U.S. Department
of Transportation

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FY 2021

Small Business Innovation Research (SBIR) Program

PHASE I PROGRAM SOLICITATION

NAICS CODE: 541715

Issue Date: February 4, 2021

Closing Date: March 8, 2021 3:00 PM ET

Small Business Innovation Research (SBIR) Program Office, V-330A
U.S. Department of Transportation (U.S. DOT)
Office of the Assistant Secretary for Research and Technology
John A. Volpe National Transportation Systems Center (Volpe Center)
55 Broadway
Cambridge, MA 02142-1093

INFORMATION ABOUT IMPORTANT DATES

Date	Description
February 4, 2021	Solicitation Open Date with amended topics (see below)
	Pre-solicitation Questions & Answers (Q&A) available on the U.S. DOT SBIR website (see Section I.D)
February 10, 2021, 5:00 PM ET	Registration Deadline for Pre-Offer Webinar (see below)
February 11, 2021, 1:00 PM ET	Pre-Offer Webinar (see below)
March 1, 2021, 5:00 PM ET	Administrative and Contract Pricing Worksheet (Appendix C) Questions Due (see Section I.D)
March 8, 2021, 3:00 PM ET	Solicitation Closing Date (See Section V)
On or about May 4-6, 2021	Pitch Day (see Section III.D)

Solicitation Open with Amended Topics

The proposed topic list shared during the pre-solicitation has been amended for the U.S. DOT FY21 Phase I Solicitation as follows:

- Topic FT1, Robots for Unmanned Disinfection and Decontamination of Transit Assets, has been updated with clarifications.
- Topic FH3, Accelerating Performance Testing Using the Asphalt Mixture Performance Tester (AMPT) Equipment, has been updated with additional links to technical references.
- Topic FH4, Reference Hardware for Infrastructure GPS Abnormality Detector for Connected and Automated Vehicle Applications, has been updated with clarifications.

Pre-Offer Webinar

The Pre-Offer Webinar will be held on Thursday, February 11, 2021 at 1:00 PM ET. The Government encourages all small businesses and persons that are interested in or considering submitting an offer to attend the pre-offer webinar. Small businesses may attend this webinar only virtually via a webinar conference. Come learn about the U.S. DOT's SBIR program, this year's topics, and Pitch Day. Administrative questions about the solicitation will be collected during the webinar, but no technical questions regarding the research topics will be accepted.

To register, visit: https://volpe-events.webex.com/volpe-events/onstage/g.php?MTID=efbf8f5000804aefdc8dfbaecf9260ffd

The deadline to register for the webinar is Wednesday, February 10, 2021 at 5:00 PM ET.

After the webinar, a captioned recording will be posted to the U.S. DOT SBIR Program website (https://www.volpe.dot.gov/work-with-us/small-business-innovation-research).

Closing Date

Offers must be received through the U.S. DOT's automated proposal website, no later than **3:00 PM ET on Monday, March 8, 2021.** The U.S. DOT's automated proposal website is located at: https://usg.valideval.com/teams/USDOTSBIR_FY21/signup.

Pitch Day

Offerors who submitted offers that receive the highest rating(s) for the respective research topics will have an opportunity to make a virtual oral presentation to the Government promoting its offer. Pitch Day is scheduled on or around May 4-6, 2021. For more information, see Section III.D.

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I. PROGRAM DESCRIPTION

A. Introduction

The United States Department of Transportation (U.S. DOT) welcomes small businesses to participate in the U.S. DOT's Small Business Innovation Research (SBIR) program. The purpose of this solicitation is to invite small businesses, with their valuable resources and creative capabilities, to submit innovative research ideas and solutions in response to the topics identified by the U.S. DOT as described in Section VIII. Under the SBIR Program, the U.S. DOT does not accept unsolicited proposals.

The goals and objectives of the SBIR Program are to:

- Stimulate technological innovation;
- Meet Federal research or research and development (R/R&D) needs;
- Foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons; and
- Increase private sector commercialization of innovations derived from Federal R/R&D funding.

The SBIR Program encourages small businesses to engage in R/R&D that has the potential for commercialization and meets Federal R/R&D objectives. The Small Business Innovation Development Act of 1982 (Public Law (P.L.) 97-219 codified at 15 U.S.C. 638) established the SBIR Program. More information is available at https://www.sbir.gov/about/about-sbir.

B. Three Phase Program

The U.S. DOT SBIR Program is a three phase program.

THIS SOLICITATION IS FOR PHASE I OFFERS ONLY.

Phase I. Phase I is the conduct of feasibility-related experimental or theoretical research or R/R&D efforts on research topics described herein. For the U.S. DOT SBIR Program, Phase I offers can be funded up to $150,000 unless otherwise noted in Section VIII. The period of performance of the resulting contract shall be six months. The basis for award is the scientific and technical merit of the offer, its commercial potential, and its relevance to U.S. DOT requirements and current research priorities. The U.S. DOT intends to award Firm-Fixed-Price (FFP) purchase orders utilizing Federal Acquisition Regulation (FAR) Part 13 Simplified Acquisition Procedures. A purchase order is an offer by the Government to buy supplies or services, including research and development, upon specified terms and conditions (in this instance, this solicitation and the contractor's offer). The U.S. DOT will require written

acceptance of the purchase order by the SBC at the time of award via the SBC signing the purchase order, thus creating a binding contract between the SBC and the Government. Award of a bilaterally signed purchase order is subject to the availability of funding.

All U.S. DOT SBIR Phase I awardees who have successfully completed Phase I are eligible to submit a Phase II proposal for evaluation and possible selection for award.

Phase II. The objective of Phase II is to continue the R/R&D effort from the completed Phase I. Award of a contract for a Phase II effort is based on the results of Phase I, the scientific and technical merit of the Phase II proposal, and the commercial potential of the proposed Phase II project. Commercial potential includes the capability to transition the technology to private sector applications, Government applications, or Government contractor applications. For the U.S. DOT SBIR Program, contracts for Phase II proposals can be funded up to $1,000,000 (except where a lower ceiling is specifically identified) and can have a period of performance of up to 24 months from the date of contract award. The Government is not obligated to fund any specific Phase II proposal.

The U.S. DOT typically awards Firm-Fixed-Price (FFP), FFP-Level-of-Effort (FFPLOE), or Cost-Plus-Fixed-Fee (CPFF) negotiated contracts for Phase II efforts utilizing FAR Part 15 Contracting by Negotiation procedures. Approximately 30 days prior to the end of Phase I efforts, the U.S. DOT SBIR Program Office will provide Phase I contract awardees details on the due date, content, submission requirements, and evaluation criteria for Phase II proposals. A summary of Phase II proposal submission requirements can be found on the U.S. DOT's SBIR website at: https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/submit-proposal.

A Phase II awardee may receive one additional, sequential Phase II award to continue the work of an initial Phase II award.

Phase III. SBIR Phase III refers to work that derives from, extends, or logically concludes effort(s) performed under a U.S. DOT or another Agency's Phase I and/or Phase II funding agreement. Phase III is funded by sources other than the set-aside funds dedicated to the SBIR Program. Phase III work is typically oriented toward commercialization of SBIR research or technology and may be for products, production, services, R/R&D, or a combination thereof. The following activities are types of SBIR Phase III work:

- Commercial application of SBIR-funded R/R&D financed by non-Federal sources of capital.
- SBIR-derived products or services intended for use by the Federal Government, funded by non-SBIR sources of funding.
- Continuation of SBIR work, funded by non-SBIR sources of Federal funding including R/R&D.

C. Eligibility

Size Rule

On December 27, 2012, the Small Business Administration (SBA) amended its regulations governing size and eligibility requirements for the SBIR program. The implementing provisions of the National Defense Authorization Act for Fiscal Year 2012 revised elements of 13 C.F.R. Part 121 that addresses ownership, control, and affiliation for participants in the SBIR program. A summary and explanation of the size rule and changes to program eligibility can be found in the Federal Register, 77 Fed. Reg. 248 (December 27, 2012) pp. 72215-76227 at http://www.sbir.gov/sites/default/files/2012-30809.pdf and SBA's Guide to SBIR/STTR Program Eligibility at http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf.

The revision includes a provision regarding an agency's option to allow participation by firms that are majority-owned by multiple venture capital operating companies, private equity firms or hedge funds. **The U.S. DOT elects at this time not to use the authority that would allow venture capital operating companies (VCOCs), hedge funds or private equity firms to participate in the SBIR Program.** Offers submitted by these parties will not be considered for award.

Each SBC submitting an offer must qualify as a SBC at the time of award of Phase I and Phase II contracts (see Section I. E. for the definition of a SBC). A SBC, together with its affiliates, must not have more than 500 employees. In addition, the following requirements must be met:

- The primary employment of the principal investigator must be with the small business firm at the time of contract award and at all times during the conduct of the proposed research. "Primary employment" means that more than one-half of the principal investigator's employment time is spent working for the small business. This typically precludes full-time employment with another organization.
- For Phase I, a minimum of two-thirds of the research or analytical effort, measured in total contract dollars using simple math, must be performed by the awardee (i.e., 66.7% of total contract cost must be for other than subcontractor/consultant costs).
- For Phase II, a minimum of one-half of the research or analytical effort, measured in total contract dollars on costs incurred for personnel, must be performed by the awardee (i.e., labor and indirect rates minus costs such as material, travel, and subcontractor/consultant).
- For both Phase I and Phase II, the R/R&D work must be performed in the United States. "United States" means the 50 states, the territories and possessions of the Federal Government, the Commonwealth of Puerto Rico, the Republic of the Marshall Islands, the Federated States of Micronesia, the Republic of Palau, and the District of Columbia.

