AMENDMENT No. 3 TO THE NASA RESEARCH ANNOUNCEMENT (NRA) ENTITLED "RESEARCH OPPORTUNITIES IN AERONAUTICS – 2020 (ROA-2020)," NNH20ZEA001N, RELEASED MARCH 26, 2021

Changes are made to the following:

- Updated Table of Contents
- Table 5. Solicited Research Programs (in order of proposal due dates)
- Table 6. Solicited Research Programs (in order of Appendices A-D)
- Appendix D.4 - University Leadership Initiative (ULI)

TABLE 5. SOLICITED RESEARCH PROGRAMS (IN ORDER OF PROPOSAL DUE DATES)

APPENDIX	PROGRAM	NOI DUE DATE	PROPOSAL DUE DATE
D.5	University Student Research Challenge (USRC)	n/a	See note 1
B.3	System-Wide Safety Project	n/a	February 15, 2021
D.4	University Leadership Initiative (ULI)	6/22/2021 See note 2	See note 3

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

1. University Student Research Challenge (USRC) will evaluate all proposals submitted to date in three cycles: Cycle One Due Date is November 12, 2020; Cycle Two Due Date is February 25, 2021; and Cycle Three Due Date is June 24, 2021.
2. University Leadership Initiative will use a 2-step proposal process. Step-A proposals are required, in place of the Notice of Intent (NOI) and are due 6/22/2021.
3. University Leadership Initiative will use a 2-step proposal process. Step-B proposals will be due 60 days after the notification for Step-B proposals is issued.

TABLE 6. SOLICITED RESEARCH PROGRAMS (IN ORDER OF APPENDICES A–D)

APPENDIX	PROGRAM	NOI DUE DATE	PROPOSAL DUE DATE
B.3	System-Wide Safety Project	n/a	February 15, 2021
D.4	University Leadership Initiative (ULI)	6/22/2021 See note 2	See note 3

D.5	University Student Research Challenge (USRC)	n/a	See note 1

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D.4 University Leadership Initiative

The University Leadership Initiative (ULI) is a portfolio item in NASA Aeronautics Research Mission Directorate's (ARMD) University Innovation (UI) Project.

D.4.1 ULI Overview and Goals

ARMD created ULI for universities to take the lead, build their own teams, and set their own research path. ULI seeks new, innovative ideas that can complement the NASA ARMD portfolio and support the U.S. aviation community.

ULI's strategic goals are:

- Assist in achieving aviation outcomes defined in the ARMD Strategic Implementation Plan ("Strategic Plan") [Ref. 1] through NASA-complementary research;
- Transition research results to an appropriate range of stakeholders that leads to a continuation of the research. Transition can occur in several ways, including the following:
  - Creates a new product line in U.S. industry or a new ARMD project,
  - Whole ULI concept is transitioned to U.S. industry/ARMD project,
  - Part of the ULI concept is transitioned to U.S. industry/ARMD project,
  - ULI findings impact direction of U.S. industry/ARMD.
- Provide broad opportunities for students at different levels, including undergraduate and graduate, to participate in aeronautics research;
- Promote greater diversity in aeronautics through increased participation of minority-serving institutions [Ref. 2] and underrepresented university faculties in ULI activities.

ULI provides the opportunity for university teams to exercise technical and organizational leadership in proposing unique technical challenges, defining interdisciplinary solutions, establishing peer review mechanisms, and applying innovative teaming strategies to strengthen the research impact. By addressing the most complex challenges associated with ARMD strategic thrusts, universities will accelerate progress toward achievement of high impact outcomes while leveraging their capability to bring together the best and brightest minds across many disciplines. In order to transition their research, Principal Investigators (PIs) are expected to actively explore transition opportunities and pursue follow-on funding from stakeholders and industrial partners during the award.

D.4.2 Description of Solicited Research

D.4.2.1 Solicited Topics

In this solicitation, NASA's University Innovation (UI) Project is seeking proposals for work in the following seven topic areas:

Topic 1: Safe, Efficient Growth in Global Operations (Strategic Thrust 1)
Topic 2: Innovation in Commercial Supersonic Aircraft (Strategic Thrust 2)
Topic 3: Ultra-Efficient Subsonic Transports (Strategic Thrust 3)
Topic 4: Safe, Quiet, and Affordable Vertical Lift Air Vehicles (Strategic Thrust 4)
Topic 5: In-Time System-Wide Safety Assurance (Strategic Thrust 5)
Topic 6: Assured Autonomy for Aviation Transformation (Strategic Thrust 6)
Topic 7: Zero Emission Aviation

Each of the first six topics correspond to an ARMD strategic thrust listed in parenthesis - see Section D.4.2.2. See section D.4.2.3 for the seventh and final topic, Zero Emission Aviation.

D.4.2.2 ARMD Strategic Thrusts and Outcomes

The six ARMD strategic thrusts are described further in the ARMD Strategic Implementation Plan [Ref. 1]. Research objectives for the strategic thrusts are provided in terms of community-based outcomes for three time periods: near-term (2015-2025), mid-term (2025-2035), and far-term (beyond 2035). These outcomes represent NASA's view of expected aviation community advancements within each strategic thrust. Achieving the outcomes will rely on research contributions from NASA and others in the aviation community, as well as the implementation of technologies and procedures onboard aircraft and ground-systems and throughout the National Airspace System.

D.4.2.3 Topic 7 – Zero Emission Aviation

This ULI topic 7 addresses the long-term challenge of Zero Emission Aviation by 2050. The focus should go beyond the next generation aircraft and pioneer new concepts, technologies and operations to achieve the zero-emissions future.

For purposes of this solicitation, zero emission technology refers to any technology that provides a pathway to the eventual adoption of aircraft that do no environmental harm in all its operating modes. This topic focuses only on reducing aviation emissions and does not target emissions from energy production. Programs addressing emissions from energy production are carried out by other governmental agencies. However, an estimate of the life cycle emissions impact of the energy used and attributable to aviation must be included in the Step-B proposal and, if awarded, developed further during the period of performance.

The following are the desired outcomes from proposals in ULI Topic 7:

1. A scenario describing the state of the future world with respect to air transportation in the 2050s (dominant aircraft – size/range/number of aircraft, general and aviation energy economy, noise, air quality and climate change drivers, etc.). The research focus should be on the dominant aircraft, and its operations, that will likely comprise the majority of passenger air-miles in the 2050s timeframe.
2. Develop transformational aircraft, technologies and operational approaches that meet economic and environmental demands of airlines, the general public and other stakeholders for a zero-emissions future by 2050, and

3. Produce the next generation scientists and engineers prepared to lead the aviation industry to a zero-emissions future.

Outcome 1 provides the drivers and energy environment/infrastructure assumptions for the research. The primary focus of any awarded work should be on outcomes 2 and 3.

Potential approaches to enabling the second outcome is to work with the aviation community to identify far term, promising concepts and begin to accelerate development of the key enabling revolutionary technologies and vehicle concepts to pioneer this future. The research should ensure that safety implications of advanced technologies and concepts are identified and considered in the development process. Addressing challenges of supporting zero emission energy infrastructure for the proposed concepts and operations may optionally be included in the proposal. The need, if any, for new standards or regulations that will be required to enable certain technologies or concepts, should be identified, as should any known cost barriers. Optional too is research to support standards and policy development to reduce costs and risks of adopting the zero-emission vehicle and technologies.

ULI desires an integrated, multi-disciplinary, multi-institutional teamed approach. Teams are strongly encouraged to collaborate with industry in developing the technical challenges (see Section D.4.4.2). The developed research products should overcome the barriers associated with the technical challenges. Proposals should clearly indicate how their research products will contribute to the topic outcomes.

Innovative concepts, technologies, and methods with the highest potential impact will be prioritized for selection. Proposals should not only explore these concepts, technologies and methods, but also verify their practicality via demonstrations to facilitate technology transfer into the aviation community.

D.4.2.4 NASA-Complementary Research

Through this solicitation, NASA looks to introduce independent research paths toward achieving the strategic thrust outcomes. To support this goal, as well as avoid duplication of effort, proposers are encouraged to develop different technical challenges than those currently pursued by ARMD and its research partners. Reference 3 provides the current ARMD technical challenges and Reference 4 provides the list of existing ULI awards. ARMD does not claim these technical challenges to be all-inclusive of those needed to address the thrust outcomes, nor do they necessarily represent the most important barriers that must be overcome. NASA's research portfolio will be enhanced through the addition of new technical challenges brought in by awardees of this solicitation. Proposer-defined technical challenges will be evaluated based on their anticipated impact, without any effort to determine their compatibility with the current ARMD portfolio.

D.4.3 Funding and Eligibility

D.4.3.1 Funding Information and Projected Distribution of Awards

Proposals should have nominal budgets in the $1-2M range per award per year. Proposals in Topics 1-6 are invited for 3-year duration and maximum total budgets

should range between $3-6M per award. Proposals in Topic 7 are invited for 3 to 5-year durations and maximum total budgets should range between $5-10M per award. The UI Project anticipates investing in two 3-year awards and one award in Topic 7. Actual budget usage by the awardees is important to NASA and so proposed budgets must consider ramp ups within the team.

