and do not represent the comprehensive set of previous research that should be considered when proposing to this topic. NASA is seeking truly novel, innovative, approaches to the objectives described in this topic and proposers should not feel compelled to use these past works as a basis for the proposed effort. However, these works are considered significant and are recommended reading materials when considering new flight deck automation and human-computer interaction functions required for NextGen.

Abbott, T. S, and Rogers, W. H. (1993) "Functional Categories for Human-Centered Flight Deck Design." Proceedings of 12th American Institute of Aeronautics and Astronautics-Institute of Electrical and Electronics Engineers, Digital Avionics Systems Conference, pp. 66-74

Barhydt, R., & Adams, C. A. (2006). Human factors considerations for performance based navigation. NASA/TM-2006-214531

Cook, C and Corbridge C. Function allocation: Optimising the Automation Boundary. (2000) Proceedings of IEE Seminar, Reference No. 2000/020, London, UK.

Federal Aviation Administration (2006). Advanced area navigation (RNAV) terminal procedures: A review of terminal RNAV procedures and implementation issues.

Federal Aviation Administration (1996). Report of the FAA Human Factors Team on: The interfaces between flight crews and modern flight deck systems.

Funk, K., Lyall, B., Wilson, J., Rebekah, V., Niemczyk, M., Suroteguh, C., et al. (1998). Flight deck automation issues. Journal of Aviation Psychology.

Palmer, M. T., Rogers, W. H., Press, H. N., Latorella, K. A., and Abbott, T. S., (1994). A Crew-Centered Flight Deck Design Philosophy for High-Speed Civil Transport (HSCT) Aircraft, (Technical Memorandum No. NASA/TM—109171). Hampton, VA: NASA Langley Research Center.

Sarter, N. B., & Woods, D. D. (1995). How in the world did we ever get into that mode? Mode error and awareness in supervisory control. *Human Factors, 37*(1), 5-19.
Sheridan, T (2000). "Function Allocation: Algorithm, Alchemy or Apostasy? In International Journal of Human-Computer Studies, 52 (2) pp. 203-216.

Schutte, P. C. (1999). Complemation: An alternative to automation. Journal of Information Technology Impact, 1(3), 113-118.

Schutte, P. C., Latorella, K. A., Comstock, J. R., Rudisill, M., & Trujillo, A. C. (1999). Countermeasures for skill, rule, and knowledge-based errors. Paper presented at the Tenth International Symposium On Aviation Psychology, Columbus, Ohio.

Sheridan, T (2000). "Function Allocation: Algorithm, Alchemy or Apostasy?" In International Journal of Human-Computer Studies, 52 (2) pp. 203-216.

For a more complete view of NextGen and its envisioned capabilities see www.jpdo.gov , and in particular, the Concept of Operations (Version 2, June 13, 2007), the Enterprise Architecture (Version 2, June 22, 2007), and the Integrated Work Plan.

TOPIC NUMBER: IIFDT-3.1

DISCIPLINE AREAS: Operator Performance and Enabling Avionics

RESEARCH TOPIC: Multi-modal flight deck interfaces supportive of NextGen operating concepts

MILESTONES SUPPORTED:

- IIFD.MM.1 Develop and evaluate improved visual interface capabilities (3rd Quarter, FY2010)
- IIFD.MM.2 Develop and evaluate improved aural/speech interface capabilities (3rd Quarter, FY2010)
- IIFD.MM.3 Develop and evaluate novel and multi-modal interface capabilities (3rd Quarter, FY2010)

DESCRIPTION:
Transformational changes in operational requirements will demand, and novel multi-modal interface technologies will enable, dramatic improvements in the effectiveness of information presentation to, and communication among, future NextGen operators. NextGen is envisioned as a 'net-centric' environment, where data link and other communication technologies provide seamless, nearly automated information transfer among functional agents, both human and automated. In this environment, the volume of information available to the flight deck will be vastly increased beyond what is available today. NextGen pilots will likely take a greater role with regard to traffic spacing and separation, and therefore, will require enhanced spatial awareness, particularly with respect to spacing from other aircraft and to avoid hazards.

The challenge to this research area is to investigate methods and concepts for appropriately utilizing *all* human-machine interface modalities to present and consume information in support of new NextGen operations (e.g., trajectory based operations in the terminal area) and to improve performance and safety using newly-available information and presentation methods and technologies that can support better-than-visual operations, improved decision-making, and multi-agent collaboration. Operational requirements will be instantiated in novel interface concepts and evaluated for effectiveness.

The research should consider state-of-the-art or newly-proposed interface technologies as well as flexible presentation of information across modalities. Flexible presentation of information is an important aspect of the envisioned multi-modal flightdeck in order to appropriately direct attention, support multi-tasking performance (*e.g.,* Spence and Driver, 1997), and increase the operator's control over the pace of information. This research is critical in light of the potential for NextGen operational concepts to overload selected interface modalities (e.g. visual displays) while others are under-utilized. Research will investigate both static and dynamic distributions across modalities. A special case of this information/presentation mapping decision pertains to representing the relative priorities of the ongoing and interrupting tasks, as well as the ability to resume ongoing activities post-interruption.

Throughout, this research should consider future flightdeck technologies, especially display technologies addressing multiple modalities and modalities in addition to visual displays. This research will help support the advancement of revolutionary pilot/flightdeck interface designs and system concepts that are properly constructed to support human performance goals for individual and group decision making quality ,task and attention management effectiveness, and response selection efficiency. While the research must build towards human-in-the-loop evaluations, these evaluations may be conducted in simulators emulating technical capabilities or concepts that are not yet developed, with the intent of defining technical and operational requirements, rather than being constrained by currently-available technologies. Initial evaluations may be proposed for smaller part task simulations to facilitate prototyping of flightdeck systems that may be difficult to incorporate in current high fidelity flight simulations/simulators.

OBJECTIVES:

Year 1:

1. Conduct a state-of-the-art, and projected, technology review to identify interface technologies that would provide the basis for communicating information (including attention directing to communicate levels and forms of alerts) to/from pilots in Next Generation aircraft (installed 2018-2025)

2. Develop a theory-based method for determining the distribution of information across a set of multi-modal interface devices, including determining how to effectively reduce switching time, and notification methods

3. Identify measures for assessing a multimodal interface to determine effects on situation awareness, performance (e.g., response times, decision quality, and error rates), user acceptability, and team coordination.

4. Develop a storyboard prototype multimodal interface (i.e., including presentation hardware and software algorithms, as well as sensors required to determine the context required for adapting the distribution across modalities) for a 4D

trajectory based operations scenario with three emergent anomaly conditions consistent with NextGen operational concepts. Evaluate this early prototype to identify potential issues with human performance for innovative flightdeck design concepts and operational scenarios. This evaluation process should involve representative users.

5. Develop design specifications and a buy-list for a multimodal presentation system to be integrated in a flight simulation facility. This system should be scoped to include functions that are not-yet ready for flight deck implementation, but may conceivably be ready in the 2018-2025 timeframe. It is desirable that the design specification and buy-list be sufficiently detailed to allow implementation in at least one of NASA's flight simulator facilities (for more information on these facilities, see www.aeronautics.nasa.gov/avsafe/iifd/facilities.htm).