Performance Benchmark Requirements for Phase I Eligibility
Section 4(a)(3) of the SBIR Policy Directive requires each Federal agency participating in SBIR to set a Phase II transition rate benchmark per Section 5165 of the SBIR/STTR Reauthorization Act of 2011. General information on the Performance Benchmark requirements is available at https://www.sbir.gov/faqs/performance-benchmarks.

Before submitting an offer to this solicitation, all potential offerors should verify their Transition Rate eligibility for Phase I awards on SBA's SBIR website at https://www.sbir.gov/. On June 1st of each year, Phase I applicants that meet the Phase I to Phase II transition rate identified below are eligible to submit an offer for a new Phase I award. General information on the Performance Benchmark requirements is available at https://www.sbir.gov/faqs/performance-benchmarks.

Phase I to Phase II Transition Rate: The U.S. DOT's Phase I to Phase II Transition Rate uses a five-year period and counts an offeror's total number of Phase I awards over the last five fiscal years, excluding the most recently completed fiscal year; and the total number of Phase II awards over the last five fiscal years, including the most recently completed fiscal year. The U.S. DOT SBIR Phase I to II Transition Benchmark is: at least 0.25.

Effective July 25, 2013, for all U.S. DOT SBIR Program Phase I offerors that have received 20 or more Phase I awards over the past 5-year period, the ratio of Phase II awards received to Phase I awards received must be at least 0.25.

Commercialization Rate: The Commercialization Rate (described at https://www.sbir.gov/faqs/performance-benchmarks) is not a requirement for this Solicitation.

D. Contact Information

If you have any administrative questions not listed on our Frequently Asked Questions (FAQs) website page (https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/frequently-asked-questions), or questions regarding this Solicitation's Appendix C: Contract Pricing Worksheet, please submit such questions via email to:

U.S. DOT SBIR Program Office
dotsbir@dot.gov

All administrative and Appendix C questions must be submitted no later than 5:00 PM ET on Monday, March 1, 2021. Questions received after 5:00 PM ET on March 1, 2021 may not be answered. The Government reserves the right to address a late question, if the Government determines an answer is in the best interests of the Government.

PLEASE NOTE:

- Technical questions pertaining to the research topics will not be answered during the solicitation period as technical questions were only permitted during the pre-solicitation period. To review the technical questions and answers, visit: https://usdot.uservoice.com/forums/932932-u-s-dot-fy-2021-phase-i-pre-solicitation-q-a.
- Inquiries regarding offer status will not be answered.

For general SBIR Program inquiries not pertaining to this solicitation, please contact:

U.S. DOT's SBIR Hotline
(617) 494 2051
dotsbir@dot.gov

In order to support full and open competition and comply with the Procurement Integrity Act, 41 U.S.C. Sections 2101-2107 requirements, during the Phase I submittal and evaluation period, offeror or potential offeror contact with U.S. DOT relative to this Solicitation is restricted to the officials identified in this Solicitation. During the open period of this Solicitation (from solicitation issuance until release of award recommendation list), contact with U.S. DOT officials (excluding certain offices and positions such as the DOT Office of the Inspector General (see herein) and the U.S. DOT/Office of the Secretary) from or at any U.S. DOT agency, other than those U.S. DOT officials identified in this Solicitation, may result in rejection of the offer determined related to such unauthorized contact.

E. Definitions

Funding Agreement
Any contract, grant, or cooperative agreement entered into between any Federal Agency and any small business concern for the performance of experimental, developmental, or research work, including products or services, funded in whole or in part by the Federal Government.

NOTE: The U.S. DOT does not award grants or cooperative agreements under the SBIR Program.

Research or Research and Development (R/R&D)
Any activity that is:

- A systematic study directed toward greater knowledge or understanding of the subject studied;
- A systematic study directed specifically toward applying knowledge and innovation to meet a recognized but unmet need; or
- A systematic application of knowledge and innovation toward the production of useful materials, devices, and systems or methods, including design, development, and

improvement of prototypes and new processes to meet specific requirements.

Subcontract
Subcontract means any agreement, other than one involving an employer-employee relationship, entered into by an awardee of a funding agreement calling for supplies or services for the performance of the original funding agreement.

SBIR Data
All data developed or generated during the performance of an SBIR award, including Technical Data and Computer Software developed or generated in the performance of an SBIR award. The term does not include information incidental to contract administration, such as financial, administrative, cost or pricing or management information.

SBIR Data Rights
The Government's license rights in properly marked SBIR Data during the SBIR protection period as follows: SBIR Technical Data Rights in SBIR Data that are Technical Data or any other type of Data other than Computer Software and SBIR Computer Software Rights in SBIR Data that is Computer Software. Upon expiration of the protection period for SBIR Data, the Government has a royalty-free license to use, and to authorize others to use on its behalf, these Data for Government purposes, and is relieved of all disclosure prohibitions and assumes no liability for unauthorized use of these Data by third parties, except that any such Data that is also protected under a subsequent SBIR award shall remain protected through the protection period of that subsequent award. The Government receives unlimited rights in all Form, Fit, and Function Data, Operations, Maintenance, Installation, or Training Purposes (OMIT) Data, and unmarked SBIR Data.

Small Business Concern (SBC)
A concern that meets the SBIR program eligibility requirements set forth in 13 CFR § 121.702, which can be found here: https://www.law.cornell.edu/cfr/text/13/121.702.

Veteran-Owned SBC
A Veteran-owned SBC means a SBC:

(1) Not less than 51% of which is owned by one or more veterans (as defined at 38 U.S.C. 101(2)) or, in the case of any publicly owned business, not less than 51% of the stock of which is owned by one or more veterans; and,
(2) The management and daily business operations of which are controlled by one or more veterans.

Women-Owned SBC (WOSB)
A WOSB is an SBC that is at least 51% owned by one or more women; or, in the case of any publicly owned business, at least 51% of the stock is owned by women; and women control the

management and daily business operations.

Socially and Economically Disadvantaged SBC (SDB)
For Eligibility, and Certification, Relating to Federal Small Disadvantaged Business Programs, See 13 CFR § 124, Subpart B at: https://www.law.cornell.edu/cfr/text/13/part-124/subpart-B.

Historically Underutilized Business Zone (HUBZone)
A HUBZone SBC means a SBC, certified by the SBA, that appears on the List of Qualified HUBZone SBCs maintained by the SBA (13 CFR § 126.103 at: https://www.law.cornell.edu/cfr/text/13/part-126)

F. Report SBIR Fraud, Waste, and Abuse

The U.S. DOT Office of Inspector General Hotline (Phone: 800-424-9071, Email: hotline@oig.dot.gov) accepts tips from all sources about allegations of fraud, waste, abuse, and mismanagement in U.S. DOT programs. If the allegations of fraud, waste, abuse or mismanagement pertain to the SBIR Program, then the reporting individual should indicate that the alleged fraud, waste and/or abuse pertains to an SBIR solicitation or contract. Additionally, the U.S. DOT SBIR Program website contains information and links to report potential fraud, waste, and abuse: https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/report-fraud-waste-and-abuse.

G. Other Information

Executive Order (EO) 13329, Encouraging Innovation in Manufacturing, February 26, 2004
"Encouraging Innovation in Manufacturing" requires SBIR agencies, to the extent permitted by law and in a manner consistent with the mission of that department or agency, to give high priority within the SBIR Programs to manufacturing-related R&D. "Manufacturing-related" is defined as "relating to manufacturing processes, equipment and systems; or manufacturing workforce skills and protection."

The U.S. DOT SBIR Program solicits manufacturing-related projects through the call for topics distributed to each of the Department's SBIR participating agencies.

Additionally, the SBA requires each agency with an SBIR program to develop a written policy on the implementation of EO 13329 as well as publish an annual report. More information about the U.S. DOT SBIR Program Office Implementation Plan and Annual Report is posted on the Program website: https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/frequently-asked-questions.

Energy Independence and Security Act of 2007, December 19, 2007

The Energy Independence and Security Act of 2007 (P.L. 110-140) amends the Small Business Act (15 U.S.C. Section 636(a)) to instruct the SBA Administrator to ensure that certain Federal Departments and agencies give priority to small business concerns that participate in or conduct energy efficiency or renewable energy system research and development projects. U.S. DOT SBIR projects that focus on conducting R/R&D in energy efficiency and/or renewable energy are reported annually to SBA.

Federal Leadership on Climate Change and Environmental Sustainability: EO 13693 – Planning for Federal Sustainability in the Next Decade

EO 13693 superseded EO 13514 and requires Federal agencies to include sustainability requirements in all federal contracts. DOT strongly encourages all SBIR applicants to include sustainability in their research and development offers. To learn more visit: https://www.energy.gov/sites/prod/files/2015/09/f26/EO13693.pdf.

II. OFFER PREPARATION INSTRUCTIONS AND REQUIREMENTS

A. Overview

This is a solicitation for Phase I R/R&D offers on advanced, innovative concepts from small business concerns (SBCs) having strong capabilities in applied science or engineering. The Phase I R/R&D offers shall demonstrate a sound approach to the investigation of an important transportation related scientific or engineering problem categorized under one of the research topics listed in Section VIII.