The actual number, value, duration, and topic of the awards will depend on the quality of the proposals received, the scope of the proposed work, funding availability, and program needs. In addition, these projections represent the program's plans at the time of the release of this solicitation. These conditions are subject to change, and therefore there is no guarantee that the awards will be allocated as described above. Awards for multiple years of performance are subject to adequate performance during previous years and funding availability in subsequent fiscal years. In some cases, only a portion of a proposal may be selected for award.

D.4.3.2 Eligibility

Lead Organization: For this solicitation, the proposing (lead) organization must be an accredited, degree-granting U.S. college or university.

Partners: Proposing organizations are invited to include partners as part of their team - a partner can receive funds from the NASA award. Partners may include other U.S. colleges and universities, U.S. companies, non-profit organizations, federally funded research and development centers (FFRDC), and any other public or private U.S. entity. Other government agencies and NASA centers are not eligible to participate as partners.

HBCU and MSI: Historically Black Colleges and Universities (HBCU) and other minority-serving institutions (MSI) are strongly encouraged to participate.

Collaborators: Proposing organizations are invited to include other collaborators as part of their team - collaborators may not receive funds from the NASA award. Proposers may describe potential plans for collaboration with industry, U.S. government agencies or other organizations in their Step-A or Step-B ULI proposals. Focused but unfunded collaboration under ULI may take many different forms. Some examples may include, but are not limited to: technology convergence, where an idea previously developed for a different government agency is utilized for NASA aeronautics in a novel way; a partnership where the industrial collaborator that will eventually utilize the proposed concept works with the ULI team to ensure this possibility; and use of a collaborator's facilities, equipment, or research capabilities.

Collaboration with other U.S. government agencies that adds value towards the research and development of the innovative concepts, while preserving the university leadership aspect of this initiative, is encouraged. Any proposed collaboration with a U.S. government agency must conform to the solicitation's instructions.

Collaboration with NASA is covered in Section D.4.5.4.

Ineligible: Foreign-owned U.S. subsidiaries and foreign organizations are not permitted for this solicitation as partners, collaborators, peer reviewers, technology recipients, etc. However, the direct purchase of supplies and/or services, which do not constitute research or research data exchange, from non-U.S. sources with NASA-awarded funds is permitted.

Other eligibility criteria, not superseded by the above, including China Funding Restriction are in Section III of this ROA.

D.4.4 Information for Proposal Development

D.4.4.1 Research Topic and Technical Challenge Identification

When selecting a topic to address, proposers are encouraged to consider a distinct set of outcome needs in a single solicited topic area and then determine technical challenges and research activities that will meet those needs. Technical challenges are distinct barriers that must be overcome in order to achieve the topic outcomes. Research activities are limited-duration projects contributing the knowledge or capabilities needed to accomplish the proposer-defined technical challenges. While a given research product may be able to meet outcomes in more than one topic area, proposers must explicitly connect their research products to specific outcomes in a single topic area. Proposers may note compatibility with multiple topics but should avoid making general associations between their expected products and multiple topics (i.e. avoid stating, "This technology could also support topics X, Y, and Z."). Alignment and focus are more important than breadth of applicability. This emphasis supports a "topic-driven" rather than "technology-driven" approach.

Through this announcement, proposers will have the opportunity to:

- Independently identify the most critical technical challenges that must be solved to achieve the topic outcomes;
- Propose independent, innovative research activities to solve the technical challenges, including developing the success criteria, progress indicators, and technical approach;
- Bring forward system-level, revolutionary concepts;
- Build a talented, diverse, and cross-disciplinary team to explore innovative, integrated solutions toward the technical challenges;
- Consider application of multi-disciplinary, multi-industry approaches, including those outside of traditional aeronautics disciplines (technology "convergence"); and
- Offer novel, high technical risk approaches that open avenues for accelerated progress.

Proposals offering integrated, multi-disciplinary solutions will be considered more favorably than a group of loosely connected single-discipline solutions, even if the single-discipline solutions address challenging problems in their own right.

D.4.4.2 Developing Technical Challenges

This section provides proposers with insight on developing technical challenges. The complete set of elements discussed below applies most directly to second stage ("Step-B") proposals. First stage ("Step-A") proposals may only require a sub-set of the information described. Please see Sections D.4.6.1.4 and D.4.6.1.6 for a complete list of required elements for Step-A and Step-B proposals, respectively.

Proposers shall identify one or more technical challenges corresponding to one of the solicited topics (Section D.4.2.1). Technical challenges have the following characteristics: they are stated in crisp, clear, and concise terms; a technical barrier or enabler is clearly defined; there is a quantifiable measure of success; and, progress is measurable in discrete increments (progress indicators). To accomplish an outcome, the aviation community must address progressively more difficult challenges across a range of research themes. Each technical challenge represents an important step toward achieving the outcomes. Proposers shall provide technical challenge(s) they expect to be achievable through their own contributions within the research activity duration.

In developing the technical challenges, proposers are encouraged to review the solicited topic areas above (Section D.4.2.1), including the Strategic Plan [Ref. 1] and determine a topic to which they can contribute. Through their own analyses, proposers should determine the technical challenges they consider important. The technical challenges may correspond to the research themes provided in the Strategic Plan or may address different themes the proposer deems necessary to accomplish the outcome. To support this goal, as well as avoid duplication of effort, proposers are encouraged to develop different technical challenges than those currently pursued by ARMD and its research partners (see Section D.4.2.4, Ref. 3 and 4). This process is comparable to that used by NASA teams in developing the current ARMD portfolio.

A technical challenge includes the following elements: statement, duration, performance metric(s), and success criteria. The statement shall be represented as a research contribution that addresses a technical barrier. A well-written statement clearly reflects a barrier that can be overcome within the established timeframe. It should be an important step towards achieving the strategic outcome and not the research area's long-term goal. Duration of the technical challenge is measured in years from the start of award. Where required, proposers shall provide a small number (nominally 1-2) of key performance metrics. These metrics will be used to determine progress and final completion of the technical challenge. Success criteria provide target levels of the performance metric upon completion of the technical challenge.

D.4.4.3 Progress Indicators

Awardees will be expected to plan and measure progress toward their technical challenges. Progress indicator charts are one such way to support this task. Reference 5 provides current or recent NASA examples for different types of research products, including tools, technologies, and concepts (Ref. 5 examples 1-3, respectively). Charts include the following elements: technical challenge statement, duration, technical performance plot, and technical maturity plot. Technical performance and technical

maturity are represented in the upper and lower plots of each example, respectively. Technical performance indicates the expected interim and final performance of the research products contributing to the technical challenge. Performance is measured using the technical challenge performance metric(s). Approximate error bands may be included. Any bands are used for illustrative purposes only and are not intended to be precise. Performance can advance through improvement in the value itself and/or a reduction in its uncertainty. Technical maturity reflects the progress of research products on the way to achieving the technical challenge. Various means to assess technical maturity may be used.

Use of TRLs and MRLs: Where applicable, ULI recommends using Technology Readiness Level (TRL) or Manufacturing Readiness Level (MRL). These are helpful metrics for technologies and manufacturing, respectively. However, TRLs and MRLs may not relate well to a tool, method, or model, nor may it be applicable to software. The software community uses other measures to reflect maturity - see for example NASA Software Engineering Handbook (https://swehb.nasa.gov/). ULI recommends using the appropriate success criteria depending on the concepts or technologies being developed.

For both technical performance and maturity plots, performance and maturity are assessed at selected milestones. Proposers may note that the Reference 5 examples represent NASA work in progress and therefore include some features that are not applicable to the planning stage (e.g. completed and/or slipped milestones).

Proposers may apply different approaches to planning their technical challenges, provided they show expected advancements in technical performance and maturity as milestones are completed. Technical performance should culminate in the target established for the technical challenge.

D.4.4.4 Research Milestones

For each technical challenge, proposers shall develop an associated set of research milestones addressing the challenge. A fully defined milestone includes the following information: title, description, duration (year and quarter-year from start of award - see Section D.4.8 for Start of Period of Performance), exit criteria, and deliverables. The description should provide a few sentences on the research activity's objectives and technical approach leading to the milestone. Exit criteria include the metrics and target levels used to determine that the milestone objectives have been achieved. They may or may not be the same as the corresponding technical challenge performance metric and success criteria. Deliverables are the research products and/or publications provided by the proposer that are associated with milestone completion. Proposers should include periodic research deliverables and/or milestones that can be used to assess research performance by non-advocate reviewers in annual meetings.

D.4.4.5 Expected Research Products

Proposers are expected to produce specific research products in the process of addressing their technical challenges. These products may include technologies, operational

concepts, methods, design tools, models, or other technical advancements. Proposals should clearly indicate how the products will contribute to the chosen topic outcomes.