Year 2:

6. Design a human-in-the-loop study to assess the functional prototype according to the metrics identified within the aforementioned scenario. IRB application document shall be included. This study experimental plan should include a description of the facility(s) to be used (NASA or other), budget, and a detailed schedule for the implementation, checkout, data collection, analysis, and reporting phases. If a NASA facility is proposed to be used for this study, it is not necessary to obtain statements of support from NASA facility managers, or to include budget items for costs incurred by NASA (e.g. NASA personnel man-hour costs and facility use costs).

7. Conduct HITL evaluation, analyze data, and report results, either as a publication, or in a form that can be submitted for publication.

EXPECTED OUTCOMES:
Proposals that include cutting-edge high-risk investigations are encouraged; however, the balance of risk versus potential gains should be discussed. Added value is placed on investigations that include interaction and/or collaboration with NASA researchers, as well as effective reporting and communication during the course of the studies. Offerors are strongly encouraged to propose team arrangements to provide the best combination of skills to provide a comprehensive, interdisciplinary evaluation of multi-modal interface design concepts.

For each year of the project, a minimum outcome comprises informal monthly status reports (e.g. via email or telephone), oral reports (and delivered presentation materials) to include, at a minimum, a kickoff presentation, an interim presentation, and final presentation with the delivery of a final written report addressing the aforementioned objective(s). The final report shall be prepared in the format suitable for publication as a NASA Contract Report (CR) – although actual publication may follow the completion of the work. Guidelines for preparing NASA CRs will be provided to winning offerors. Publication(s) in other, peer-reviewed, venues are highly valued and may be able to

supersede the CR requirement. Winning offerors will also be asked to participate in a Technical Interchange Meeting, or the AvSafe Annual Technical Conference, to report and share results of the activity. As a minimum, the budget for travel shall provide for two such NASA technical meetings per year at a NASA-selected site in the continental United States.

DURATION:
NASA anticipates investing approximately $700K in this topic over two years, at $350K/year for proposals spanning all objectives. Proposals spanning only selected objectives should scale the proposed budget accordingly. NASA anticipates awarding contracts or cooperative research agreements for this topic that will be structured with one year for the first phase and one year for the second phase. Proposals submitted under this topic must cover both the first and second phases. The decision at the end of the first phase on whether to continue to phase two will be based on:

- NASA's judgment of the progress made during the first year relative to quantifiable metrics defined in the proposal and agreed to by the NASA Technical Monitor at the onset of the agreement.
- NASA's judgment of the impact the findings will have on the goals of the IIFDT project.
- NASA's judgment of the ability to further develop and validate the multi-modal interface concept in conjunction with other IIFDT concepts under study.
- The availability of resources to support the proposed work for the second year.

Proposals shall include a schedule with milestones that support the evaluation of progress and highlight the achievement of goals. Decision points are acceptable as milestones.

POTENTIAL NASA RESOURCES:
For a list of NASA facilities that could be considered for the design and evaluation activities, see www.aeronautics.nasa.gov/avsafe/iifd/facilities.htm .

2. Programmatic Considerations

In general, the topics stated within this NRA announcement must be addressed clearly and must present the development and research techniques that will be applied to accomplish the relevant issues. In addition, the cost to the Government of each major task shall be clearly stated. Proposals that do not comply may be rejected for award. Other considerations to note: (1) Proposals may be awarded in full, or only specific tasks may be selected for award; (2) Proposals for individual topic areas may address only a portion of the described needs but the budget should be scaled accordingly; (3) Estimated total funds available for awards is given in the Table in Section 3 of this appendix, actual funding levels will be determined based on the quality and content of individual proposals and the total available funds; (4) Multi-year awards will be subject to renewal annually based on findings and/or satisfactory performance reviews of the work to date;

(5) Proposals should include plans for technical interchange with NASA and for interim reporting. (6) Milestones with measurable metrics toward achieving the proposer's goal must be provided, with a minimum of one metric per year.

In addition, the nature and extent of the required tasks for the government and for the proposal team must be outlined. NASA's involvement may include collaborative relations, access to a NASA site or equipment, and sharing NASA facilities and personnel. Proposals that include temporary exchanges of personnel (e.g. graduate students or researchers visiting NASA or NASA researchers visiting awarded organizations) are desirable to encourage close collaborations and mentoring. If access to a NASA site or equipment, and/or sharing NASA facilities and personnel is required, the proposals must identify the specific requirements and proposed schedule.

Review and Selection Process
The Review and Selection process is described in Appendix B.1 above.

Due Dates
For the Integrated Intelligent Flight Deck Technologies Project, the due date for the first round of evaluations is May 28, 2009. To be considered in the first round of evaluations, proposals must be received by 11:59 p.m. Eastern Time on the due date as described in Section IV(c). It is expected that the majority, and perhaps all, of the available funds will be allocated during this first round of evaluations. However, the topics in this section will remain open until July 27, 2009 in case funding still remains after the first round of evaluations. A note will be posted on the ROA page on NSPIRES if funds are expended and no further reviews are expected. Proposers who decide to wait until after the first round of evaluations do so at their own risk.

3. Summary of Key Information

Expected annual program budget for new awards	~$950K (for new awards in this solicitation)
Number of new awards pending adequate proposals of merit	~3 (one award per subtopic)
Maximum duration of awards	3 years (for the FLI subtopic) 18 months (for the automation subtopic) 2 years (for the multi-modal subtopic)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA and Section 2 above.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA and Section 2 above.
NASA strategic objective(s) which proposals must state and demonstrate relevance to	Every proposal must address the specified subtopic objective(s) and outcome(s) in the solicitation of this NRA.
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	20 pp.; see also Chapter 2 of the *Guidebook for Proposers -2009*
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers - 2009*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected Type of Award	Cooperative agreements or contracts are expected to be primary awards, however grants may be considered in appropriate instances.
Funding opportunity number	NNH09ZEA001N-IIFDT1
NASA point of contact concerning this program	Dr. Steven D. Young Principal Investigator NASA Langley Research Center Mailstop 130

	Hampton, VA 23681-2199 NRA_flightdeck@larc.nasa.gov IIFDT NRA Manager : Sherri Yokum, sherri.l.yokum@nasa.gov Procurement POC: Tim Cannella, timothy.p.cannella@nasa.gov (until May 22, 2009) Roberta Keeter, Roberta.i.keeter@nasa.gov (after May 22, 2009)

APPENDIX B.4 Integrated Vehicle Health Management (IVHM)

Project Overview

The goal of the Integrated Vehicle Health Management (IVHM) project is to develop validated tools, technologies, and techniques for automated detection, diagnosis and prognosis to enable mitigation of adverse events during flight. Adverse events include those that arise from system, subsystem, or component faults or failures due to damage, degradation, or environmental hazards that occur during flight. The project offers a research program that addresses both the hardware and the software aspects of the aircraft. These new IVHM capabilities will enable rapid detection and diagnosis of adverse events and estimation of severity and remaining useful life (RUL) with confidence bounds for the affected system(s). Maintenance workers, flight crew, adaptive configuration systems and other control systems can use this information to enhance the safety profile of the aircraft.