An offer may respond to any of the research topics listed in Section VIII herein, but must be limited to one topic. No one offer may be accepted under more than one topic. An SBC may, however, submit separate offers on different topics, or different offers on the same topic under this solicitation. Where similar research is discussed under more than one topic, the SBC shall choose that topic which appears to be most relevant to the SBC's technical concept.

The proposed research must have relevance to the improvement of some aspect of the national transportation system or to the enhancement of the ability of an Operating Administration of the U.S. DOT to perform its mission. Offers shall be confined principally to scientific or engineering research, which may be carried out through construction and evaluation. Offers must be for R/R&D, particularly on advanced or innovative concepts.

Each offer shall be self-contained and checked carefully by the offeror to ensure compliance with all preparation instructions (see Appendix D, Offer Submission Checklist).

All offers must be submitted using the U.S. DOT's SBIR online submittal page:
https://usg.valideval.com/teams/USDOTSBIR_FY21/signup**.**

B. Solicitation Requirements

The following requirements must be met by the submission deadline for the offer to be evaluated for award:

1. **SBA Company Registry Confirmation** – Each SBC applying to the SBIR program is required to complete its registration in SBA's Company Registry (http://sbir.gov/registration) prior to submitting its application. At a minimum, registration requires a Data Universal Numbering System (DUNS) identification number or Tax Identification Number (TIN). Completed registrations will receive a unique SBC Control ID and PDF file, which should be submitted as the first page in the Technical Section of the Offer.

2. **Submission of Offer** – Offers must be submitted using the U.S. DOT SBIR Program's electronic submission process during open solicitation periods only. Offers must be complete, accurate and submitted as four separate files:

   a. **Technical Section** – The technical section must be submitted in PDF format in accordance with the following requirements:

      i. The technical section shall not exceed 15 pages. The SBA Company Registry Confirmation, and Prior Phase II Awards do not count towards the 15 pages.
      ii. Font size shall be no smaller than 10 point.
      iii. Offers shall be on standard letter size pages (8.5" by 11").
      iv. All pages should be numbered consecutively.

   b. **Appendices A and B** – Appendix A: Signature Page and Appendix B: Project Summary must be saved as one single PDF file, which does not count toward the 15 page limit for the technical section.

   c. **Appendix C: Contract Pricing Worksheet** – The Contract Pricing Worksheet must be submitted as an Excel file. This section does not count towards the 15 page limit for the technical section. SBCs **must** use the template provided by the U.S. DOT SBIR Program Office in order to be considered responsive.

   d. **Contract Pricing Worksheet Supporting Documentation** – Supporting documentation for Appendix C: Contract Pricing Worksheet must be submitted as a PDF file, and must include the required supporting information described on page 15 of this Solicitation and in Appendix C. This section does not count towards the 15 page limit for the technical section. There is no limit on the number of pages for the Contract Pricing Worksheet Supporting Documentation.

3. **Offer File Names** – Offer file names for each of the four separate files shall include the following:

   a. The first three characters shall be the topic number that the offer is associated with (e.g., FH2).

   b. The remaining characters must include an abbreviation of the company's name and a distinct character to designate each file (e.g., 1, 2, 3, and 4).

4. **Offer Submission Deadline** – Offers must be received no later than **3:00 PM ET on Monday, March 8, 2021** through the U.S. DOT's automated proposal website at: https://usg.valideval.com/teams/USDOTSBIR_FY21/signup. Offers received after that time will be automatically rejected; no exceptions will be permitted. Please be aware that the submittal process requires answering several questions; be sure to allow ample time to complete the multi-step submittal process. Offers will not be considered received by the Government until this multi-step process is complete. Offerors are encouraged to

submit their offers as early as possible.

5. **Duplicate Offers** – Only one offer shall be submitted through the U.S. DOT's automated proposal website. No duplicate offers shall be sent by any other means. An offer may respond to any of the research topics listed in Section VIII herein, but must be limited to one topic. No one offer may be accepted under more than one topic. A SBC may, however, submit separate offers on different topics, or multiple separate offers on the same topic under this solicitation. *Note:* To submit a separate offer in the proposal website, submit the form a second time by adding the new topic number or other distinction at the end of the company name in the Company Name field (e.g., Small Business, Inc. – FH1). This will create a second profile.

6. **Specific Instructions for the Four Separate Offer Files:**

Technical Section (PDF)
Includes SBA Registry Confirmation, Technical Section, and Prior Phase II Awards.

SBA Company Registry Confirmation (does not count toward the 15 page limit) *Page 1 of PDF*	All SBIR applicants are required to be registered in SBA's company registry database. The confirmation page from registering in the database should be included as the first page of the Technical Section. It does not count towards the 15 page limit. See https://www.sbir.gov/registration to register or print your registration confirmation.
Technical Section (not to exceed 15 pages)	Submitted offers must include the following headings in bold (in cases where a section does not apply, please state "Not Applicable"): 1. **Identification and Significance of the Problem or Opportunity.** State the specific technical problem or innovative research opportunity addressed and its potential benefit to the national transportation system. 2. **Phase I Technical Objectives.** State the specific objectives of the Phase I R/R&D effort; including the technical question(s) the research seeks to answer to determine the feasibility of the proposed approach. 3. **Phase I Work Plan.** Describe the Phase I R/R&D plan. The plan shall indicate what will be done, where it will be done, when it will be done, and how the R/R&D will be managed or directed and carried out. Phase I R/R&D shall address the objectives and the question(s) cited above in No. 2. Discuss in detail the methods planned to achieve each objective or task, including the level of effort associated with each task.

	4. **Related Research or R&D.** Describe significant R/R&D that is directly related to the offer including any R/R&D conducted by the project manager/principal investigator or by the proposing firm. Describe how related research affects the proposed effort, and any planned coordination with outside sources. The SBC must persuade reviewers of its awareness of recent, key R/R&D conducted by others in the specific topic area. 5. **Key Personnel and Bibliography of Directly Related Work.** Identify key personnel involved in Phase I including related education, experience, and bibliographic information. Where vitae are extensive, summaries that focus on the most relevant experience or publications are desired and may be necessary to meet page limitation. 6. **Relationship with Future Research and Development.** State the anticipated results of the proposed approach if the project is successful (Phase I and Phase II). Discuss the significance of the Phase I effort in providing a foundation for a Phase II R/R&D effort. 7. **Facilities.** Provide a detailed description of the availability and location of instrumentation and physical facilities proposed for Phase I. 8. **Subcontractors/Consultants.** Involvement of consultants in the planning and research stages of the project is permitted. Describe any intended consultant involvement in detail. For Phase I, a maximum of one-third of the research or analytical effort, measured in total contract dollars using simple math, may be performed by subcontractors/consultants. 9. **Potential Post Applications.** Briefly describe whether and how the proposed project appears to have (1) potential commercial application; and (2) potential use by the Federal Government. 10. **Similar Offers and/or Awards.** While it is allowed, with notification, to submit identical offers or offers containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, **it is unlawful to enter into funding agreements requiring essentially equivalent effort**. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award. If an SBC elects to submit similar or identical offers containing equivalent work under other Federal program solicitations, a statement must be included in each offer indicating: • The name and address of the agencies to which offers were

	submitted or from which awards were received; • Date of offer submission or date of award; • Title, number, and date of SBIR Program solicitations under which offers were submitted or awards received; • The applicable research topics for each SBIR offer submitted or award received; • Titles of research projects; • Name and Title of Principal Investigator or Program Manager for each offer submitted or award received. 11. **Human Factors**. Research that involves human subjects may be subject to additional regulations found in 49 C.F.R. Part 11 (Part 11) as well as other applicable federal and state laws and regulations. Research will be considered to involve human subjects under Part 11 if the research obtains (1) data through intervention or interaction with an individual(s), and/or (2) identifiable private information. Unless exempt under 49 C.F.R. §11.101(b) or §11.101(i), human subject research must adhere to the regulations of Part 11, which includes review and approval of the research by a federally approved Institutional Review Board (IRB). Due to the short timeframe associated with Phase I of the SBIR process, the DOT does not recommend the submission of Phase I offers that require the use of Human Subjects Testing. For more information, visit the FAQ at: https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/frequently-asked-questions.
Prior SBIR Phase II Awards (does not count toward the 15 page limit)	If the SBC has received more than a total of 15 Phase II awards in the prior five fiscal years, submit the name of the awarding agency, date of award, funding agreement number, dollar amount, topic or subtopic title, follow-on agreement dollar amount, source and date of commitment, and current commercialization status for each Phase II. Provide the name and title of the project manager or principal investigator for each offer submitted or award received.

Appendices A and B (PDF)

Signature Page (Appendix A) *Page 1 of PDF*	Complete the signature page in Appendix A.

Project Summary (Appendix B) *Page 2 of PDF*	Complete the Project Summary Sheet in Appendix B. The Project Summary of successful offers may be published by the U.S. DOT and, therefore, shall not contain classified or proprietary information. The Project Summary must include at a minimum: 1. A technical abstract with a brief statement of the problem or opportunity, project objectives, and description of the effort. a. The technical abstract shall be prepared in accordance with the instructions on the Appendix B Project Summary sheet, e.g., word limit using space on form, no proprietary/classified information. 2. Anticipated results and potential applications of the proposed research.