Research products developed over the course of the award period should demonstrate a growing level of validation, integration, and technical maturity. Strong proposals will build upon early-stage exploration and progress toward system-level solutions later in the award period. For these proposals, earlier research products will effectively converge to address increasingly more complex and multi-faceted problems as the work advances.

D.4.4.6 Intellectual Property

Ownership of subject inventions is governed by Section II (d) of ROA-2020.

D.4.4.7 Transition

Teams are expected to explore transition opportunities for their research products or technologies developed over the course of the award. The intent is to have a successful transfer of the technologies from a research environment to an operational environment that provides the U.S. aviation industry with the best possible technologies at the earliest possible dates.

In order to transition their research, the team is expected to actively explore transition opportunities and pursue follow-on funding from stakeholders and industrial partners during the award.

If new business models are proposed, then NASA will require risk management as part of the transition planning. This plan should include, but not be limited to, maturity, market, economic, and workforce risks.

D.4.4.8 Teaming

Subject to eligibility requirements (Section D.4.3.2), building and applying a diverse, multi-disciplinary team is part of the strategic leadership role entrusted to awardees of this solicitation. Proposers are expected to incorporate wide-ranging capabilities and apply innovative teaming methods that strengthen the proposal's overall contributions and promote education of the next generation of engineers. When putting together their teams, lead institutions are encouraged to explore new partnerships in addition to leveraging those they have previously developed. Partnerships could include other departments at the PI's institution, other colleges or universities, industry members, non-profit organizations, or other U.S.-based entities. Undergraduate education programs should be incorporated. HBCUs and MSIs are strongly encouraged to participate. Proposers are expected to consider partnerships with schools that may have less prior experience in working on NASA Aeronautics research projects. Lead organizations can demonstrate leadership by creating mentoring opportunities, providing access to facilities or contacts, and otherwise helping to nurture and fully integrate the capabilities of less-established partners.

ULI encourages broadly diverse groups to increase their participation in this solicitation (for example but not limited to female PIs, minority PIs, and new PIs). Each of these

groups is crucial to making the national aeronautics research infrastructure healthy and reflective of the US.

Diverse partnerships are expected to bring a wealth of talent and different perspectives that can contribute to novel, innovative approaches. These benefits notwithstanding, proposers should not add members solely for the purpose of lengthening their partnership list. Each partner should have a meaningful role.

D.4.4.9 Workforce Development

The university community is the ultimate source of the future aeronautics workforce needed to keep the U.S. industry and U.S. government in the position of aerospace global leadership.

ULI encourages the use of undergraduate students, in addition to graduate students, by providing plenty of research opportunities in all its projects. It gives students a practical view of what many of them will be doing after they graduate – an opportunity for the next generation of engineers to see real-world problems being formulated, solved and implemented in agile, multi-organizational environments.

D.4.4.10 Risk Identification

The desire for increasing technical maturity notwithstanding, proposers are encouraged to bring forward revolutionary, high technical risk approaches that open avenues for accelerated progress toward the strategic outcomes. Research results that do not ultimately meet their technical objectives will be readily accepted, provided the proposers openly share their findings and insight.

Proposals should identify credible primary risks and how the team will manage those risks.

D.4.4.11 Proposed Use of Unique NASA Capabilities

Proposers are encouraged to carry out a substantial portion of the overall work objectives (experimental and computational) prior to using a NASA facility and consider NASA facilities for the final validation of concepts or models.

Proposers wishing to use NASA facilities should refer to Section I (c) of ROA-2020 for general proposal requirements.

Each NASA facility is managed differently. If use of NASA facilities is proposed, prior to submitting Step-A proposals the proposers should have a general discussion with the facility manager – can they accommodate you, order of magnitude cost details, who pays etc. Only for tests at NASA facilities managed by Aerosciences Evaluation and Test Capabilities, if the proposal gets awarded then it will be a non-reimbursable test under the UI Project, i.e. at a lower cost to the proposer.

If use of NASA facilities is proposed, the costs associated with fabricating test articles, fixtures, instrumentation, and testing required should be included in the proposed cost.

Specific timeframe and duration of testing will be negotiated upon selection of a proposal. For use of a NASA facility, a letter of commitment from the facility manager, or equivalent, should be included in the Step-B proposal.

General information on NASA test and evaluation facilities, including points of contact, can be found using the websites given below.

Armstrong Flight Research Center
https://www.nasa.gov/centers/armstrong/capabilities/index.html
https://www.nasa.gov/aeroresearch/programs/iasp/fdc

Ames Research Center
Air Traffic Management Simulations:
https://aviationsystems.arc.nasa.gov/facilities/index.shtml

Ames Wind Tunnels:
https://www.nasa.gov/centers/ames/orgs/aeronautics/windtunnels/index.html

Glenn Research Center
https://www1.grc.nasa.gov/facilities/

Langley Research Center
https://researchdirectorate.larc.nasa.gov/facilities-capabilities/

Advanced Supercomputing
Information on NASA Advanced Supercomputing facilities can be found at
https://www.nas.nasa.gov/hecc/resources/
A letter of support for supercomputing is not possible during the proposal submission phase. If awarded, one can apply for supercomputing allocation under the UI Project.

D.4.5 Management Information

D.4.5.1 Non-Advocate Peer Review
As part of the strategic leadership aspect of this initiative, proposers and the university-led teams must take primary responsibility for maintaining high levels of relevance, quality, and performance across their portfolio. Proposers should therefore establish their own methods for regular external peer review and reporting of the review results to NASA. Proposers have broad leeway to select external reviewers they believe will add value to their research efforts. These reviewers should be non-advocates – i.e. experts that are not otherwise involved in performing the team's research. Reviewers selected from industry should be from U.S. companies (see Section D.4.3.2 on Eligibility). To promote independence from NASA research activities and minimize NASA's role in technical oversight, proposers should not include current NASA employees on their review panels. Proposals can include a travel budget for peer reviewers.

During the research effort, awardees are encouraged to propose necessary course corrections to maintain continued relevance based on peer review recommendations and other interactions with key stakeholders.

D.4.5.2 Reporting and NASA Oversight

NASA intends to conduct oversight through annual reviews and quarterly reports.

As part of the non-advocate peer review process, awardees are asked to hold an annual review to assess the work effort's relevance, quality and performance. The location and medium for this review are at the discretion of the awardee. The review will also provide a forum to discuss the awardee's handling of issues and risks that have arisen during the year, as well as any technology transfer that has occurred. In addition, awardees will be asked to share results from peer assessments occurring during the prior year. NASA, who will be a participant at the annual meeting, will allow time for private caucus between the university team and its non-advocate reviewers, and will be an additional recipient of the peer review information.

Awardees shall also conduct quarterly status reviews with their peer reviewers and NASA. These reviews shall provide an update on technical challenge progress, completed milestones, notable accomplishments, and any changes to the plan that occurred during the quarter. This review discussion is expected to take place via video or teleconference. Quarterly status reviews will occur after the first, second, and third quarters of each fiscal year during the period of performance. No quarterly status review is required for the fourth quarter (i.e. the quarter preceding the annual review). Information from the fourth quarter can be incorporated into the annual review.

NASA's determination of adequate progress will consider results from the annual review, quarterly status reviews/reports, and additional insight gained from the non-advocate peer reviews. NASA reserves the right to discontinue funding if it determines the awardee has been unable to correct serious performance problems.

In addition to reviews and reports, there will be a kick-off meeting at the beginning of the award period. Annual oral presentations made as part of an open technical exchange meeting for purposes of technology transfer and knowledge dissemination are also required. Direct participation by contributing partners and collaborators is encouraged, especially for the kick-off meeting and annual reviews. NASA program and project personnel may also coordinate with the awardee to arrange informal visits to the awardee's institution or facilities.

All technical deliverables identified in the proposal, along with a final report documenting the approach, results, recommendations, and conclusions of the entire work effort shall be submitted no later than 90 days after the end of the period of performance. Sensitive information may be provided to NASA in a proprietary appendix. Software developments and/or enhancements shall be developed in modular form and delivered in appropriate computer file formats.

D.4.5.3 Cost Monitoring

Cost monitoring is a part of performance monitoring. The ULI teams should have procedures for planning, budgeting, tracking, and reporting their costs from all partners. To enable the UI Project to optimize the use of available funds, a phasing plan (costing to NASA) for the first fiscal year shall be submitted within 30 calendar days of the award date and within 30 days of start of the following fiscal years of the award (by October 30th). NASA will provide the phasing plan templates for costing. Monthly and quarterly assessment of execution to phasing plans is the responsibility of the PI. Although NASA understands that there will be a time lag between the institutions' use of funds and when funds are drawn down, invoicing should be timely and prompt.