Developing real-time automated reasoning and decision making tools and techniques to integrate messages from the health management systems of individual aircraft and combining them with results from analysis of fleet-wide vehicle health assessments is also a critical challenge for the IVHM project. Therefore, fundamental research will include the development of probabilistic models of potential fault and failure modes and data mining algorithms to analyze large heterogeneous data sources from current aircraft fleets to develop static and dynamic models of potential system faults and failures. This capability will enable aircraft-wide and system-wide study and will be used to continue development of tools and technologies in support of the Aviation Safety and Information Analysis and Sharing (ASIAS) collaboration with the Federal Aviation Administration (FAA). Although this project is primarily focused on the vehicle, it also addresses system-level concerns with the national air transportation system.

The project is organized under the following areas:

Multidisciplinary Levels

- Evaluation of Multidisciplinary IVHM Technologies, Tools, and Techniques
- Systems Analysis for Health Management
- IVHM Discovery in Aeronautics Systems Health (Dashlink) Collaborative Website
- Research Test and Integration

Theme Levels

- Detection
- Diagnosis
- Prognosis
- Mitigation
- Integrity Assurance

An IVHM reference document is available on the Aeronautics Research Mission Directorate website (http://www.aeronautics.nasa.gov/nra_pdf/ivhm_tech_plan_c1.pdf).

Description of Solicited Research

Research is solicited for Vehicle Health Management Reasoning

Proposers should structure their proposed research to respond to the description and should detail the outcome under an assumed award for the duration specified. All funding levels should be interpreted as estimated amounts, and offerors should identify and justify the budget levels required for the proposed work. Multiyear awards will be subject to renewal annually based on findings and/or satisfactory performance reviews of the work performed to date as well as changes in programmatic direction and availability of funds. Proposals that combine efforts from multiple institutions are encouraged and may be appropriate to address the topics.

These Topics all support NASA Strategic Sub-goal 3E:

> Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

1. MULTIDISCIPLINARY LEVEL TOPIC AREA: Vehicle-Level Reasoning System
TOPIC NUMBER: IVHM-1.1
RESEARCH TOPIC: Evaluation of Multidisciplinary IVHM Technologies, Tools, and Techniques
(IVHM Technical Plan – IVHM 4.1)

MILESTONES SUPPORTED:
4.1.1., 4.1.2, 4.1.3

DESCRIPTION:
The Integrated Vehicle Health Management project has a goal to detect, diagnose, predict, and mitigate adverse events during the flight of an aircraft, regardless of the subsystem(s) from which the adverse event arises. To properly address this problem, it is critical to develop technologies that can integrate large, heterogeneous (meaning that they contain both continuous and discrete signals), asynchronous data streams from multiple subsystems in order to detect a potential adverse event, diagnose its cause, predict the effect of that event on the remaining useful life of the vehicle, and then take appropriate steps to mitigate the event if warranted. These data streams may have highly non-Gaussian distributions and can also contain discrete signals such as caution and warning messages which exhibit non-stationarity and obey arbitrary noise models.

The IVHM project is interested in proposals that will research, develop, and test tools and technologies for a Vehicle-Level Reasoning System (VLRS). The VLRS must take advantage of component, subsystem, and vehicle level models which would represent connectivity and potential causal chains of failure. Similarly, physics-based models of damage propagation for certain subsystems (such as the airframe or actuators) may be appropriate for inclusion in the model. Finally, data-driven methods to characterize interactions between components, subsystems, and systems may be appropriate for the design.

In order to ensure that the scope of this project is executable within the time frame of this NRA, proposers are encouraged to identify and focus on, as part of their proposal, a subset of particularly important components, subsystems, and systems. Proposers should address the detection, diagnosis, and prognosis (estimation of remaining useful life) of adverse events arising from at least three of the following four subsystems:
Aircraft systems (this includes but is not limited to avionics, actuation hardware, wiring, electromechanical systems)
Airframe (structures within and comprising the airframe and other physical structures in the aircraft)
Propulsion (engines, fuel systems, related control systems)

Software (including but not limited to software in the flight management system, embedded software, and software involved with guidance, navigation, and control).[1]

The VLRS may query specific systems and subsystems to determine their health status. Thus, proposers may assume that the system can take an *active role* to reason about the health of the vehicle, as opposed to a passive, data gathering and analysis activity. In this context, an 'active role' means that the VLRS could generate and test internal hypotheses about the root-cause of a particular adverse event by selecting subsystems and issuing queries designed to verify a hypothesis.

Mathematically motivated and justifiable tools and techniques must be developed that manage uncertainty and the propagation of that uncertainty through the reasoning system, so that each hypothesis of a root-cause has an associated probabilistic confidence. The probability distributions that characterize the uncertainty can be developed using data mining, machine learning, or other appropriate approaches and can be used to characterize the remaining useful life of the affected system, subsystem, or component.

The VLRS can provide aircraft with at least two significant capabilities: improvement of aircraft safety due to enhanced monitoring and reasoning about the aircraft's health state, and also potential cost savings by enabling Condition Based Maintenance (CBM). The VLRS technologies developed in this project will produce a significant amount of data that can be used to enable conditioned-based maintenance (CBM) for aircraft. CBM continues to be one of the key motivations for the development of health management technology in a wide variety of aeronautical applications. CBM includes tools and technologies that enable automated, need-based maintenance (as opposed to schedule-based maintenance) using data and information derived from in-situ sensors and external test and measurement equipment and maintenance logs. With CBM, maintenance is only to be performed when there is an anticipated need. Proposers are encouraged to discuss the particular user requirements on the VLRS that arise due to a potential application in CBM and to perform a cost-benefit analysis regarding the application of the VLRS to CBM.

EXPECTED OUTCOME:
Proposals that include cutting-edge high-risk investigations are encouraged; however, the balance of risk versus potential gains should be discussed. Added value is placed on investigations that include interaction and/or collaboration with NASA researchers, as well as effective reporting and communication during the course of the studies. Offerors are strongly encouraged to propose team arrangements to provide the best combination of skills to provide a comprehensive, interdisciplinary evaluation of VLRS needs and its development, combined with an assessment of CBM benefits likely to be achieved within realistic operational constraints. A high value will be placed on results that include useful models, system and interface design and performance requirements, validation test data, performance predictions, algorithms, and operational assessments supporting the case for

[1] The IVHM project has identified Software as a subsystem of an aircraft. More information on each subsystem can be found in Sections 2.1-2.4 in the IVHM Technical Plan at http://www.aeronautics.nasa.gov/nra_pdf/ivhm_tech_plan_c1.pdf.

transition to CBM that can themselves be used for rigorous, repeatable designs by others in the aviation community.

For each year of the project, a minimum outcome comprises monthly status reports (e.g. via email or online presentations), oral reports (and delivered presentation materials) to include, at a minimum, a kickoff presentation, an interim presentation, and final presentation with the delivery of a final written report addressing the aforementioned objective(s). The final report shall be prepared in the format suitable for journal publication(s). Winning offerors will also be asked to participate in a Technical Interchange Meeting, or the AvSafe Annual Technical Meeting, to report and share results of the activity. As a minimum, the budget for travel shall provide for two such NASA technical meetings per year at a NASA-selected site in the continental United States.

Proposals addressing the description above should propose a research and development approach that will address a coherent effort spanning as many of the following tasks as reasonable within the proposed budget.