Appendix C: Contract Pricing Worksheet (Excel)

The required Appendix C template is available on our website here in Microsoft Excel 2016 format.	A Phase I Contract Pricing Worksheet must be submitted using the template provided. SBCs **must** use the template provided by DOT. Some cost breakdown items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information for each and every item. When completing your cost offer, please consider the following: • It is important to provide enough information to allow the U.S. DOT to understand how the SBC plans to use the requested funds if an award is made. • Phase I contract awards may include profit. Note: FFP purchase orders are the type used for Phase I SBIR awards. • Travel is allowable, however, unusual, for Phase I projects. • The SBC must note its TIN and DUNS identification number in Appendix C, in the Contract Pricing Worksheet Coversheet. The DUNS number is assigned by Dun & Bradstreet, Inc. (See III (D) below). If you are not able to receive a DUNS number before the solicitation deadline, please indicate "Pending" in the DUNS field of Appendix C. An offeror must have a DUNS number before a funding agreement can be awarded. If you have any trouble accessing the Appendix C spreadsheet please contact the U.S. DOT SBIR Program Office via email at dotsbir@dot.gov no later than March 1, 2021. Offers that exceed the Phase I Estimated Award Amount listed in Section VIII will not be considered for award.

Contract Pricing Worksheet Supporting Documentation (PDF)

See the first two tabs of Appendix C for instructions and further examples of supporting documentation.	Supporting documentation for the costs and pricing proposed in Appendix C must be submitted as a separate file in PDF format. Supporting documentation must be provided for **all** costs proposed (e.g., materials quotes, subcontractor proposals, indirect rate calculations, etc.).

7. **Specific Instructions for Pitch Deck:**

PITCH DECK (FOR INVITED OFFERORS ONLY)
Not part of the initial offer submission.

Pitch Deck (not to exceed 15 slides)	Upon invitation only and separate from the initial submission, offerors invited to Pitch Day must submit a pitch deck in MS PowerPoint or PDF via email to the SBIR Program Office (dotsbir@dot.gov) no later than 3 business days prior to the event. There is no set format for the slide content. Pitch deck slides are not to be submitted with the initial offer and will not be considered.

C. Other Information

1. **Offer Control.** Offers will be available only to Government employees in the U.S. DOT team of engineers and/or scientists responsible for evaluating the offer, the U.S. DOT SBIR Program Office, and/or Volpe Center staff pertinent to the SBIR program. The Government reserves the right to have different evaluators participate in Pitch Day.

2. **Fraudulent Information**. Submitting plagiarized information and/or false information pertaining to the company, the principal investigator and/or work to be performed may result in:
   a. An offer being deemed non-responsive;
   b. A recommendation for Phase I award being rescinded;
   c. Termination of an award; or
   d. Possible referral to the Suspension and Debarment authority for review and action.

3. **Technical and Business Assistance (TABA).** The SBIR Program Policy Directive permits an agency to provide technical and business assistance to an SBIR awardee. For

the U.S. DOT, this amount shall be up to and not exceed $6,500 for Phase I awards. This amount is in addition to the award amount for Phase I awards.

The purpose of TABA, as defined by the SBA Policy Directive, is to assist SBIR awardees in: (1) making better technical decisions on SBIR projects; (2) solving technical problems that arise during SBIR projects; (3) minimizing technical risks associated with SBIR projects; and (4) commercializing the SBIR products or processes.

A U.S. DOT SBIR awardee can receive support through TABA in one of two ways:

a. The U.S. DOT SBIR Program Office has a Blanket Purchase Agreement (BPA) with Foresight Science & Technology Incorporated (34 Hayden Rowe St., Hopkinton, MA) that can provide support to Phase I and Phase II awardees. Once an offer is recommended for award, the prospective awardee will receive notification from the U.S. DOT SBIR Program Office identifying the services available and guidance on how to obtain these services at no cost to the small business.

   These services for Phase I include a kick-off meeting with the TABA vendor and an individualized Commercialization Readiness Assessment report to support the development of the Phase II proposal's commercialization strategy,

   OR

b. Awardees can receive assistance in an amount not to exceed $6,500 not using the BPA of the SBIR Program Office. To do so, an awardee must, through its own efforts, obtain a vendor to provide TABA services.

   If recommended for award, the awardee must provide at that time of award recommendation an outline of the specific services its proposed vendor will provide and the detailed qualifications and experience of the proposed vendor, as well as pricing information. This information should not be included in the initial offer, the pitch deck (if selected for pitch day), or the Appendix C contract pricing worksheet.

4. **National Institute of Standards and Technology (NIST)/Hollings Manufacturing Extension Partnership (MEP).** An SBC may wish to contact its local NIST Hollings MEP for manufacturing and other business-related support services. The MEP works with small and mid-sized companies to help them create and retain jobs, increase profits, and save time and money. The nationwide network provides a variety of services, from business development assistance to innovation strategies to process improvements and the identification of commercialization opportunities. MEP is a nationwide network of locally managed extension centers with over 1,400 technical experts, located in every state. To contact an MEP center, call 1-800-MEP-4-MFG (1-800-637-4634) or visit MEP's website at http://www.nist.gov/mep.

D. System for Award Management (SAM) and Data Universal Numbering System (DUNS) Identification Number

Any business that seeks to work with the Federal Government under a FAR-based contract is mandated to register in SAM before being awarded a contract. It is recommended that such business register in SAM before submitting an offer as some items in SAM are due at the time of or before offer submission. Additional information on SAM and the registration process is provided on the SAM website at: https://sam.gov/SAM/. Businesses that already have a DUNS number can register on the SAM website by following the prompts. Instructions for obtaining a DUNS number can be found at: http://fedgov.dnb.com/webform/displayHomePage.do.

III. METHOD OF SELECTION AND EVALUATION CRITERIA

A. Basis of Award

All Phase I offers will be evaluated and judged on a competitive basis. Initially, all offers will be screened to determine responsiveness to the solicitation. All non-responsive offers will be rejected by the Government and will not be further evaluated.

Each offer will be judged on its own merit. A Phase I contract award will be made to the responsive and responsible SBC(s) whose offer provides the best value to the Government, based on the technical and scientific merit of the offer. **The U.S. DOT is under no obligation to fund any offer or any specific number of offers on a given topic. For any given topic, the U.S. DOT reserves the right to award more or less than the anticipated quantity of awards stated in Section VIII, and to make no awards under a given topic.**

B. Phase I Evaluation Criteria

Offerors will be evaluated based on the criteria outlined below. Selections will be based on best value to the Government considering the following criteria, which are listed in descending order of importance. Details of what are considered within each criteria are included below.

Technical Merit & Feasibility	Demonstration of understanding of the problem and solution alignment with the topic description; innovative approach; scientific feasibility
Experience, Qualifications, and Facilities	Description of technical personnel; equipment and facilities; and partnerships/subcontracts (when applicable)
Effectiveness of Proposed Work Plan	Clarity of technical plan and timeline
Commercial Potential	Market understanding and awareness of regulatory, compliance, or legal issues
Offer Quality	Quality of narrative and supporting evidence

C. Offer Responsiveness Review

Each offer will be examined to determine if it is complete and contains adequate technical data. **An offer that does not meet the requirements of the solicitation as described in Section II.B may be excluded from further consideration.**

D. Evaluation and Selection of Awardees

Responsive offers will be evaluated in a two-step process in order to reduce the time from submission to selection and award.

1. Each responsive offer will be evaluated against the evaluation criteria described in Section III.B. After evaluations are complete, the highest rated offerors within each topic will be invited by the Government to move on to the next evaluation step, Pitch Day, and have an opportunity to be considered for award. At the time the Government identifies the offerors that will participate in Pitch Day, all offerors will be notified of their evaluation status. Offerors invited to Pitch Day will receive instructions on how to prepare a short (15-slide maximum) Pitch Deck to present at the event.

2. The highest rated offerors will be invited to attend a virtual Pitch Day event on or around May 4, 2021. At Pitch Day, offerors will have no more than 15 minutes (timed) to present their Pitch Decks to the team of Government evaluators and respond to Government Q&A on the presented pitch.

   It is recommended that no more than three individuals attend Pitch Day, and no more than five shall be permitted. Further logistical information will be made available closer to the event.

   Pitches will be evaluated against the evaluation criteria described in Section III.B independently of the initial offer. Once Pitch Day evaluations are complete, all Pitch Day offerors will be notified of the offers that the Government is recommending for award. At this time, the U.S. DOT SBIR Program Office will also post a listing of all Phase I offers recommended for award on the U.S. DOT SBIR Program webpage: http://www.volpe.dot.gov/sbir.

E. Time to Award Requirements

The SBIR Program Policy Directive requires all SBIR agencies to make Phase I awards within 180 days after the close of the solicitation.

The U.S. DOT SBIR Program Office intends to make recommendations for SBIR Phase I awards no later than 90 days after the closing date of this solicitation. If circumstances are such that notification to each applicant cannot be met within 90 days after the solicitation closing date, the U.S. DOT SBIR Program shall notify each applicant as soon as practicable.