D.4.5.4 Collaboration with NASA

As noted in Section D.4.3.2, proposers may not include NASA centers or researchers as partners. NASA does seek to collaborate with awardees in a manner that adds value towards the research and development of the innovative concepts, while preserving the university leadership aspect of this initiative. Therefore, proposed informal collaboration with NASA researchers during the performance period is encouraged only where it a) adds value towards achieving the research objectives of the topic area, b) promotes technology transfer into NASA or the broader aviation community, and c) preserves inherent differences in technical approach between proposer-led and NASA research activities. The proposers may propose such informal collaborative activities, but without specifying NASA researchers, Center, or Project names in the proposal. Only NASA management can assign NASA personnel to work on projects, so proposals including NASA names will be penalized appropriately. If a proposal is selected for negotiation towards a potential award, then and only then can the details of any proposed collaboration including time in residency at a NASA Center, if applicable, be discussed with NASA management and finalized.

D.4.6 Proposal Process

D.4.6.1 Proposal Format and Submission Information

Proposals involving multiple cooperating organizations must be submitted by a single institution, which becomes the Lead Institution. The Lead Institution must be the PI's home institution. Proposals must be submitted by an official at the PI's organization who is authorized to make such a submission.

Proposals submitted in response to this solicitation are required to be clearly legible in both the body of the text and in the figure captions. Text within figures and tables may be smaller but must still be judged by the reviewers to be readable. Expository text necessary for the proposal may not be located solely in figures or tables, or in their captions.

D.4.6.1.1 Proposal Submission Site

Proposers must submit electronic proposals in response to this solicitation to NSPIRES (https://nspires.nasaprs.com). The NSPIRES system will guide proposers through

submission of all required proposal information. The presentation *NSPIRES Organization Registration*, located in the "Tutorials and User Guides" section of this website, provides information on how to register an organization in NSPIRES.

In order to be able to submit a proposal all investigators must be preregistered in NSPIRES and have received a User ID and password. This includes the PI, all Co-Investigators (Co-Is) and Partners. It is optional for Collaborators and is not needed for Advisory Board members, Technical Panelists, or Peer Reviewers. NSPIRES registration can be done at the website https://nspires.nasaprs.com/external/aboutRegistration.do. Early registration is advised. A Help Desk is available at (202) 479-9376 or by E-mail at nspires-help@nasaprs.com.

D.4.6.1.2 Applicant's Workshop

An applicant's workshop will be held on the date and time given in Section D.4.8. The workshop will provide interested parties with the opportunity to better understand the intent, scope, and selection criteria of this solicitation. A presentation on the solicitation will be followed by a question and answer period. The briefing will be live streamed with participation available to anyone having Internet access.

Applicants are invited to register and learn more at https://uli.arc.nasa.gov/applicants-workshops/workshop5. Upon registering, you will receive an automatic e-mail with connection details to join the virtual ULI applicant's workshop. During the workshop, all participants will have the opportunity to enter their questions in the chat and/or verbally ask them. Interested parties can also submit their questions in advance to hq-univpartnerships@mail.nasa.gov.

A week after the event, links to the applicant's workshop charts and video recording will be posted on NSPIRES.

D.4.6.1.3 Two-Step Proposal Procedure

The information in Section IV of this ROA and the *NASA Guidebook for Proposers* is superseded by the following:

This solicitation will use a two-step proposal process in which a mandatory Step-A proposal is first submitted. A separate Step-A proposal must be submitted for each intended, and thus corresponding, Step-B proposal. Only proposers who submit a Step-A proposal and are invited to submit a Step-B proposal are eligible to submit a Step-B proposal. The submission of a Step-A proposal is not a commitment to submit a Step-B proposal.

D.4.6.1.4 Step-A Proposal Format and Contents

The Step-A proposal Scientific/Technical/Management section may not exceed five (5) pages in length, with a minimum 12-point font size and one-inch margins on all sides. Step-A proposals that exceed the five-page limit may be rejected without review. This section must cover the following topics:

- Title of proposed task
- Topic and outcome addressed
- Name and organization of PI
- List of partners known to date (may be changed if proposer is selected to submit a Step-B proposal)
- Research objectives
- Partially defined technical challenge(s) (to include only technical challenge statement and duration for each technical challenge submitted)
- Summary of technical approach for the effort
- Assessment of what is innovative or novel in the proposed concept and how it will contribute to the chosen strategic thrust outcome(s)
- Expected research products
- Anticipated transition opportunities of research products/technologies to the U.S. aviation industry or NASA
- Overall teaming and education strategy

Proposals may also include a list of references which will not count against the 5-page Scientific/Technical/Management section limit in Step-A proposals.

The period of performance will be an important consideration in the Step-A evaluation process – proposals will be evaluated from two pools, one for 3-year awards and another for 4- or 5-year award. NASA will use the period of performance and total budget to ensure final selections can be supported by the anticipated ULI budget. The period of performance should remain the same between Step-A and Step-B, and proposers may only increase their total Step-B budget request within 7% of their total Step-A budget request.

D.4.6.1.5 Other Step-A Proposal Submission Considerations

The NSPIRES proposal submission system requires certain information be input before proposal submission. Note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements even for a Step-A proposal. In Step-A, NASA will only review the five-page proposal. The other information (Proposal Summary, Business Data, Program Specific Data, Detailed Budget, Letters of Commitment, etc.) will not be reviewed.

Step-A proposals do not need to submit a Detailed Budget, but proposers are requested to provide an estimated yearly and total budget in the Cover Page Elements of the proposal. If the Step-A budget form is not available for NSPIRES entry, please add an extra page with the yearly and total budgets in your submission. This page will not count against the 5-page limit for the Scientific/Technical/Management section.

Note: Besides the budget, there may be other elements required by NSPIRES for submitting a Step-A proposal, otherwise the Step-A proposal will not be accepted by NSPIRES. Proposers need to complete these elements even though NASA may not review these elements.

D.4.6.1.6 Step-B Proposal Format and Contents

The Scientific/Technical/Management section may not exceed twenty-five (25) pages in length, with a minimum 12-point font size and one-inch margins on all sides. This section must cover the following topics:

- Title of proposed task
- Topic and outcome addressed
- Name and organization of PI, Co-Is, Partners and Collaborators
- Research objectives and overall strategy
- Fully defined technical challenge(s):
  - Statement
  - Duration (year from start of award)
  - Performance metric(s)
  - Success criteria
- Progress indicators for each technical challenge, including:
  - Statement
  - Duration (year from start of award)
  - Technical performance, using the proposer-defined performance metric
  - Technical maturity, using the proposer's preferred means to assess technical maturity

  Proposers may provide this information using progress indicator charts (modeled after the examples shown in Reference 5) or any other method that uses distinct events to mark improving performance and maturity on a path toward achieving the technical challenge. A legend should be provided as necessary to define any colors and symbols used.

  If applying the Reference 5 examples, proposers should use their own performance metric(s), success criteria, and interim and final milestones. Proposers are encouraged to use the examples as a general guide, adapting the content and style as needed to fit their technical challenges. If the required technical challenge elements are provided in full in the progress indicator depiction, they need not be repeated in a separate table or list. Further discussion on progress indicators is provided in Section D.4.4.3.
- Milestones (at least one per year):
  - Title
  - Description
  - Duration (year and quarter-year from start of award)
  - Exit criteria (metrics and expected performance levels)
  - Deliverables
  - Technical challenge supported (if more than one technical challenge proposed)
- Technical approach
- Assessment of what is innovative or novel in the proposed concept and how it will contribute to the chosen strategic thrust outcome(s)
- Expected research products and schedule during the period of performance
- Plans for peer review to assess relevance, technical quality, and performance on a quarterly and annual basis

- Anticipated transition opportunities of research products/technologies to the U.S. aviation industry or NASA. The ULI award should serve as a catalyst with stakeholder-funding taking over. Provide a roadmap for transitioning research with stakeholder requirements and increasing stakeholder involvement.
- Qualifications, capabilities, and experience of the team members, including PI, Co-Is, and other collaborators
- Teaming strategy
- Plans to include faculty and students from HBCU and/or MSIs in ULI research
- Innovative training for U.S. citizen or permanent resident student team members in leadership, management, entrepreneurship and/or public policy. This would support the graduation of students who are trained to lead and would encourage partnership between engineering schools with other university departments.
- Proposers may include cost sharing in their proposals at their own discretion. Such offers will become binding and auditable resource commitments upon award. Cost sharing is not an evaluation criterion for peer review. However, cost sharing may be considered by the Selecting Official in the final selection of awards.
- Statement of what intellectual property is expected to be publicly available at the conclusion of the work
  - Note: It is NASA's intent to share knowledge developed under this solicitation, thus, any restrictions to this objective may impact the evaluation of the proposal. Securing intellectual property rights through the patent process is permitted. It is the responsibility of the investigator to secure desired protections prior to public briefings required by ULI.
- Test facilities to be used including proposed use of NASA facilities (see Section D.4.4.11)
- If any NASA Supercomputing resource usage is proposed, include specific computing requirements (CPUs, hours, memory, storage, timeframe, etc.) and state its criticality to the proposed work (select either one of two from below):
  - Require NASA computation resources as go/no go for proposed work
  - Optional need for NASA computation resources to enhance research execution

Please refer to Section IV of ROA-2020 for additional requirements on proposal content, format, budget details, and submission procedures. A budget justification, including justification for any foreign travel, is required for the Step-B proposal, but will not be counted toward the Scientific/Management page limit; nor will other supporting information, such as the Data Management Plan, references, résumés and optional letters of support from partners and collaborators.