Year 1:

- Provide recommendations regarding the architecture of a VLRS, addressing areas such as data transfer protocols, speeds, and communications requirements for airframe, propulsion, aircraft, and software subsystems. The recommendations, requirements, and associated metrics should be based on the needs of the user community.
- Develop a health management information protocol that includes requirements for the information and formats needed to be passed through all levels of the VLRS.
- Provide a concept of operations of the VLRS including a study of the trade-space between complexity, accuracy, cost, and impact on aviation safety. The trade-space between the numerous (and sometimes conflicting) user requirements and the customer's desire to minimize cost should be clearly documented. This trade-space is perhaps more important than the technologies since it may dictate that some technologies may never be used.
- Develop a comprehensive set of user-requirements for Condition Based Maintenance and the application of the VLRS to enable appropriate predictive maintenance based on a fleet management perspective. Document in a NASA Technical Manuscript or other peer-reviewed publication.
- Provide recommendations regarding appropriate metrics for CBM in the context of all of the subsystems mentioned above and discuss how the proposed VLRS addresses those metrics. Document in a NASA Technical Manuscript or other peer-reviewed publication.
- Provide a concept of operations of the VLRS tools and technology, describing the potential cost-benefit tradeoffs in terms of CBM for a real-world aircraft that can be enabled by the VLRS. Requirements and cost benefit analysis should be documented with respect to user requirements that they are supporting or trading

off (logistics, maintenance, flight, fleet management, training, etc.) Document in a NASA Technical Manuscript or other peer-reviewed publication.

- Demonstrate the proposed concept of operation in a software simulation for a subset of seeded faults (selected from the Table 2 Adverse Events Table IVHM Tech Plan) in a vehicle configuration consisting of at least different subsystems.
- Publication of results in peer-reviewed journal(s) and NASA Technical Manuscripts.
- Publication of all non-proprietary data to Dashlink, the IVHM Project's collaborative website.
- Acquire data sets from a fleet of at least 10 aircraft with at least 10 flights per aircraft of similar make and model to establish probability distributions to characterize noise, uncertainty, and other statistical processes of the data streams from the at least two subsystems of the aircraft. Data from fixed-wing aircraft would be preferred but rotorcraft data would be acceptable.

Year 2

- Develop data mining algorithms that integrate and analyze large fleet-wide, asynchronous, heterogeneous data sources to establish conditional probability distributions for use in the VLRS. Document the data analysis requirements from a fleet management perspective in an effort to facilitate business decision systems of the future.
- Integrate detection, diagnostic, and prognostic reasoning and decision making algorithms into a VLRS and demonstrate on a virtual testbed (high-fidelity combination of simulated and real-time playback components) that contains three subsystems as identified above. Evaluate VLRS accuracy and performance.
- Demonstrate ability to interrogate subsystems to disambiguate root-causes of adverse events and enable accurate detection, diagnosis, and prognostics. Evaluate VLRS accuracy and performance.
- Demonstrate and quantify communications costs using the System Architecture defined in Year 1.
- Evaluate the potential cost savings of the VLRS in terms of the CBM cost benefit analysis done in Year 1. Document results in peer-reviewed journal publication(s).
- Publication of results in peer-reviewed journal(s) and NASA Technical Manuscripts.
- Publication of all non-proprietary data to Dashlink, the IVHM Project's collaborative website.

Year 3 (Optional)

- Demonstrate vehicle-level reasoning and decision making under uncertainty for detection, diagnosis, and prognosis in a hardware-in-the-loop simulation of adverse events (selected from Table 2 – Adverse Events Table in the IVHM Tech Plan) that arise from single and multiple subsystems.

- Demonstrate ability to interrogate subsystems to disambiguate root-causes of adverse events and enable accurate detection, diagnosis, and prognostics. Evaluate VLRS accuracy and performance.
- Demonstrate and quantify communications costs using the System Architecture defined in Years 1 and 2.
- Document the system architecture to enable resilient adaptive control and flight deck automation technologies based on the output of the VLRS.
- Document the data and analysis techniques needed to validate the system on future tests.
- Publication of results in peer-reviewed journal(s) and NASA Technical Manuscripts.
- Publication of all non-proprietary and non-restricted data to Dashlink, the IVHM Project's collaborative website.

DURATION:

NASA anticipates investing approximately $2700K in this topic over the next three years, at $1200K for Year 1 divided into two awards, $1000K for Year 2 for one award, and potentially $500K for Year 3 for a single award. Please note that the funding for Year 3 is based on availability of funds. NASA anticipates granting two awards in Year 1, each for approximately $600K. Based on the technical merit of the outcome of Year 1, the strongest team will be selected to continue to Years 2. Thus, only one team will continue for Year 2 beyond Year 1. Year 3 will be an optional year exercised at NASA's discretion.

Proposals submitted under this topic must cover all three years. The decision at the end of each year on whether to continue to the next year will be based on:

- NASA's judgment of the progress made each year relative to quantifiable metrics defined in the proposal and agreed to by the NASA Technical Monitor at the onset of the agreement.
- NASA's judgment of the impact the findings will have on the goals of the IVHM project.
- NASA's judgment of the ability to further develop and validate the reasoning methods with other IVHM technology concepts.
- The availability of resources to support the proposed work for subsequent years.

Proposals shall include a schedule with milestones that support the evaluation of progress and highlight the achievement of goals. Decision points are acceptable as milestones.

POTENTIAL NASA RESOURCES:

NASA computing facilities may be requested. However, proposers are encouraged to ensure that they have access to their own computational resources to address their research needs.

PROGRAMMATIC CONSIDERATIONS

In general, the topics stated within this NRA announcement must be addressed clearly and proposers must present the development and research techniques that will be applied to address the relevant issues. In addition, the cost to the Government of each major task should be clearly stated. Proposals that do not comply may be rejected for award. Other considerations to note: (1) Proposals may be awarded in full, or only specific tasks may be selected for award; (2) Proposals for individual topic areas may address only a portion of the described needs; (3) Estimated total funds available for awards is given in the Table in Section 3 of this appendix, actual funding levels will be determined based on the quality and content of individual proposals and the total available funds; (4) Multi-year awards will be subject to renewal annually based on findings and/or satisfactory performance reviews of the work to date; (5) Proposals should include plans for technical interchange with NASA and for interim reporting; (6) Milestones with measurable metrics toward achieving the proposer's goal must be provided, with a minimum of one metric per year; (7) A clear statement of intellectual property rights must be included (see evaluation criteria in Appendix B.1); and (8) Ensure that the proposal format guidance in section IV(b) (ii) (including a SOW if applicable) are followed.

In addition, the nature and extent of the required tasks for the government and for the proposal team must be outlined. NASA's involvement may include collaborative relations, access to a NASA site or equipment, sharing NASA facilities and personnel, NASA's mentoring/advising of graduate students, and/or hosting students/faculty for various periods of time. If access to a NASA site or equipment, and/or sharing NASA facilities and personnel is required, the proposals must identify the specific requirements and proposed schedule.