F. Debriefing Requests

Each offeror will have an opportunity to access a written debriefing regarding the evaluation of its offer. Debriefings will be available electronically via the offer submission website. Debriefing information will consist of a summary of ratings across all evaluation criteria and may include comments received by the Government evaluators. The identity of the evaluators will not be disclosed. Debriefings will be available as follows:

Offerors who do not advance on to Pitch Day may access its written debriefing within ten (10) calendar days from the notification from the Government. If there is no response from the SBC within these ten (10) calendar days, the debriefing shall close without further notice. Offerors who do advance on to Pitch Day may access feedback regarding their offer within ten (10) calendar days from the notification from the Government, and will also receive information regarding Pitch Day.

Within ten (10) calendar days after Pitch Day, offerors who have participated in Pitch Day may access their debriefings. Offerors will have ten (10) calendar days to access the debriefing. If there is no response from the SBC within these ten (10) calendar days, the debriefing shall close without further notice.

IV. CONSIDERATIONS

A. Funding Awards

The Government anticipates awarding a total of thirteen Phase I awards among all the topics identified in this solicitation, but reserves the right to make fewer, more, or no awards if it is in the best interest of the Government. The actual number of contract awards is subject to the availability of funding and the responses from small business firms to the solicited research topics described in Section VIII.

1. **Dollar Value of Awards**. The U.S. DOT SBIR Program has set the maximum thresholds for Phase I and Phase II awards at $150,000 and $1,000,000, respectively.

    a. **Phase I Awards**. Phase I is the conduct of feasibility-related experimental or theoretical research or R/R&D efforts on research topics described herein. For the U.S. DOT SBIR Program, Phase I offers can be funded up to $150,000 unless otherwise noted in Section VIII. The period of performance of the resulting contract shall be six months. The basis for award is the scientific and technical merit of the offer, its commercial potential, and its relevance to U.S. DOT requirements and current research priorities. The U.S. DOT intends to award Firm-Fixed-Price (FFP) purchase orders utilizing Federal Acquisition Regulation (FAR) Part 13 Simplified Acquisition Procedures. A purchase order is an offer by the Government to buy supplies or services, including research and development, upon specified terms and conditions (in this instance, this solicitation and the contractor's offer). The U.S. DOT will require written acceptance of the purchase order by the SBC at the time of award via the SBC signing the purchase order thus creating a binding contract between the SBC and the Government. Award of a bilaterally signed purchase order is subject to the availability of funding.

    All U.S. DOT SBIR Phase I awardees who have successfully completed Phase I are eligible to submit a Phase II proposal for evaluation and possible selection for award.

    b. **Phase II Awards**. The objective of Phase II is to continue the R/R&D effort from the completed Phase I. Award of a contract for a Phase II effort is based on the results of Phase I, the scientific and technical merit of the Phase II proposal, and the commercial potential of the proposed Phase II project. Commercial potential includes the capability to transition the technology to private sector applications, Government applications, or Government contractor applications. For the U.S. DOT SBIR Program, contracts for Phase II proposals can be funded up to $1,000,000 (except where a lower ceiling is specifically identified) and can have a period of performance of up to 24 months from the date of contract award. The Government is not obligated to fund any specific Phase II proposal.

The U.S. DOT typically awards Firm-Fixed-Price (FFP), FFP-Level-of-Effort (FFPLOE), or Cost-Plus-Fixed-Fee (CPFF) negotiated contracts for Phase II efforts utilizing FAR Part 15 Contracting by Negotiation procedures. Approximately 30 days prior to the end of Phase I efforts, the U.S. DOT SBIR Program Office will provide Phase I contract awardees details on the due date, content, submission requirements, and evaluation criteria for Phase II proposals. A summary of Phase II proposal submission requirements can be found on the U.S. DOT's SBIR website at: https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/submit-proposal.

A Phase II awardee may receive one additional, sequential Phase II award to continue the work of an initial Phase II award.

2. **Phase II Contract Type and Accounting System Audits.** The Contracting Officer will consider whether a FFPLOE, CPFF, or other contract type is appropriate for each Phase II award. Phase II awardees MUST have an accounting system that is adequate for determining costs applicable to the contract or order to receive a cost type contract.

B. Reports

Under Phase I SBIR efforts, three (3) reports will be required, consisting of two (2) interim narrative reports, and a comprehensive final report. These reports are due at two-month intervals starting at the end of month two. An acceptable report is one that is comprehensive and describes all efforts and progression made on the R&D from the start of the funding agreement through the report submitted time.

C. Payment Schedule

The SBC can invoice for three partial payments for Phase I awards based on the SBC's delivery of, and the Government's acceptance of, each report. The SBC must ensure invoices are submitted in accordance with instructions in the award document, in conjunction with or after the submission by the SBC of an acceptable report(s) as described in above Paragraph B. Invoices submitted before submission of a due report will be rejected until the Phase I awardee submits an acceptable report.

Contracts for Phase II, and/or III will allow for incremental payments to the successful SBC as work progresses dependent on the negotiated contract type, invoice/payment contract requirements, and/or payment schedule incorporated into the contract.

D. Innovations, Inventions, and Patents

1. **Proprietary Information.** Information contained in unsuccessful offers will remain the

property of the SBC. The Government will, however, retain copies of all offers. Public release of information in any offer submitted will be subject to existing statutory and regulatory requirements.

The U.S. DOT prefers that SBC offers avoid the inclusion of proprietary data. If the inclusion of proprietary data is considered essential for meaningful evaluation of an offer it must adhere to the terms explained in this paragraph IV.D.

If proprietary information is provided by a SBC in an offer that constitutes a trade secret, or commercial or financial information, it will be treated in confidence, to the extent permitted by law, provided the offer is clearly marked by the SBC as follows:

The following legend must appear on the title page of the offer:

> "This offer contains information that shall not be disclosed outside the Federal Government and shall not be duplicated, used, or disclosed in whole or in part for any purpose other than evaluation of this offer, unless authorized by law. The Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract if award is made as a result of the submission of this offer. The information subject to these restrictions are contained on all pages of the offer except for pages [*insert page numbers or other identification of pages that contain no restricted information*.]
>
> (End of Legend)"; and,

The following legend must appear on each page of the offer that contains information the SBC wishes to protect:

> "Use or disclosure of information contained on this sheet is subject to the restriction on the title page of this offer."

2. **Rights in Data Developed under SBIR Funding Agreements.** Rights in technical data, including software developed under any award resulting from this solicitation, shall remain with the SBC except that the Government shall have the limited right to use such data for Government purposes and shall not release such data outside the Government without permission of the SBC for a period of twenty years from the award date of the Phase I project from which the data was generated. However, effective at the conclusion of the twenty-year period, the Government shall retain a royalty free license for Federal Government use of any technical data delivered under an SBIR contract whether patented or not.

3. **Copyrights**. With prior written permission of the Contracting Officer, the SBC may copyright and publish (subject to and consistent with appropriate national security considerations, if any) material developed with U.S. DOT support. The U.S. DOT receives a royalty free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

4. **Patents/Invention Reporting**. SBCs may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty free license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must manufacture it domestically. To the extent authorized by 35 U.S.C. 205, the Government will not make public any information disclosing a Government-supported invention for a two-year period to allow the SBC a reasonable time to pursue a patent.

5. **Invention Reporting Process**. Awardees shall report SBIR inventions to the U.S. DOT through the iEdison Invention Reporting System (http://www.iedison.gov/). Use of the iEdison System satisfies all invention reporting requirements mandated by any award.

E. Cost Sharing

The U.S. DOT permits cost sharing for its Phase II efforts under the topic areas identified in this solicitation; however, cost sharing is not required nor is it a factor in evaluation of offers. Cost Sharing is not applicable to Phase I offers or awards.

F. Profit

A profit is allowed on awards to SBCs under the U.S. DOT SBIR Program consistent with the Federal Acquisition Regulations.

G. Joint Ventures or Limited Partnerships

Joint venture (JV) and limited partnerships are permitted to submit offer(s) to this solicitation provided the entity created qualifies as a small business concern in accordance with the Small Business Act, 15 U.S.C. 632, and the definition of small business concern included in this solicitation (Paragraph I.E.6). JVs must be properly registered in SAM as a JV prior to receiving an award. As this can be a time consuming process, if offering as a JV, working with SAM to get the registration done before offer submission is highly recommended.

H. Research and Analytical Work

1. For Phase I, a minimum of two-thirds of the research or analytical effort, measured in total contract dollars using simple math, must be performed by the awardee (i.e., 66.7% of total contract cost must be for other than subcontractor/consultant costs).
2. For Phase II, a minimum of one-half of the research or analytical effort, measured in total contract dollars on costs incurred for personnel must be performed by the awardee (i.e., labor and indirect rates minus costs such as material, travel, and subcontractor/consultant).

I. Awardee Commitments

Upon award of a U.S. DOT SBIR contract, the SBC will be required to make certain legal commitments through acceptance of Federal Acquisition Regulation (FAR) and Transportation Acquisition Regulation (TAR) clauses, and other Government requirements. The FAR and TAR may be found using the following links:

FAR: https://www.acquisition.gov/browse/index/far

TAR: https://www.acquisition.gov/tar

The Summary Statements that follow are illustrative of the types of clauses to which the SBC would be committed. This list does not represent a complete list of clauses to be included in Phase I awards, and does not provide the specific wording of such clauses. A complete copy of the terms and conditions will be provided upon issuance of the contract for signature prior to award.

J. Summary Statements

1. **Standards of Work.** Work performed under all SBIR efforts must conform to high professional standards.