D.4.6.1.7 Step-B Data Management Plan (DMP)

The requirements for DMP are in Section II (c) of the ROA. Reasonable costs associated with the DMP (i.e., costs of sharing, preservation, etc.) may be included in the proposal budget. Specific questions regarding a DMP should be directed towards the POCs in Section D.4.8 as they may provide guidance to proposers and awardees, in addition to their responsibility for compliance with DMPs.

D.4.6.1.8 Proposal Team and NSPIRES

Note that NSPIRES has a different interpretation than the ULI terminology for PI, Co-I, Partner, Collaborator, and Reviewer. It is not important how they are registered in NSPIRES, provided the technical part of the proposal identifies them correctly.

Every funded Co-I and Partner is critical for the conduct of the investigation through the contribution of expertise and/or capabilities. They must demonstrate their commitment to participate in the proposed investigation by electronic confirmation in NSPIRES for the Step-A and Step-B proposal.

Collaborators and Reviewers need not confirm their electronic participation in NSPIRES. Letters of commitment from unfunded collaborators will suffice to show their intent to participate in the work. Advisory Board members, Technical Panelists, or Peer Reviewers do not have to confirm their participation either through NSPIRES or through letters of commitment.

D.4.6.2 Proposal Evaluation and Selection

All proposals will be reviewed according to the Selection and Evaluation Criteria listed in this section.

D.4.6.2.1 Selection Process

The following steps will be followed for this solicitation and selection process.

- NASA releases this solicitation.
- Proposers submit a Step-A proposal in NSPIRES.
- NASA will review and make the final selection decision on which Step-A proposals will be invited to submit a Step-B proposal. Through NSPIRES, NASA will also notify all proposers who are not selected.
- NASA will invite all the selected Step-A proposers to submit a Step-B proposal for this solicitation.
- Step-B proposals will be due at least 60 days from the issue date of the notification and/or invitation E-mail.
- Invited proposers submit a Step-B proposal in NSPIRES.
- Proposals are evaluated by a Technical Review Panel consisting of government subject matter experts.
- The Selecting Official is the ARMD Transformative Aeronautics Concepts Program Director.
- NASA will notify all Step-B proposers of the final award decisions.

E-mail debriefs of the review panel comments of Step-A and Step-B proposals from NASA will be provided after Step-A and Step-B are completed, respectively.

Note that NASA reserves the right to offer selection of only a portion of a proposed investigation; in such a case, the proposer will be given the opportunity to accept or decline NASA's offer.

D.4.6.2.2 Step-A Proposal Evaluation Criteria

Step-A proposals will be evaluated against the criteria listed below. The evaluation criteria in the *Guidebook for Proposers* are superseded by the following:

- Relevance to ULI objectives (weight 40%)
  - Relevance to ULI strategic goals of Section D.4.1.
  - Clear link between the proposed technical challenges and research products to the selected topic outcomes.
  - Viable transition path for the research products/technologies.
- Technical Merit (weight 40%)
  - Overall scientific or technical merit of the proposal, including unique and innovative methods (such as technology convergence), approaches, or concepts.
  - Technical challenges that represent complex, system-level problems.
- Innovative Teaming and Education (weight 20%)
  - Innovative and inclusive teaming methods that contribute to overall proposal strength, promote diversity, inclusion of faculty and students from HBCUs and/or MSIs, and promoting education of the next generation of undergraduate and graduate engineers (see ULI Goals in Section D.4.1).

Failure of a Step-A proposal to be highly rated in any one of the evaluation criteria is sufficient cause for the proposal to not be selected. Proposals without the appropriate involvement of HBCUs and/or MSIs will be rejected. Step-A proposals will be evaluated from two pools, one for 3-year awards and another for 4- and 5-year awards. The period of performance cannot change between Step-A and Step-B.

D.4.6.2.3 Step-B Proposal Evaluation Criteria

Step-B proposals will be evaluated against the criteria listed below. The evaluation criteria in the *Guidebook for Proposers* are superseded by the following:

- Relevance to ULI objectives (weight 25%)
  - Relevance to ULI strategic goals of Section D.4.1.
  - Clear link between the proposed technical challenges, milestones, and research products to the selected topic outcomes.
  - Viable research transition roadmap for the research products/technologies. See ULI transition goals in Section D.4.1.
- Technical Merit (weight 25%)
  - Overall scientific or technical merit of the proposal, including unique and innovative methods (such as technology convergence), approaches, or concepts.
  - Technical challenges provide distinct research barrier and represent complex, system-level problems.
  - Demonstrated ability and technical breadth of proposed team.
  - Credible, integrated, multi-disciplinary technical approach, including a clear assessment of primary risks and means to address them.
- Innovative Teaming and Education (20%)
  - Integrated team contributes to overall proposal strength.

  - Innovative and inclusive teaming methods that promote diversity, inclusion of faculty and students from HBCUs and/or MSIs, and promoting education of the next generation of undergraduate and graduate engineers (see ULI Goals in Section D.4.1).
  - Innovative training of student team members to become future leaders.
- 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.
  - Strong peer review process for assessing relevance, technical quality, and performance.
- Cost (weight 15%)
  - Proposed cost realism and reasonableness. Appropriateness of proposed effort and proposed other direct costs with those required to accomplish the goals of the investigation. Phasing plans provided by teams on plans to meet the funding required at start up and during the rest of the years.
  - Value of the proposal - cost to NASA in time and budget relative to the expected impact.

Failure of a proposal to be highly rated in any one of the evaluation criteria is sufficient cause for the proposal to not be selected. Proposals without the appropriate involvement of HBCUs and/or MSIs will be rejected. Total Step-B budget request should not be over 7% of the total Step-A budget request.

D.4.6.2.4 Source Selection

After the review of Step-B proposals, the Selecting Official has the option to consider program portfolio priorities, cost sharing and budget constraints when making a final selection.

D.4.6.3 Contact with NASA during Solicitation Period

Except to obtain information about NASA facilities, communications with NASA during the solicitation period can only occur through the designated POC (see Section D.4.8). There can be no direct or indirect communications with NASA researchers and managers from the time this solicitation is posted to the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) until proposal selections are final. NASA personnel may not be involved in any aspect of proposal writing.

Communications with NASA facility POCs are permitted during the solicitation blackout period - solely to obtain facility capability, availability, and costs information for the proposed tests. Proposers may refer to Section D.4.4.11 for information on NASA facilities and points of contact.

D.4.7 References

[1] NASA, "NASA Aeronautics Strategic Implementation Plan, 2019 Update" https://www.nasa.gov/aeroresearch/strategy, 2019.

[2] U.S. Department of Education, "List of postsecondary institutions enrolling populations with significant undergraduate minority students," http://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[3] List of ARMD Technical Challenge Statements

Program and Project Acronyms (as listed in technical challenge statements):

AAVP – Advanced Air Vehicles Program *AATT* – Advanced Air Transport Technology Project *AC* – Advanced Composites Project *CST* – Commercial Supersonic Technology Project *RVLT* – Revolutionary Vertical Lift Technology Project *HT* – Hypersonic Technology Project
AOSP – Airspace Operations and Safety Program *ATD* – Airspace Technology Demonstrations Project *ATM*-X – Air Traffic Management – Exploration Project *SWS* – System-Wide Safety Project *UTM* – Unmanned Aircraft Systems Traffic Management Project
IASP – Integrated Aviation Systems Program *FDC* – Flight Demonstrations and Capabilities Project *UAS in the NAS* – Unmanned Aircraft Systems Integration in the National Airspace System Project
TACP – Transformative Aeronautics Concepts Program *TTT* – Transformational Tools and Technologies Project

ARMD Technical Challenge Statements by Program and Project
(As of October 30, 2020)

Program	Project	TC Name	TC Statement	FY Complete
AAVP	AATT	Higher Aspect Ratio Optimal Wing	Enable a 1.5-2X increase in the aspect ratio of a lightweight wing with safe structures and flight controls.	FY20
AAVP	AATT	Fan and High-Lift Noise	Reduce fan (lateral and flyover) and high-lift system (approach) noise on a component basis by 4 dB with minimal impact on weight and performance.	FY21
AAVP	AATT	Low NOx Fuel-Flex Combustor	Reduce NOx emissions from fuel-flexible combustors to 80% below the CAEP/6 standard with minimal impacts on weight, noise, or component life.	FY19
AAVP	AATT	Compact High Overall Pressure Ration (OPR) Gas Generator	Enable reduced size/flow high pressure compressors and high temperature disk/seals that are critical for 50+ OPR gas generators with minimal impact on noise and component life.	FY20
AAVP	AATT	Hybrid Gas-Electric Propulsion Concept	Establish viable concept for 5-10 MW hybrid gas-electric propulsion system for a commercial transport aircraft.	FY19
AAVP	AATT	Engine Icing	Predict likelihood of icing events with 90% probability in current engines operating in ice crystal environments to enable icing susceptibility assessments of advanced ultra-efficient engines.	FY20
AAVP	CST	LBFD Prediction Validation Tools (ProViT)	Provide a suite of prediction tools to support timely and accurate validation of the acoustic performance of the LBFD aircraft, rapid pre-flight exposure planning for Community Response Testing, and a foundation for future configuration design and certification analysis of supersonic aircraft.	FY23
AAVP	CST	Sonic Boom Community Response	Validated field study methodology, including indoor and outdoor	FY20