Summary of Key Information

Expected annual program budget for new awards	FY09: $1.2M FY10: $1.0M FY11: $0.5M
Number of new awards pending adequate proposals of merit	~2 for first year, 1 for subsequent year(s)
Maximum duration of awards	3 years (see descriptions for the subtopic above)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA and Section 2 above.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA and Section 2 above.
NASA strategic objective(s) which proposals must state and demonstrate relevance to	Every proposal must address one or more strategic goals or strategic outcomes from Table 1. See also Sections I(a) and IV(e) in the *Summary of Solicitation* of this NRA.
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	20 pp; see also Chapter 2 of *the Guidebook for Proposers – 2009*
Submission medium	Electronic proposal submission is required; no hard copy is required. See also section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers – 2009.*
Web site for submissions of proposal via NSPIRES	http://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected Type of Award	Cooperative agreements or contracts are expected to be primary awards, however grants may be considered in appropriate instances.
Funding opportunity number	NNH09ZEA001N-IVHM1
NASA point of contact concerning this program	Dr. Ashok Srivastava, Principal Investigator Dr. Lilly Spirkovska, IVHM NRA Manager roa-ivhm@nx.arc.nasa.gov Procurement POC: Tim Cannella, timothy.p.cannella@nasa.gov (until May 22, 2009) Roberta Keeter, Roberta.i.keeter@nasa.gov (after May 22, 2009)
Frequently asked questions	IVHM-specific FAQ is located under “Other Documents” on the IVHM Project page for the solicitation.

APPENDIX B.5 Integrated Resilient Aircraft Control (IRAC)

1. Project Overview

The goal of the IRAC project is to arrive at a set of validated multidisciplinary integrated aircraft control design tools and techniques for enabling safe flight in the presence of adverse conditions (ex: faults, damage and/or upsets). The technical approach is relative to the four levels of research defined by the Aeronautics Research Mission Directorate. System level research (Level 4) activities focus on the development of multidisciplinary integrated methods, tools, and technologies for achieving control resilience under adverse conditions and the validation of integrated IRAC technologies using simulation and vehicle test beds, and technology requirements definitions based on accident/incident analyses, comprehensive integrated technology evaluations, and partnering.

Multidisciplinary research (Level 3) focuses on stability, maneuverability, and safe landing using flight control to prevent and/or maneuver safely after an adverse event. To achieve this, integrated adaptive aircraft control for stability and safe maneuverability, integrated adaptive mission management tools for safe flight, and verification and validation of the integrated system are identified as key elements.

Discipline research (Level 2) focuses on methods and tools that are required for the development of integrated modeling, control, and response prediction methodologies for adverse events. The research disciplines include: Integrated Dynamics and Flight Control; Integrated Propulsion Controls and Dynamics; Airframe & Structural Dynamics; Intelligent Flight Planning and Guidance; and Verification and Validation Methods and Testbeds.

Foundational research (Level 1) focuses on fundamental theory and methods for the characterization of adverse conditions, theoretical advances in adaptive control, intelligent planning and guidance, and relevant control metrics for measuring available stability and controllability margins. Fundamental theory and methods will be developed in: 1) physics-based computational modeling of fluid, structural, and engine dynamics to characterize the effects of adverse conditions, 2) control under adverse conditions, 3) experimental methods for testing under these conditions, and the validation and verification of adaptive and learning systems.

The proposed research efforts are an integral research component of the overall project content and have been defined to contribute to specific technology needs associated with the project's application focus on multidisciplinary integrated aircraft control design synthesis.

2.Description of Solicited Research

The Integrated Resilient Aircraft Control Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

3. Summary of Key Information

Expected annual project budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected type of award	TBD
Funding opportunity number	TBD
NASA point of contact concerning this program	NRA Manager: Stephen A. Jacklin Procurement POC: Kelly Kaplan, Kelly.G.Kaplan@nasa.gov

APPENDIX C: AIRSPACE SYSTEMS PROGRAM

C.1.1 Program Overview

The Airspace Systems Program (ASP) is dedicated to the mastery and intellectual stewardship of the core competencies of Aeronautics relative to air traffic management for our Nation's airspace. The primary goal of the ASP is to develop innovative R&D solutions for a safe, efficient, high-capacity airspace system on the ground and in the air. In pursuit of this goal, the ASP is aligning its R&D portfolio to address the future air traffic management research needs through the Next Generation Air Transportation System (NextGen) Initiative as defined by the Joint Planning and Development Office (JPDO).

Consistent with NextGen capabilities, ASP will focus on two major NextGen Air Traffic Management (ATM) projects: Airspace and Airportal. ASP will perform foundational research to enable revolutionary capabilities in multi-aircraft flow and airspace optimization, trajectory design and conformance, separation, spacing, and sequencing methods, and adaptive systems management. Research in the two projects will be integrated for gate-to-gate solutions.

ASP has a four-level approach to technology development: (1) conduct foundational research to further our understanding of the underlying physics and the ability to model that physics, (2) leverage the foundational research to develop technologies and analytical tools focused on discipline-based solutions, (3) integrate multi-disciplinary methods and technologies to create sub-system level capabilities, and (4) integrate capabilities developed in (3) to provide solutions for a safe, efficient, and high-capacity airspace system.

The ASP was realigned in FY 2006 to address the needs of the NextGen initiative as defined by the multi-federal agency JPDO. These research needs were further clarified and documented in the JPDO Research and Development Plan established in FY 2007. The objective of the program is to develop revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of our National Airspace System (NAS)--an objective that is clearly aligned with the JPDO's vision of the NextGen. The ATM research conducted in the ASP is a vital component of the fundamental research conducted in support of the NextGen vision. However, increasing the capacity of the NAS by factors of two to three will not be sufficiently effective unless coupled with technology advances produced in areas of Fundamental Aeronautics and Aviation Safety. The relevance of the ASP research portfolio to national needs will be enhanced by close coordination and integration with developments in all ARMD programs.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

C.2 NextGen Airspace Project

C.2.1. Project Overview

The NextGen Airspace Project develops and explores fundamental concepts and integrated solutions that address the optimal allocation of ground and air automation technologies necessary for next generation air transportation system (NextGen). The Project will focus NASA's technical expertise and world-class facilities to address the question of where, when, how and the extent to which automation can be applied to moving aircraft safely and efficiently through the National Airspace System (NAS). Research in this Project will address 4D Trajectory Operations, including advances in the science and applications of multi-aircraft trajectory optimization that solves the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties and while keeping aircraft safely separated. The Project's research will develop and test concepts for advanced traffic flow management to provide trajectory planning and execution across the spectrum of time horizons from "strategic planning" to "separation assurance." Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed.

The NextGen Airspace Project team has developed a plan that will integrate solutions for a safe, efficient and high-capacity airspace system through joint research efforts and partnerships with other government agencies. In addition to core research and development to be conducted by NASA, Space Act Agreements will be established with U.S. industry to address research partnerships at the system-wide level including systems integration and operational applications. The Project will utilize this NASA Research Announcement (NRA) to leverage in-house foundational research with academic institutions, non-profit organizations and industry performing foundational research to address technology gaps.