2. **Inspection.** Work performed under all SBIR efforts are subject to Government inspection and evaluation.

3. **Default.** The Government may terminate the funding agreement if the Contractor fails to adhere to its terms.

4. **Termination for Convenience.** The Government may terminate the funding agreement if the Government deems termination to be in the Government's best interest. In such case, the Contractor may submit its costs for work performed and for reasonable termination costs.

5. **Disputes.** Any dispute concerning the funding agreement which cannot be resolved by agreement shall be decided by the Contracting Officer with right of appeal in accordance with the Contracts Disputes Act of 1978, 41 U.S.C. 71.

6. **Certain Telecommunications and Video Surveillance Services or Equipment.** Work performed under all SBIR efforts will require certification by an Awardee as to its use of and/or delivery of covered telecommunications equipment/services and compliance with any restrictions/prohibitions based on that certification. The offeror shall review a list of excluded parties in SAM for entities excluded from receiving federal awards for "covered telecommunication equipment or services" as specifically prohibited by Section 889 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Pub. L. 115-232).

7. **Equal Opportunity.** The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

8. **Equal Opportunity for Veterans.** The Contractor shall not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam Era.

9. **Equal Opportunity for Workers with Disabilities.** The Contractor shall not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

10. **Officials Not to Benefit.** No Government official must benefit personally from the SBIR funding agreement.

11. **Gratuities.** The Government may terminate the funding agreement if any gratuity is or was offered to any representative of the Government to secure the award.

12. **Patent Infringement.** The Contractor shall report each notice or claim of patent infringement based on the performance of the funding agreement to the SBIR Program Contracting Officer.

13. **Procurement Integrity.** Submission of an offer under this solicitation subjects the Offeror to the "Restrictions on Obtaining and Disclosing Certain Information" (41 U.S.C. §§ 2101-2107, commonly known as the Procurement Integrity Act). This statute, as implemented by Federal Acquisition Regulation (FAR, 48 C.F.R.) §3.104, prohibits the following conduct during an agency procurement: prohibits federal employees and certain Government contractors involved in federal procurements from **disclosing** contractor bid or proposal information or source selection information (§2102); prohibits any individual from obtaining contractor bid or proposal information or source selection

information prior to award (§2102); requires agency officials to **report employment contacts** regarding non-Federal employment (§2103); and bans for a definitive period certain personnel from accepting compensation from the vendor and the vendor from compensating such certain personnel during this definitive period (§2104). Violations of the statute may result in criminal and/or civil penalties, and administrative actions (e.g., suspension and debarment, cancellation of the procurement, and/or rescission of the contract).

14. **Section 508 Access Board Standards**. All information and communication technology (ICT) deliverables rendered under this contract must comply with the Revised Section 508 Standards of the Rehabilitation Act and the Access Board Standards, available for viewing at https://section508.gov/. For purposes of Revised Section 508 compliance, the definition of ICT includes information technology and other equipment, systems, technologies, or processes, for which the principal function is the creation, manipulation, storage, display, receipt, or transmission of electronic data and information, as well as any associated content. ICT acquired by a contractor incidental to this contract shall not be required to conform to the Revised 508 Standards. Unless otherwise indicated the contractor represents by signature on this contract or order that all deliverables will comply with the Access Board Standards.

15. **Government Property**. Materials, equipment, special tooling, and special test equipment either furnished by the Government or, in a cost type contract, acquired by the contractor or fabricated by the contractor, is subject to FAR clause 52.245-1 Government Property and may also be subject to special clauses specific to certain items of property.

16. **American Made Equipment and Products**. When purchasing equipment or products under an SBIR funding agreement, purchase only American-made items whenever possible.

K. Additional Information

1. This solicitation reflects current planning. Although not expected, there may be inconsistencies between the information contained in the FY 2021 solicitation and the terms and conditions of any resulting SBIR contract. The terms and conditions of the contract once executed are controlling.

2. The SBC shall complete an Online Representations and Certifications Application at https://sam.gov/SAM/. The SBC should be certified in the designated NAICS code (541715) of this solicitation. The size standard of NAICS code 541715 for the SBIR program is 500 employees.

3. The Government may request the SBC to submit additional management, personnel, and financial information in order for the Government to consider and determine the responsibility of the SBC.

4. The Government is not responsible for any monies expended by the SBC before award of any contract.

5. This solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

6. The U.S. DOT SBIR Program is not a substitute for existing unsolicited offer mechanisms. Unsolicited offers shall not be accepted under the U.S. DOT SBIR Program for either Phase I or Phase II efforts. For information pertaining to submission requirements for unsolicited offers please refer to the U.S. DOT's Guidelines for Unsolicited Proposal Submission at https://www.volpe.dot.gov/work-with-us/guidelines-unsolicited-proposal-submission.

V. SUBMISSION OF OFFERS

Offers must be received no later than **3:00 PM ET on Monday, March 8, 2021** through the U.S. DOT's automated proposal website at: https://usg.valideval.com/teams/USDOTSBIR_FY21/signup.

Offers received after that time will be automatically rejected; no exceptions will be permitted. Please be aware that the submittal process requires answering several questions; be sure to allow ample time to complete the multi-step submittal process. Offers will not be considered received by the Government until this multi-step process is complete. Offerors are encouraged to submit their offers as early as possible.

VI. SCIENTIFIC AND TECHNICAL INFORMATION SOURCES

The following publications and websites are referenced in the research topics found in Section VIII.

A. Federal Highway Administration (FHWA)

21-FH1: Device for Assessing Environmental Impact of Post-Consumer Waste Plastic in Highway and Airfield Materials and Pavements

- Methods for sampling and detection of microplastics in water and sediment: A critical review. – https://doi.org/10.1016/j.trac.2018.10.029
- Recycling Concrete Pavement Materials: A Practitioner's Reference Guide – https://intrans.iastate.edu/app/uploads/2018/09/RCA_practioner_guide_w_cvr.pdf
- Federal Highway Administration 2020 Annual Modal Research Plan – https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020
- Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage: 2018 – https://www.asphaltpavement.org/uploads/documents/IS138/IS138-2018_RAP-RAS-WMA_Survey_Final.pdf

21-FH2: In-situ Determination of Pore Solution Resistivity

- Performance-Engineered Mixtures – https://cptechcenter.org/performance-engineered-mixtures-pem/
- Insitu Electrical Sensing and Material Health Monitoring in Concrete Structures – https://www.researchgate.net/publication/27239045_Insitu_electrical_sensing_and_material_health_monitoring_in_concrete_structures
- Development of Electrical Conductivity-Based Sensors for Health Monitoring of Concrete Materials Development of Electrical Conductivity-Based Sensors for Health Monitoring of Concrete Materials – https://www.researchgate.net/publication/228616569_Development_of_Electrical_Conductivity-Based_Sensors_for_Health_Monitoring_of_Concrete_Materials
- Technical Brief: Performance Engineered Pavements – https://www.fhwa.dot.gov/pavement/materials/hif20005.pdf
- Federal Highway Administration 2020 Annual Modal Research Plan – https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020

21-FH3: Accelerating Performance Testing Using the Asphalt Mixture Performance Tester (AMPT) Equipment

- Federal Highway Administration 2020 Annual Modal Research Plan – https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020
- Asphalt Mixture Performance Tester (AMPT) – https://www.fhwa.dot.gov/pavement/asphalt/tester.cfm
- Cyclic Fatigue Index Parameter (Sapp) for Asphalt Performance Engineered Mixture Design, FHWA-HIF-091, 2019 – https://www.fhwa.dot.gov/pavement/asphalt/analysis/
- Appendix E of NCHRP Report 629 from Project 9-29 – https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=963
- FHWA contract DTFH6117C00037 Draft Report – https://drive.google.com/file/d/1R1k5bATsw0lNV-DaS-COuwRbhdeg_pgZ/view
- Fabrication of Small and Large Specimens – https://youtu.be/raDoPi1jcag
- Dynamic Modulus Small Specimen Test – https://youtu.be/ZlCHD3Mf1z4
- Cyclic Fatigue Small Scale Specimen Test – https://youtu.be/MKN1ihZkWr0
- Stress Sweep Rutting Test – https://youtu.be/bUChELQ28c0

21-FH4: Reference Hardware for Infrastructure GPS Abnormality Detector for Connected and Automated Vehicle Applications

- IS-GPS-705 Navstar GPS Space Segment/ User Segment L5 Interfaces – https://www.gps.gov/technical/icwg/IS-GPS-705G.pdf
- Global Positioning System (GPS) Standard Positioning Service (SPS) Performance Standard – https://www.gps.gov/technical/ps/2020-SPS-performance-standard.pdf

B. Federal Motor Carrier Safety Administration (FMCSA)

21-FM1: Automated Vehicles: Deployment of Traffic Warning Devices (Triangles)

- Emergency equipment on all power units, 49 CFR §393.95 – https://www.ecfr.gov/cgi-bin/text-idx?SID=cb001c9d3ababa7a159c20cf177e0853&node=pt49.5.393&rgn=div5#se49.5.393_195
- Emergency signals; stopped commercial motor vehicles, 49 CFR §392.22 – https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=9da6cea6d44c58a9a5205a21f872f26a&mc=true&r=PART&n=pt49.5.392#se49.5.392_122
- Federal Motor Carrier Safety Administration 2020 Annual Modal Research Plan –

https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-motor-carrier-safety-3

21-FM2: Readiness Assessment Technology

- Drowsy Driving – https://www.nhtsa.gov/risky-driving/drowsy-driving
- Federal Motor Carrier Safety Administration 2020 Annual Modal Research Plan – https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-motor-carrier-safety-3

C. Federal Railroad Administration (FRA)

21-FR1: Passenger Train Exterior Side Door Safety

- APTA PR-M-S-18-10 Standard for Powered Exterior Side Door System Design for New Passenger Cars – https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-PR-M-S-018-10.pdf
- Exterior side door safety systems—new passenger cars and locomotives used in passenger service, 49 CFR §238.131 – https://www.ecfr.gov/cgi-bin/text-idx?SID=38f57bf84ee49d55bd6d556cea7dc8a0&mc=true&node=pt49.4.238&rgn=div5#se49.4.238_1131
- Passenger Train Exterior Side Door Safety – https://www.federalregister.gov/documents/2015/12/07/2015-30488/passenger-train-exterior-side-door-safety

21-FR2: Wheel Measuring Device

- APTA PR-M-S-015-06 Standard for Wheel Flange Angle for Passenger Equipment – https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-PR-M-S-015-06.pdf

D. Federal Transit Administration (FTA)

No references.