Program	Project	TC Name	TC Statement	FY Complete
		Metric & Methodology	noise metrics, exposure estimates, survey tools, and test protocols to support community studies with a low-boom flight demonstration aircraft.	
AAVP	CST	Low Boom Flight Demonstrator Data Measurement	Develop key flight systems for enhanced data quality, safety and operational efficiency, and transition these systems to the Low Boom Flight Demonstration (LBFD) Project. Develop and demonstrate techniques to collect high quality validation data from the LBFD aircraft in flight.	FY21
AAVP	CST	Community Test Planning & Execution	Planning and execution of sonic boom tests with the LBFD aircraft over large non-experienced communities within the U.S.	FY27
AAVP	HT	System-level Uncertainty Quantification (UQ) Method Development and Validation	Develop/validate a system-level uncertainty propagation methodology to guide uncertainty-informed decision-making. Hypersonic vehicles are highly integrated, complex systems with sensitive performance characteristics. There is a high reliance on modeling and simulation to predict system-level flight performance due to an inability to test full-scale models in a flight relevant environment, including mission duration and varying conditions. The methodology and tools to identify and quantify significant uncertainty contributors and their impact to system/mission performance does not exist.	FY22
AAVP	HT	Combined Cycle Mode Transition Progress Indicator	Demonstrate autonomous control and establish performance/operability assessment methodologies for future reusable hypersonic propulsion systems that use turbine engines at slow speeds and transition to scramjets for high-speed operations. Address the technology barrier of propulsion system mode transition via ground tests.	FY23
AAVP	RVLT	Demonstration of Design and Flight Operation Methods for Reduced Vertical Take-off and Landing (VTOL) Aircraft Noise Impact	To overcome the growth in community helicopter noise complaints, NASA will combine improved flight operations, a high-fidelity rotor/vehicle design approach, and human factors research to provide a 50% reduction in the Sound Exposure Level (SEL) footprint area for commercial VTOL vehicles in common use. This goal is targeted at vehicles that are nominally from 4-20 passengers or 2400 to 24,000 pounds gross weight, but the methods may be applicable to other vehicle sizes.	FY20
AOSP	ATD	Integrated/Arrival/Departure/Surface Operations	Develop and deliver an integrated metroplex traffic manager to the FAA NextGen and Air Traffic Organizations, flight operators, and airport operators, that leverages NASA, FAA and industry technologies to enable simultaneous improvement of the predictability and efficiency of arrival, departure and surface operations.	FY21
AOSP	ATM-X	Integrated Demand Management Trajectory Based Operations	Develop requirements and procedures validated through high-fidelity experiments to enable unimpeded gate-to-gate TBO that improves throughput, reduces delays and enables user-preferred trajectories by synchronizing their access to airspace, airport, and weather constraint bottlenecks across the NAS.	FY20
AOSP	ATM-X	Initial Urban Air Mobility Operations Integration	Develop technologies for airspace and vertiport management to enable UAM missions at user-specified tempo in lower-controlled airspace.	FY23
AOSP	ATM-X	Increasing Diverse Operations	Develop systems for improved data exchange and develop auto-negotiation technologies for collaboration to enable traditional operators' desire for flexibility and predictability and new entrants' desire to access and operate in the higher-controlled airspace.	FY23
AOSP	SWS	Validation & Verification for Commercial Ops	Develop, transfer and measure the benefit of NASA-developed tools and techniques to lower the cost and time of certification while maintaining safety.	FY23
AOSP	SWS	In-Time Terminal Area Risk Management	Develop and demonstrate integrated risk assessment capabilities to monitor terminal area operations based on data analytics and predictive models.	FY23
AOSP	SWS	In-Time Safety Nets for Emerging Operations	Develop and demonstrate integrated dependable monitoring, assessment and mitigation capabilities for safety-critical risks to low altitude urban beyond visual line-of-sight for small UAS operations.	FY24
AOSP	SWS	Complex Autonomous Systems Assurance (CASA)	Develop and demonstrate innovative V&V tools and methods to provide assurance of the safe operation of complex, increasingly	FY24

Program	Project	TC Name	TC Statement	FY Complete
			autonomous, non-deterministic systems.	
AOSP	UTM	UAS Traffic Management (UTM)	Develop and validate airspace operational and integration performance requirements to enable safe, large-scale UAS operations in low-altitude airspace.	FY20
IASP	UAS in the NAS	UAS Detect and Avoid Operational Concepts and Technologies	Develop Detect and Avoid (DAA) operational concepts and technologies in support of standards to enable a broad range of UAS that have Communication, Navigation, and Surveillance (CNS) capabilities consistent with IFR operations and are required to detect and avoid manned and unmanned air traffic.	FY21
IASP	UAS in the NAS	UAS Satcom and Terrestrial Command and Control	Develop Satellite (Satcom) and Terrestrial based Command and Control (C2) operational concepts and technologies in support of standards to enable the broad range of UAS that have Communication, Navigation, and Surveillance (CNS) capabilities consistent with IFR operations and are required to leverage allocated protected spectrum.	FY21
IASP	FDC	Landing Gear Community Noise	Demonstrate novel landing gear porous fairing and wheel cavity treatments that reduce the airframe component of community noise by 1.5 EPNdB with minimal impact on aircraft weight and performance, and to validate an advanced, physics-based methodology for the accurate prediction of airframe noise.	FY20
IASP	FDC	LBFD Phase 2 Shock Measurements	Develop and demonstrate LBFD Mission Phase 2 capabilities to safely measure in-flight 1) near-field acoustic characteristics of the LBFD aircraft and 2) atmospheric effects on the far-field sonic boom signatures	FY22
IASP	FDC	Mobile Operations Facility	Develop and demonstrate mobile operations facility (MOF) capabilities required to safely conduct LBFD Mission Phase 3 community response overflight studies.	FY22
IASP	FDC	Electric Propulsion Airframe Integration	Demonstrate 5x lower energy use at high speed cruise through unique integration of a complex Distributed Electric Propulsion system. Ensure lessons learned are used to influence development of certification criteria for electric propulsion.	FY23
IASP	FDC	Crossflow Attenuated Natural Laminar Flow (CATNLF)	Validate the CATNLF design methodology at transonic commercial cruise flight conditions to achieve >50% chord natural laminar flow which will lead to >9% aircraft drag reduction.	FY21
TACP	TTT	Combustion Modeling	Demonstrate capability to predict sensitivity of combustor efficiency, emissions, and operability to changes in fuel composition.	FY21
TACP	TTT	Multidisciplinary Design Analysis and Optimization (MDAO)	Integrate aero, propulsion, acoustic, and structural (MDAO) tools with multi-fidelity concept assessment tools to enable multi-to-high fidelity optimization of the latest ARMD concept configurations.	FY22
TACP	TTT	Efficient Eddy-Resolving Methods for CL*max* Prediction	Develop and demonstrate computationally efficient, eddy-resolving modeling tools that predict maximum lift coefficient (CL*max*) for transport aircraft with the same accuracy as certification flight tests.	FY25