This current solicitation seeks proposals related to the following NextGen Airspace Project research focus areas: the Airspace Super Density Operations (ASDO), Separation Assurance (SA), and System-Level Design, Analysis, and Simulation Tools (SLDAST). ASDO conducts research on concepts for simultaneous sequencing, spacing, merging, and de-confliction in terminal airspace. SA conducts research on failure-tolerant automated technology for sequential processing of merging and sequencing with separation in transition and cruise airspace. This includes analysis of human cognitive workload, situational awareness, performance, human/machine operating concepts, human/automation allocation, and controller/pilot roles and responsibilities during nominal and off-nominal operations. SLDAST will develop system design and analysis tools to assess the functional/temporal distribution of authority and responsibility among/between automation and humans. Solicitations for other research focus areas will be posted in future announcements.

Milestone references for Subtopics in this section of the NRA are provided below under

the heading "Milestones Supported" so that it is possible to see how the NRA topics fit into the NASA Aeronautics research plan. These milestones are listed on project roadmaps that are available on the ARMD website (www.aeronautics.nasa.gov, under the Programs link).

C.2.2 Evaluation Process and Description of Solicited Research
Evaluation Criteria

This Topic supports NASA Strategic Sub-goal 3E:

> Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

The Technical Review and Evaluation Team will consider the merit of the specific proposals against the established criteria as stated in the NRA and listed below.

1. Relevance to NASA's objectives (weight: 20%)
   - Clear link between the proposed work and the Subtopic.
   - Compatibility between the proposed work products and the Subtopic outcomes.
   - Potential to extend applicability of the proposed work to one or more of the Research Focus Areas described in the *NextGen-Airspace FY2009 Project Plan, available in Reference Materials at http://www.aeronautics.nasa.gov/asp/airspace*
   - Quality of proposed collaboration with NASA researchers, including joint use of facilities, sharing of materials, and synergistic research goals. Proposals that include a willingness of the principal investigator and/or key personnel to serve a period of residency at the appropriate NASA Center are highly desirable.

2. Intrinsic Merit (weight: 50%)
   - Overall scientific or technical merit of the proposal, including unique and innovative methods, approaches, or concepts.
   - Credibility of technical approach, including a clear assessment of primary risks and a means to address them.
   - Proposer's capabilities, related experience, facilities, and techniques, which are integral factors for achieving proposal objectives. Includes principal investigator and key personnel critical in achieving proposal objectives.
   - Overall evaluation against the state of the art.

3. Effectiveness of the Proposed Work Plan (weight: 15%)
   - Comprehensiveness of work plan, effective use of resources, management approach, and proposed schedule for meeting the objectives.
   - Measurable metrics toward achieving the proposer's goal must be provided, with a minimum of one metric per year. Proof-of-concept demonstrations are encouraged. Tangible outcomes at the end of the effort are desirable. Annual oral presentations made as part of an open Technical Exchange Meeting for purposes

of technology transfer and knowledge dissemination will be expected.

- A clear statement of what intellectual property is expected to be publicly available at the conclusion of the work is required. It is our intent to share all knowledge developed under this solicitation; thus, any restrictions to that objective will cause a lower score in this area.

4. Subtopic-unique Criteria (weight: 5%)
Criteria unique to a given Subtopic area, has been established and is noted in the Subtopic description. (If no Subtopic-unique Criteria is listed for a given Subtopic, the 5% will be added to the weight factor for Intrinsic Merit.)

5. Proposed Costs realism and reasonableness, (weight: 10%)

C.2.3 Description of Solicited Research

Subtopic 1: Novel, capacity-enhancing criteria for safe separation

Funding for this research activity is approximately $600K for an 18-month effort.

Objective
Identify and evaluate alternative criteria for “minimum safe separation standards” with potential to increase the capacity of the NextGen airspace system.

Milestone(s) Supported
AS.1.5.01 – Alternative criteria for minimum separation standards

Background
NASA is charged with developing technology and concepts that will dramatically increase the capacity of our National Airspace System (NAS) for the NextGen timeframe. A fundamental determinant of airspace capacity is the separation standard for flight operations in controlled airspace. In the NextGen timeframe, advances in navigation and surveillance capabilities—as well as new separation assurance automation and procedures—will provide an opportunity to consider new criteria for separation standards that enable more efficient use of the NAS. Such standards need not be defined by static, distance-based, symmetrical volumes centered about the aircraft, as is the case with today's "separation hockey puck." A fresh, risk-based derivation of separation criteria based on NextGen operational assumptions such as performance-based services could produce significantly different standards from those of today, promising more efficient use of NAS resources.

In its report to the FAA Administrator, the FAA Research, Engineering, & Development Advisory Committee's Separation Standards Working Group made the following observations:

- Historically, separation standards have been developed empirically based on judgment, extrapolation of past experience, and limited analysis. Analytic and

probabilistic studies are an essential piece in the larger process of determining safe standards.

- As navigation and surveillance performance improves, separation standards will be driven more by the need to accommodate blunders and system failures than by variations in nominal system performance.
- Little is known about such blunders and failure modes: their frequency of occurrence, their magnitude, under what circumstances they are most likely to occur. Existing information is primarily anecdotal.
- To evaluate the major changes in separation standards that will be required for NextGen, it may be necessary to evaluate system risk against an independent threshold, as opposed to comparison against a reference system such as the current NAS.

In response to these observations, this solicitation proposes a set of research activities that address the key recommendations of the FAA report and, in so doing, identify novel, capacity-enhancing criteria for safe separation.

References:

Joint Planning & Development Office, "Next Generation Air Transportation System Integrated Work Plan: A Functional Outline," Version 1.0, September 30, 2008. Available for download at http://www.jpdo.gov/

- Research Activity R-500: Complete applied research on options for procedures, standard specifications, decision-support aids, and displays to support an alternative selection to enable variable separation standards based on performance levels in all airspace.

- Enabler EN-0212: Separation management standards and procedures that allow Air Navigation Service Provider's (ANSP) and flight operators to safely manage separation using aircraft parameters and operating conditions. Safe separation standards and procedures will reflect aircraft capabilities, wake turbulence characteristics, operational geometries, and environmental conditions.

FAA Research, Engineering, and Development Advisory Committee, "FAA Separation Standards Working Group Final Report," September 20, 2006. Available for download at http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/nextgen/research_planning/redac/reports/media/pdf/Report_Separation_Standards_Working_Group.pdf

Approach
Develop a data-driven, risk-based, objective methodology for determining separation standards for NextGen operations.

Task 1:Literature review

Conduct a literature search to survey the history and state of the art with respect to research on standards for safe separation of vehicles. The "FAA Separation Standards Working Group Final Report" cited above would be a good departure point. An annotated literature review will constitute the first deliverable.

Task 2: Data collection
Establish the means to collect relevant data from NAS operations. At least two sorts of data are of interest:
1. Operational data to develop a statistical understanding of performance-based navigation, communication and surveillance systems in normal operations through various flight regimes; and
2. Operational data to develop a statistical understanding of the type, frequency, magnitude and circumstances surrounding gross trajectory deviations, or "blunders," precipitated by human or system failures.

Collecting this data is not expected to be a straightforward matter of accessing existing databases. It will likely require the development of new processes and partnerships. The FAA/NASA Performance Data Analysis and Reporting System (PDARS) program may be one possible vendor with whom the proposer and the solicitor (NASA's NextGen-Airspace Project) can collaborate in order to develop and implement a process to acquire such data. NASA is open to considering other avenues for acquiring said data.