E. National Highway Traffic Safety Administration (NHTSA)

21-NH1: Securing Safe Passage when Crossing a Roadway to Board Buses

- 2019 Survey on Illegal Passing of School Buses –Summary Results – https://nasdpts.org/resources/Documents/2019%20NASDPTS%20Illegal%20Passing%20Results%20Summary-7-24-19-v2-Updated%201-3-20%20to%20Include%20DC.pdf

- Vehicle Collision with Student Pedestrians Crossing High-Speed Roadway to Board School Bus, Rochester, Indiana, October 30, 2018 – https://www.doe.in.gov/sites/default/files/transportation/ntsb-full-final-report-rochester-fatalities-2018-april-2020.pdf

21-NH2: Ignition Interlock Device Data-Integrated Mobile Device App

- Randomized, Controlled Pilot Trial of a Smartphone App for Smoking Cessation Using Acceptance and Commitment Therapy – https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4201179/
- Self-Monitoring in Weight Loss: A Systematic Review of the Literature – https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3268700/?referringRepId=225798
- There is an app for that – Or is there? A content analysis of publicly available smartphone apps for managing alcohol use – https://www.sciencedirect.com/science/article/abs/pii/S0740547217301691
- Review of Smartphone Applications for the Treatment of Eating Disorders – https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4847127/
- National Center for Statistics and Analysis (NCSA) Motor Vehicle Traffic Crash Data Resource Page – https://crashstats.nhtsa.dot.gov/#!/
- Risk of Alcohol-Impaired Driving Recidivism Among First Offenders and Multiple Offenders – https://ajph.aphapublications.org/doi/pdfplus/10.2105/AJPH.2008.154575
- The Effects of Closer Monitoring on Driver Compliance with Interlock Restrictions – https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3153731/

F. Pipeline and Hazardous Materials Safety Administration (PHMSA)

No references.

VII. SUBMISSION FORMS AND CERTIFICATION (APPENDICES)

A. Offer Signature Page (Appendix A)

MS Word version of Appendix A is available on U.S. DOT's SBIR website.

B. Project Summary (Appendix B)

MS Word Version of Appendix B is available on U.S. DOT's SBIR website.

C. Contract Pricing Worksheet (Appendix C)

MS Excel Version of Appendix C is available on U.S. DOT's SBIR website.

D. Offer Submission Checklist (Appendix D)

(Do not include with offer – for offeror's use only)

A. Offer Signature Page (Appendix A)

U.S. DEPARTMENT OF TRANSPORTATION
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
SOLICITATION NO. 6913G621QSBIR1, FY 2021
SIGNATURE PAGE

Offer Information		
Topic No. (see Solicitation):	Solicitation No.: 6913G621QSBIR1	
Topic Title:		
Offer Title:		
Company Information		
Company:		
Address:		
City:	State:	Zip:

Offeror Certification	
By signing belowand submitting this offer in response to Solicitation No. 6913G621QSBIR1, Topic Number_, I(We) am(are) representing on my own behalf, and on behalf of the SBIR applicant, that the information provided in this certification, the application, and all other information submitted in connection with this application, is true and correct as the date of the submission. I acknowledge that any intentional or negligent misrepresentation of the information contained in this certification may result in criminal, civil or administrative sanctions, including but not limited to: (1) fines, restitution and/or imprisonment under 18 U.S.C. § 1001; (2) treble damages and civil penalties under the False Claims Act (31 U.S.C. § 3729 *et seq.*); (3) double damages and civil penalties under the Program Fraud Civil Remedies Act (31 U.S.C. § 3801 *et seq.*); (4) civil recovery of award funds, (5) suspension and/or debarment from all Federal procurement and non-procurement transactions (FAR Subpart 9.4 or 2 C.F.R. part 180); and (6) other administrative penalties including termination of SBIR awards.	
Principal Investigator Name:	Corporate/Business Official Name:
Title:	Title:
Address:	Address:
Telephone Number:	Telephone Number:
Email:	Email:
Signature:	Signature:
Date:	Date:

B. Project Summary (Appendix B)

U.S. DEPARTMENT OF TRANSPORTATION
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
SOLICITATION NO. 6913G621QSBIR1 FY 2021
PROJECT SUMMARY

Project Summary
Abstract (Limited to two hundred words in this space only. The Project Summary of successful offers may be published by the U.S. DOT and, therefore, shall not contain classified or proprietary information.).
Anticipated Results/Potential Commercial Applications of Results.
Keywords

C. Contract Pricing Worksheet (Appendix C)

U.S. DEPARTMENT OF TRANSPORTATION
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
SOLICITATION NO. 6913G621QSBIR1, FY 2021
CONTRACT PRICING WORKSHEET

Appendix C can be found on our website here in Microsoft Excel 2016 format. Please fill out the spreadsheets as directed in the instructions.

Additional information about the contract pricing worksheet and its requirements can be found in the Appendix C instructions in the first two tabs of the workbook and on our FAQ page (https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/frequently-asked-questions).

If you have any questions regarding Appendix C not listed on our FAQ page, please submit such questions via email to:

U.S. DOT SBIR Program Office
dotsbir@dot.gov

All administrative and Appendix C questions must be submitted no later than 5:00 PM ET on Monday, March 1, 2021. Questions received after 5:00 PM ET on March 1, 2021 may not be answered. The Government reserves the right to address a late question, if the Government determines an answer is in the best interests of the Government.

D. Offer Submission Checklist (Appendix D)

U.S. DEPARTMENT OF TRANSPORTATION
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
SOLICITATION NO. 6913G621QSBIR1, FY 2021
OFFER SUBMISSION CHECKLIST

This is a CHECKLIST OF REQUIREMENTS for your offer. Please review the checklist carefully to assure that your offer meets the U.S. DOT SBIR requirements. Failure to meet these requirements may result in your offer being returned without consideration. (See Section III.B of this Solicitation). **Do not include this checklist with your offer.**

____ 1. The offer reflects that for Phase I, a minimum of two-thirds of the research or analytical effort, measured in total contract dollars using simple math, must be performed by the awardee (i.e., 66.7% of total contract cost must be for other than subcontractor/consultant costs).

____ 2. The offer is submitted according to the requirements described in Section II.

____ 3. The offer is limited to only ONE of the research topics in Section VIII.

____ 4. The budget may be up to $150,000 *unless otherwise indicated in Section VIII of the solicitation* and duration does not exceed six months.

____ 5. The technical abstract contains no proprietary information, does not exceed 200 words, and is limited to the space provided on the Project Summary sheet (Appendix B).

____ 6. The offer contains no type smaller than ten point font size.

____ 7. All Appendices (A, B, and C) have been completed.

____ 8. The Technical Section includes all items identified in Section II.B of the Solicitation.

____ 9. The additional information on prior Phase II awards, if required, in accordance with Section II.B, is included.

____ 10. The Contract Pricing Worksheet (Appendix C) has been completed and the Contract Pricing Worksheet Supporting Documentation file provides the necessary supporting information.

____ 11. The offer must be submitted online and received by the U.S. DOT automated proposal

website by **3:00 PM ET, March 8, 2021. Offers received via email or any other means will not be accepted. Do not send duplicate offers via email or by any other means.**

VIII. RESEARCH TOPICS

The FY 2021 Solicitation Phase I research topics for U.S. DOT Operating Administrations are listed on the following pages. These topics indicate the specific areas for which SBIR Phase I offers are to be considered for acceptance by U.S. DOT. The topics are not listed in any order of priority. Each offer submitted must respond to one (and only one) topic and/or focus area as described in this section. An offer may, however, indicate and describe its relevance to other topics. Offerors are encouraged to review Section VI of this solicitation for scientific and technical information sources that may be referenced in the respective topic descriptions.