[4] List of ULI Awards

University Leadership Initiative Awards

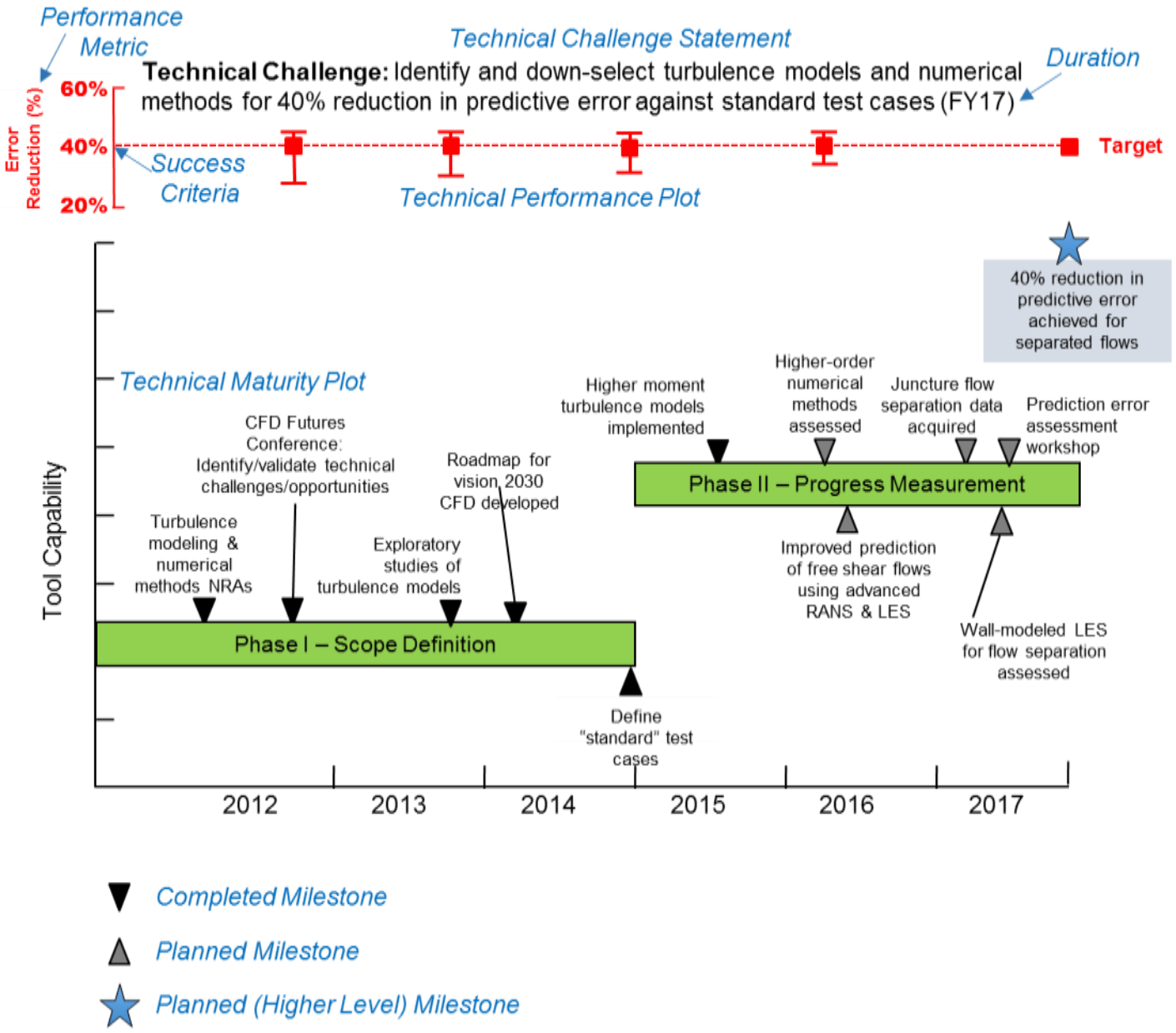
(As of Feb 12, 2021)

Program	Project	ULI Title	Summary	FY Complete
TACP	UI	Hyper-Spectral Communications, Networking & ATM as Foundation for Safe and Efficient Future Flight: Transcending Aviation	Communication capabilities for improving link/network capacity, reliability, security in support of new Air Traffic Management applications (Thrust 1)	FY21
TACP	UI	Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation	Small real-time geometric outer mold line reconfigurations to minimize boom signatures and drag in response to changing ambient conditions (Thrust 2)	FY22

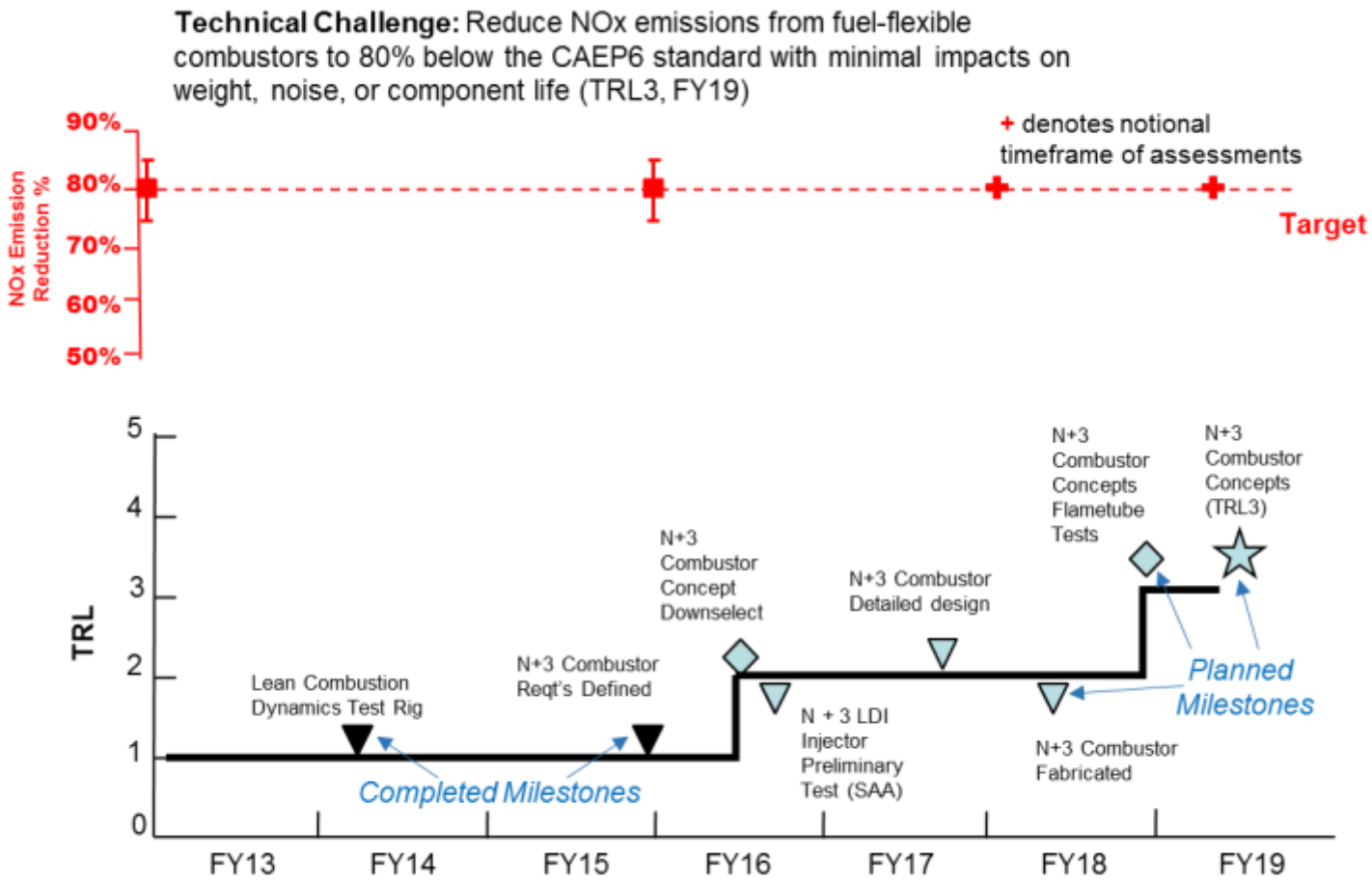
TACP	UI	Advanced Aerodynamic Design Center for Ultra-Efficient Commercial Vehicles	Develop slotted, natural laminar flow airfoil to reduce wing profile drag (Thrust 3)	FY22
TACP	UI	Electric Propulsion: Challenges and Opportunities	Advance electric power systems, battery and energy storage, thermal management supporting electric propulsion aircraft (Thrust 3, Transition to Alternative Propulsion and Energy)	FY22
TACP	UI	Information Fusion for Real-Time National Air Transportation System Prognostics under Uncertainty	System-wide, real-time prognostics framework with rigorous V&V for proactive health management of NextGen National Airspace System (Thrust 5)	FY22
TACP	UI	Development of an Additive Manufacturing Ecosystem for Qualification of Additive Manufacturing Processes and Materials in Aviation	Developing a scientifically sound basis for qualifying parts from additive manufacturing, as well as demonstrate facilities for the efficient large-scale production of these parts (Advanced Aviation Manufacturing)	FY22
TACP	UI	Effective Human-Robot Teaming to Advance Aviation Manufacturing	Explore new ways in which humans can use robotics to improve the efficiency and flexibility of aviation-related manufacturing processes in a manner that enhances the safety of human workers (Advanced Aviation Manufacturing)	FY22
TACP	UI	Center for Cryogenic High-Efficiency Electrical Technologies for Aircraft (CHEETA)	Produce several novel superconducting electrical system components that use liquid hydrogen in fuel cells to power an electric aircraft propulsion system (Thrust 3, Transition to Alternative Propulsion and Energy)	FY22
TACP	UI	Real-time Weather Awareness for Enhanced Safety Assurance in UTM	Prediction of low-level winds and turbulence in both natural and urban environments to improve safety of UAS and UAM operations (Thrust 5)	FY24
TACP	UI	Synthetic Design Synthesis of 'Thermoplastic UD Tape based, Fastener-free assemblies' for Urban Air Mobility vehicles	Develop Thermoplastic Unidirectional Tape based Fastener-free Assemblies without loss of material strength or need for adhesive or mechanical joining (Materials and Structures)	FY24
TACP	UI	Composite Manufacturing Technologies for Aerospace Performance at Automotive Production Rates	Science-based part/process design methodology for TuFF composites meeting aerospace performance at automotive manufacturing rates (Materials and Structures)	FY24
TACP	UI	Safe Aviation Autonomy with Learning-enabled Components in the Loop: from Formal Assurances to Trusted Recovery Methods	Design fault detection, isolation, and recovery methods for the machine learning components and develop framework for assuring machine learning components for UAS/UAM (Thrust 6)	FY24
TACP	UI	Secure and Safe Assured Autonomy	For UAS/UAM develop and integrate coordination and control algorithms, secure algorithms, and V&V procedures to support certification of these technologies (Thrust 6)	FY24
TACP	UI	Autonomous Aerial Cargo Operations at Scale	Develop a theory and concept of operations that could be used by the Advanced Air Mobility community to help verify if their concept of autonomous cargo operation could work and if it makes economic sense to deploy on a large scale (Thrust 1)	FY25
TACP	UI	Leading Advanced Turbine Research for Hybrid Electric Propulsion Systems	Identify the optimal design of a gas turbine engine that could be used in a future single-aisle, medium- and short-haul aircraft that uses hybrid-electric propulsion (Thrust 3)	FY25
TACP	UI	Rapid Development of Urban Air Mobility Vehicle Concepts through Full-Configuration Multidisciplinary Design, Analysis, and Optimization	Create computational tools that would enable U.S. industry to rapidly develop electric vertical takeoff and landing vehicles that would fly as part of an Advanced Air Mobility environment (Thrust 4)	FY24
TACP	UI	Emission & Absorption Spectroscopy Sensors for Hypersonic Flight Control	Refine techniques and hardware associated with a particular set of optical and laser sensors that can be used in examining the surfaces of a hypersonic vehicle in a way that can help that aircraft maintain control in flight (Special Topic: Novel In-Flight and Ground Measurement Techniques for Hypersonic Flight)	FY24
TACP	UI	Innovative Manufacturing, Operation, and Certification of Advanced Structures for Civil Vertical Lift Vehicles	Improve accessibility, affordability, and safety by developing simulation tools and operational processes to optimize the cost, safety, and performance of civilian vertical lift air vehicles and transitioning successful research in advanced materials (Thrust 4)	FY24