Task 3: Mathematical analysis
Characterize statistically the data collected in Task 2. Our hypothesis is that, under NextGen operational assumptions, the contribution of "type 1" (i.e., nominal) trajectory errors to the separation risk analyses will be overwhelmed by "type 2" (i.e., off-nominal) trajectory error. This is expected to have implications for the form and composition of new separation standards.

Task 4: Standards development
Propose at least one candidate framework for new separation standards that would enable more efficient use of the NAS.

Task 5: Risk assessment
Adopt or develop a methodology to assess the risk associated with alternative separation standards. At this stage of analysis, it is recognized that there will be many unknowns in terms of system components, roles and responsibilities, failure modes and failure rates, etc. Document all assumptions carefully.

Task 6: Sensitivity study
Evaluate the sensitivity of the risk-assessment results to the assumptions.

Task 7: Target Level of Safety (TLS) establishment
Recommend a metric and threshold value for "Target Level of Safety" based on mathematical analysis. For the separation standards proposed, identify parameter values that will achieve this "Target Level of Safety."

Task 8. Identify key challenges associated with the implementation of the proposed separation standard. Examine both technical and institutional challenges; e.g., how is the separation standard made observable to the party responsible for separation (ANSP, operator, or automation), both at the current time and in the near-term future.

Task 9. Identify research requirements going forward. What are the remaining questions to be answered before we can implement—or even determine—the separation standards that will be most appropriate for NextGen operations?

Outcome(s)
The outcomes of this NRA subtopic shall include findings and recommendations in the form of deliverable documents—formal conference and/or journal publications are preferred. A recommended template for the desired outcomes is provided below, recognizing that early research findings may suggest a different flow of desired outcomes in later quarters. The following also assumes that some tasks take place in parallel by researchers with complementary skill sets.

1st quarter:

- A kickoff meeting is held to acquaint the NASA research community and the proposer's research team with one another, to discuss the proposer's technical approach, and to acquaint the proposer's research team with the relevant NASA facilities and capabilities.
- An annotated literature review is delivered to NASA (ref. Task 1).

2nd quarter:

- A mechanism and process is in place to collect relevant data, per Task 2.

3rd quarter:

- Hypothesis in Task 3 is confirmed or refuted in a technical whitepaper suitable for publication.*

4th quarter:

- A whitepaper proposes at least one candidate framework for new separation standards that would enable more efficient use of the NAS (ref. Task 4).
- A conceptual framework for “target level of safety” is proposed in a whitepaper (ref. Task 7).
- A technical interchange meeting is held with key members of the proposer's research team and the NASA research community to review progress, inventory current challenges, coordinate next steps, and make strategic adjustments, as necessary.

5th quarter:

- Work period. No specific work product deliverables or outcomes.

6th quarter:

- A whitepaper documents the results of the initial risk assessment (ref. Task 5), where the driving terms are identified based on mathematical (or higher fidelity) sensitivity analysis (ref. Task 6).
- A whitepaper proposes a threshold target level of safety and evaluates the proposed new separation standards against it (ref. Task 7).
- A final report is written summarizing all findings and recommendations. Key technical and institutional challenges associated with the implementation of the proposed separation standard are cited. Research requirements for future work are included (ref. Tasks 8 & 9).

* Technical whitepaper suitable for publication (hereafter, "whitepaper"): In this context, a "whitepaper" is extended prose and key figures describing the problem, approach, rationale, results and implications of a specific research task/activity. While a whitepaper could be filled out to become a conference or journal submission, it may be desirable to combine two or more whitepapers into a single manuscript for publication. The whitepaper is envisioned as an expedient means of documenting and sharing important findings and/or recommendations with NASA, while still providing a basis for eventual dissemination to the broader research community through a peer-reviewed publication process.

Note: Where appropriate, the proposer may be asked to engage with specific FAA personnel, to be dictated by the course of the research. The envisioned interaction is of the "periodic joint meeting/telecon" and/or "shared communications/reports" variety. Task 2 specifically may require FAA coordination.

Subtopic-unique criteria (Applies to Evaluation Criteria, Item 4)

- Collaborative posture toward NASA. This work is intended to be cooperative with NASA. The outcomes are expected (indeed required) to fulfill NASA program milestones and directly feed future NASA research activities. Proposals with provisions to better facilitate collaboration with NASA will be judged more favorably.
- Expertise and experience in risk analysis. For incremental changes to an existing system, system risk may be evaluated by comparison against the reference system. For major changes such as those foreseen as part of NextGen, system risk may be better evaluated against a threshold "Target Level of Safety." Proposal teams that feature demonstrated expertise and experience conducting the latter type of risk analysis will be judged more favorably.

C.2.4. Summary of Key Information

Expected annual program budget for new awards	Approximately $600K. It should not be expected that the entire annual NRA program budget will be awarded by means of this specific solicitation. Additional solicitations may follow. Note: **For these topics, approximate funding levels are provided for each Subtopic due to budget constraints. While NASA will consider proposals above the stated level, exceeding this level will impact the evaluation.**
Number of new awards pending adequate proposals of merit	One award is expected
Maximum duration of awards	18 months
Due date for Notice of Intent to propose (NOI)	(See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.)
Due date for proposals	(See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.)
NASA strategic objective(s) which proposals must state and demonstrate relevance to	Strategic Sub-goal 3E: Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems. Outcome 3E.2: By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements for the Next Generation Air Transportation system.
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	Maximum of 20 pages; see also Chapter 2 of the *Guidebook for Proposers*
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	Not applicable
Expected type of award	Cooperative Agreement or Contract. If a contract is desired, please provide a draft Statement of Work with proposal.
Funding opportunity number for downloading an application package from Grants.gov	Not applicable
NASA technical point of contact concerning this program Note: Please submit questions in writing on-line to <ARC-nextgen.airspace@mail.nasa.gov> We will post answers on-line so that all will have access to the same information.	Parimal H. Kopardekar Parimal.h.kopardekar@nasa.gov Principal Investigator or Michael R. Landis Michael.r.landis@nasa.gov Project Manager NextGen-Airspace Project NASA Ames Research Center Mail-Stop 210-15 Moffett Field CA, 94035-1000
NASA Procurement point of contact concerning this program	Christine Munroe christine.l.munroe@nasa.gov

C.3: NextGen-Airportal

C.3.1 Project Overview

The NextGen-Airportal Project will work in close collaboration with the NextGen-Airspace Project to conduct airspace and airportal foundational research and discipline-based technology development for the nation. The NextGen-Airportal Project will focus on achieving the highest possible efficiency in the use of such airportal resources as gates, taxiways, runways, and metroplex airspace. In pursuit of that goal, the project will research, develop, demonstrate, and validate operational concepts, proof-of-concept systems, algorithms, technologies, tools, and operational procedures for use in maximizing capacity and throughput in the airportal environment while enabling associated elements of the NextGen as defined by the JPDO.

Performance objectives include the use of 4-D trajectories (aircraft path from "block-to-block," including the path along the ground) to plan and execute system-wide operations; integrating 4-D trajectory operations with safe, optimized surface and terminal area traffic operations, particularly those associated with wake hazard prediction and avoidance; balancing environmental issues in and around airports; matching surface and airside capacities with arrival and departure air traffic flow; and assessing local benefits of airportal transformation by modeling changes to the current airport configuration.