[5] Progress Indicator Examples

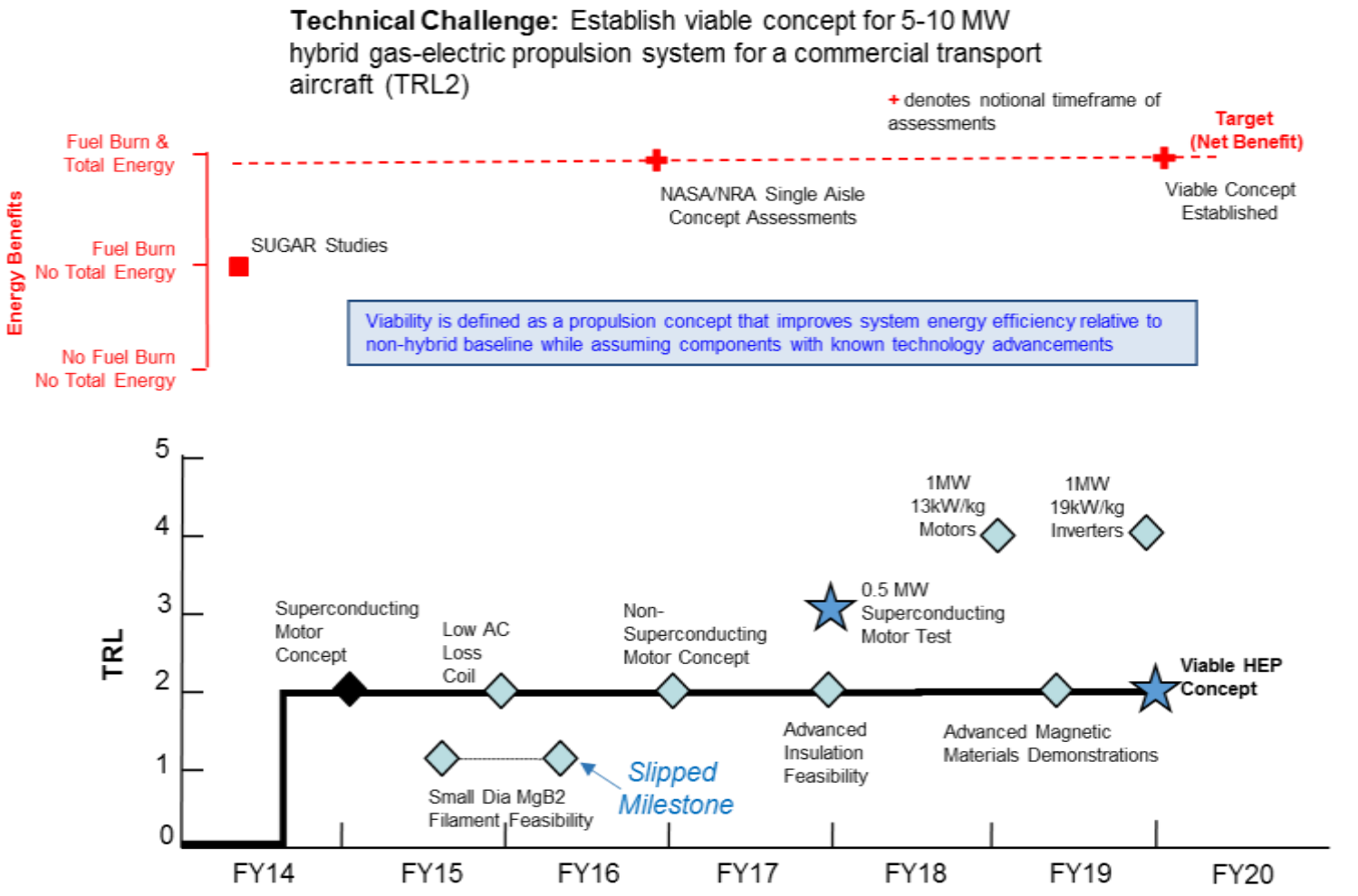
Example 1



Example 2


Technical Challenge: Reduce NOx emissions from fuel-flexible combustors to 80% below the CAEP6 standard with minimal impacts on weight, noise, or component life (TRL3, FY19)
NOx Emission Reduction %
90%
80%
70%
60%
50%
+ denotes notional timeframe of assessments
Target
TRL
5
4
3
2
1
0
Lean Combustion Dynamics Test Rig
N+3 Combustor Reqt's Defined
N+3 Combustor Concept Downselect
N + 3 LDI Injector Preliminary Test (SAA)
N+3 Combustor Detailed design
N+3 Combustor Fabricated
N+3 Combustor Concepts Flametube Tests
N+3 Combustor Concepts (TRL3)
Completed Milestones
Planned Milestones
FY13
FY14
FY15
FY16
FY17
FY18
FY19

Example 3



D.4.8 Summary of Key Information

Expected program budget for new awards	Nominally $1-2M per award per year, depending on scope
Anticipated number of new awards pending adequate proposals of merit and funds availability	Nominally two 3-year awards and one award in Topic 7
Maximum duration of awards	Up to 5 years
Applicant's Workshop	Thursday April 15, 2021; 1:00-3:00 p.m. ET
Due date for Step-A proposals	June 22, 2021, 5 pm ET
Due date for Step-B proposals	60 days after request for Step-B proposals issued

Start of Period of Performance	Fall 2022
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 D.4.6.1 and the *Guidebook for Proposers* Responding to a NASA Research Announcement – February 2021 at https://www.nasa.gov/sites/default/files/atoms/files/2021_ed._nasa_guidebook_for_proposers.pdf
Page limit for the central Science-Technical-Management section of proposal	5 pages for Step-A; 25 pages for Step-B
Submission medium	See the *Guidebook for Proposers* Responding to a NASA Research Announcement – February 2021 at https://www.nasa.gov/sites/default/files/atoms/files/2021_ed._nasa_guidebook_for_proposers.pdf
Web site for submission of proposal via NSPIRES	https://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Expected award type	Cooperative Agreements
Funding opportunity number	NNH20ZEA001N-ULI
NASA points of contact (POC) NASA will post any Q&A on-line (in the ULI section of NSPIRES) so that all proposers will have access to the same information.	Quickest way to resolve questions about this NRA is to e-mail questions to: HQ-UnivPartnerships@mail.nasa.gov Procurement POC: Ken Albright, <kenneth.e.albright@nasa.gov>, (228) 813-6127 Technical POC: Koushik Datta, <koushik.datta@nasa.gov>, (650) 604-2195 Written responses will be posted on the solicitation website. NASA Facility POCs: See Section D.4.4.11