In support of these objectives, research activities will focus on:

- Optimization of surface traffic
- Dynamic airport configuration management
- Advanced technologies to detect and avoid wake vortex hazards
- New procedures for performing safe, closely spaced and converging approaches at closer distances than are currently allowed
- Modeling, simulation, and experimental validation research focused on efficient operations of single and multiple regional airports (metroplex)

The research focus areas for the NextGen-Airportal project are:

Safe and Efficient Surface Operations (SESO):
The purpose of the SESO RFA is to manage traffic on the airport surface (gates, taxiways, and runways) safely and efficiently to enable maximum throughput and capacity in the airport environment.

Coordinated Arrival and Departure Operations Management (CADOM):
The CADOM research area focuses on concepts and technologies needed to mitigate operational constraints to maximizing single and multiple -airport capacity.

Airportal and Metroplex Integration (AMI):
The AMI RFA focuses on management of metroplex operations, as well as integration of work across the Project's technical areas and performing crosscutting research (e.g., human/system integration and concept analyses for portfolio management).

C.3.2 Description of Solicited Research

The NextGen Airportal Project is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

C.3.3. Summary of Key Information

Expected annual program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers-2009*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected type of award	TBD
Funding opportunity number	TBD
NASA technical point of contact concerning this program: Note: Please submit questions in writing on-line to airportal@mail.arc.nasa.gov We will post answers on-line (in the Airportal Project section of NSPIRES) so that all will have access to the same information.	Leighton Quon, Principal Investigator Or Neil O'Connor, Project Manager Or Mike Madson, Project Scientist NRA Manager: Sherri Yokum, sherri.l.yokum@nasa.gov
NASA Procurement point of contact concerning this program:	Kelly Kaplan, Kelly.G.Kaplan@nasa.gov

APPENDIX D: Aeronautics Test Program

D.1 Program Overview

NASA's Vision and mission are implemented through its four Mission Directorates. All four of these Mission Directorates, in carrying out their mission for NASA, utilize NASA's major wind tunnels/ground test facilities, and flight operations/test infrastructure. The Aeronautics Test Program (ATP) is designed to corporately manage these assets and sustain and improve NASA's core capabilities in these assets to ensure that a minimum core capability is maintained and available to support the needed Mission Directorate testing. The ATP's purpose is to ensure the strategic availability of a minimum, critical suite of aeronautical test facilities that are necessary to meet the long-term needs and requirements of the Nation. At present, the ATP is responsible for the major wind tunnels/ground test facilities at the Ames Research Center, Glenn Research Center, and Langley Research Center and the Western Aeronautical Test Range (WATR), Support Aircraft, Testbed Aircraft, and the Simulation and Loads Laboratories at Dryden Flight Research Center (DFRC).

The need for reliable facilities to support future NASA aeronautics research, NASA exploration development, Department of Defense (DoD) military systems development, and the commercial sector development of new civil aircraft presents the ATP with challenges in meeting the above objectives while servicing the potential customers. Today's customers are looking for excellent service with extremely dependable test results, yet also demand cost effectiveness and efficiency.

In order to meet the goals of corporate management and sustaining core capability, the ATP is formulated around the following objectives:

- Implement an integrated, consistent approach to the management of major wind tunnels/ground test facilities and flight operations/test infrastructure.
- Accomplish efficient and effective use of NASA's major wind tunnels/ground test facilities and flight operations/test infrastructure and other resources to optimize customer service and to meet national test requirements.
- Ensure stable, affordable, and competitive prices for ATP facilities.
- Maximize the return on investments through facility modernization, technology development, and sound maintenance strategies.
- Provide a stable level of investment, including maintenance, revitalization, and required upgrades.
- Periodically identify and validate a set of facilities that the Aeronautics Research Mission Directorate (ARMD) and/or Shared Capability Assets Program (SCAP) will support.
- Develop a facility divestment and investment plan that supports NASA's, DoD's, and the U.S. Industry's current and/or long-term missions.
- Maintain and develop mutually beneficial testing partnerships between NASA, DoD, and the U.S. commercial sector.

The ATP has been organized into two projects to support the above objectives:

- **Aero Ground Test Facilities Project**:

- ***Facility Operations Support***: Provide 60 percent to 75 percent of the facility fixed costs for ground test facilities to ensure facility and staff availability and user price stability.
- ***Facility Maintenance and Upgrades***: Provide funding for maintenance and upgrades that correct known deficiencies in facility safety, reliability, and productivity and enable the facilities to meet near-term and future testing requirements.
- ***Facility Test Technology:*** Develop and implement new technologies that increase test capability, improve productivity and efficiency, and improve data quality.
- ***Facility Related Research***: Activities in this project will be competed openly with a strong desire to involve universities with experimental work in major facilities.

- **Flight Operations and Test Infrastructure Project**:
  - ***Western Aeronautical Test Range, Support Aircraft Maintenance and Operations, Testbed Aircraft***: Provide up to 100 percent of the facility fixed costs for flight facilities to ensure facility and staff availability and user price stability.
  - ***Simulation and Flight Landing Loads Laboratories***: Provide up to 20 percent of the fixed costs for labs to ensure facility and staff availability and user price stability.

This NRA is specifically addressing the Facility Related Research aspect of the ATP in the Aero Ground Test Facilities Project. For further information on the ATP and its facilities, please visit the following website: http://www.aeronautics.nasa.gov/atp.

Appendix D.2: Facility Related Research

1. Overview

The ATP facility-related research primary objectives are to support research in the NASA ATP facilities that solve fundamental problems by novel means in areas such as facility characterization, simulation of test conditions, or test techniques and to foster the development of future researchers in the techniques of large scale aeronautics testing. In order to maintain NASA's facilities at a world class level, it is necessary to push the state-of-the-art in facility technologies at all levels including those at the fundamental level. The solutions to these fundamental problems are expected to apply broadly to aeronautics test facilities that could benefit more than one NASA ATP facility and potentially other facilities across the nation.

1.1 Description of Specific Solicited Research

The Aeronautics Test Program is not soliciting research topics at this time. Please continue to monitor this solicitation for future amendments.

Summary of Key Information

Expected annual program budget for new awards	TBD
Number of new awards pending adequate proposals of merit	TBD
Maximum duration of awards	TBD
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
General information and overview of this solicitation	See the *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2009* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Page limit for the central Science-Technical-Management section of proposal	TBD
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected contract type	TBD
Funding opportunity number	TBD
NASA technical point of contact concerning this program	NRA Manager: Steve Helland
NASA Procurement point of contact concerning this program	Melissa Merrill, Melissa.A.Merrill@nasa.gov

APPENDIX E: CROSS-PROGRAM RESEARCH

E.1 Program Overview

ARMD is soliciting proposals in areas of research that are cross-program in scope. The Aeronautics enterprise is one of highly leveraged and integrated technologies, and ARMD recognizes that sponsored research which addresses cross-discipline systems level problems will be of high value to establishing an R&D portfolio with the broadest national value. Sub-topics that are listed under this appendix will be ones that are jointly sponsored by several programs and projects in ARMD. For more information, please see http://www.aeronautics.nasa.gov/programs.htm. At the time of the initial release of ROA-2009 there are no initial topics in Appendix E.