U.S. DOT Operating Administration	Topic Number & Title	Estimated Award Amount Phase I*	Estimated Award Amount Phase II**
Federal Highway Administration (FHWA)	21-FH1: Device for Assessing Environmental Impact of Post-Consumer Waste Plastic in Highway and Airfield Materials and Pavements	$150,000	$1,000,000
	21-FH2: In-situ Determination of Pore Solution Resistivity	$150,000	$1,000,000
	21-FH3: Accelerating Performance Testing Using the Asphalt Mixture Performance Tester (AMPT) Equipment	$150,000	$1,000,000
	21-FH4: Reference Hardware for Infrastructure GPS Abnormality Detector for Connected and Automated Vehicle Applications	$150,000	$500,000
Federal Motor Carrier Safety Administration (FMCA)	21-FM1: Automated Vehicles: Deployment of Traffic Warning Devices (Triangles)	$150,000	$1,000,000
	21-FM2: Readiness Assessment Technology	$150,000	$1,000,000
Federal Railroad Administration (FRA)	21-FR1: Passenger Train Exterior Side Door Safety	$150,000	$300,000
	21-FR2: Wheel Measuring Device	$150,000	$400,000
Federal Transit Administration (FTA)	21-FT1: Robots for Unmanned Disinfection and Decontamination of Transit Assets	$150,000	$900,000
	21-FT2: Using Artificial Intelligence (AI) to Inspect, Repair and Sanitize Transit Vehicles	$150,000	$650,000

National Highway Traffic Safety Administration (NHTSA)	21-NH1: Securing Safe Passage when Crossing a Roadway to Board Buses	$150,000	$500,000
	21-NH2: Ignition Interlock Device Data-Integrated Mobile Device App	$150,000	$500,000
Pipeline and Hazardous Materials Safety Administration (PHMSA)	21-PH1: Lithium Ion Battery Packaging	$150,000	$350,000

* Proposals that exceed the Phase I Estimated Award Amount will not be considered for award.

**The Phase II funding level noted above is an estimate only, is subject to the availability of funds and/or the technical requirements to accelerate the development of a commercial product and/or innovation. Any changes to the Phase II estimated funding level listed above will be communicated to the small business when instructions on the Phase II process are sent approximately 1 month prior to the end of the Phase I project.

Research topics are organized into six sections:

A. Federal Highway Administration (FHWA)
B. Federal Motor Carrier Safety Administration (FMCSA)
C. Federal Railroad Administration (FRA)
D. Federal Transit Administration (FTA)
E. National Highway Traffic Safety Administration (NHTSA)
F. Pipeline and Hazardous Materials Safety Administration (PHMSA)

A. Federal Highway Administration (FHWA)

About Us: FHWA's Research, Technology, and Evaluation Program strives to generate new solutions, build more effective partnerships, and provide better information and tools for decision making, which will enable the Nation to enhance and make the best investments in the U.S. transportation system.

21-FH1: Device for Assessing Environmental Impact of Post-Consumer Waste Plastic in Highway and Airfield Materials and Pavements

The National Asphalt Pavement Association estimates about 82.2 million tons of reclaimed asphalt pavement (RAP) was used in 2018 paving operations (National Asphalt Pavement Association, 2019[1]). A 2014 estimate of recycled concrete aggregate from the Construction and Demolition Recycling Association suggests around 140 million tons per year (Snyder et al., 2018[2]). As interest in using post-consumer waste plastic in pavement materials grows, a critical question to answer remains: can we recycle a plastic-modified mixture and reincorporate into a future pavement section?

A recycled/reclaimed pavement material mixture is generally (but not always) considered to be resource-conscious, whether it be through retained natural resources, lower CO2 emissions, or reduced landfilling. For plastic-modified mixtures, a critical issue surrounding recyclability, and use in general, circles around environmental safety. Microplastics represent one element in the environmental safety evaluation. According to the National Oceanic and Atmospheric Administration, microplastics are any type of small plastic less than five millimeters in length. There are concerns over the ability of microplastics to be inhaled by construction workers or to absorb other hazardous chemicals and make their way into the water sources. Methods have been developed to characterize or detect the presence of microplastics in oceans and are described in the literature (Prata et al., 2019[3]).

The research challenge to be addressed through this project is to develop a device to assess environmental impacts of pavements with post-consumer waste plastics or other polymer-based additives that present an environmental concern for inclusion in highway and airfield paving materials. The specific solution being sought would provide a sensor or product that could be used to assess leaching of plastics during operation or potential airborne microplastics that could be released during construction or rehabilitation of pavements incorporating post-consumer waste plastics. The specific solution shall be able to accurately measure microplastic contents of a range of particle sizes that could leach from the pavement surface, with consideration of potential contaminants presence on the pavement (e.g., deicing salts, dirt). A successful outcome will contribute to achievement of the DOT and FHWA Innovation and Infrastructure goals by providing an innovative and sustainable alternative to conventional asphalt and concrete paving materials used in highway and airfield construction and rehabilitation. Additionally within the

[1] https://www.asphaltpavement.org/uploads/documents/IS138/IS138-2018_RAP-RAS-WMA_Survey_Final.pdf
[2] https://intrans.iastate.edu/app/uploads/2018/09/RCA_practioner_guide_w_cvr.pdf
[3] https://doi.org/10.1016/j.trac.2018.10.029

pavement community, the desire to include recycled pavement materials into future sections is very high.

The use of post-consumer waste content through incorporation in paving materials represents an innovative approach to cut down on the incineration and landfilling of plastics. This solution will provide a tool or device to ensure that the construction, operation, rehabilitation, and end-of-life of pavements incorporating post-consumer waste plastics do not place undue burden on the environment. This project will support the key activity outlined by FHWA's Annual Modal Research Plan (AMRP)[4] of assessing the durability of recycled materials and industrial byproducts for use in pavements. The project will support FAA's evaluation of "green technologies" for use in airfield pavements by providing a tool to ensure minimal environmental impact of waste stream plastics.

The opportunity for commercialization in the U.S. is very high. A large portion of post-consumer waste plastic ends up in waste disposal streams, and many groups have been investigating ways to use this waste stream as an ingredient in pavement materials. This has the potential to create a whole new market. The owners in this new market would be infrastructure owners that often have a desire to minimize the environmental impact of construction, operation, and rehabilitation of their systems. This proposed solution would give them a tool to address microplastics, an item of growing concern as this market expands, and explain environmental impacts of the project to the local community.

Expected Phase I Outcomes

Through the Phase I proof of concept reports, this phase will seek to demonstrate with high confidence that the technique and framework for an assessment tool will result in satisfaction of the performance requirements described above. The Phase I final report shall summarize a novel use for a device to measure and detect leaching or airborne microplastic generation in pavement materials, investigate the market availability of raw materials and any necessary processing equipment, discuss any economic or environmental concerns, present critical opportunities and obstacles to implementation, and provide a tentative plan for verification and demonstration to be conducted in Phase II.

Expected Phase II Outcomes and Deliverables

Phase II shall scale the concept detailed in Phase I to small-scale production for evaluation on test specimens. Phase II shall demonstrate the sensor or tool to assess the microplastics content over time so that the aging implications of microplastic development are better understood. This demonstration shall be documented in a format that can be peer-reviewed by the pavement materials research community to establish accuracy targets or thresholds. The Phase II plan

[4] https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020

should detail how the device cost can be reduced for manufacturing purposes and how the testing time can become more efficient by using the device.

21-FH2: In-situ Determination of Pore Solution Resistivity

Rapid evaluation of the durability of concrete materials used in transportation infrastructure has recently focused on electrical-based measurements, specifically resistivity and formation factor. While measurements (resistivity) can be conducted very quickly (on the order of minutes) to properly assess the microstructure of the material and link to a quantifiable parameter (formation factor), information about the electrical properties of the pore solution is a key link between the measurements and ability to understand the quality of a concrete's microstructure.

The Performance Engineered Mixtures (PEM) initiative has implemented transport properties and formation factor concepts, and the key document in this initiative (a guide specification termed AASHTO PP84-20, more information available at https://www.fhwa.dot.gov/pavement/materials/hif20005.pdf and https://cptechcenter.org/performance-engineered-mixtures-pem/) has identified three methodologies to determine the electrical properties of the pore solution. The most accurate methodology is measurement of the pore solution properties. Currently, this is accomplished through invasive and destructive techniques that require specialized equipment and skills that many state highway agency (SHA) laboratories may not be able or willing to perform. Furthermore, this existing procedure is time intensive, can only yield results from early ages, and is susceptible to changes due to environmental conditions (e.g., carbonation of the pore solution). These challenges have hampered the adoption of this assessment technique, and forced users to the technique that approximates the pore solution properties.

An alternative option would make use of sensors or a sensor system physically embedded in the concrete (laboratory cylinder specimens or field pours) that would determine the electrical properties of the pore solution (an approach shown in literature suggests this to be possible and practical[5,6]). The solution being sought would provide a simple tool that would enable SHAs using formation factor-based durability performance evaluation of their concrete mixtures to reduce the subjectivity, the number of assumptions, and the complexity of physical tests that are made in the evaluation of mixture durability.

[5] Rajabipour, Farshad, Gaurav Sant, and W. Jason Weiss. 2007. "Development of Electrical Conductivity-Based Sensors for Health Monitoring of Concrete Materials Development of Electrical Conductivity-Based Sensors for Health Monitoring of Concrete Materials." In *Proceedings of the Transportation Research Board*, 1–16. Washington, DC. https://www.researchgate.net/publication/228616569_Development_of_Electrical_Conductivity-Based_Sensors_for_Health_Monitoring_of_Concrete_Materials

[6] Rajabipour, Farshad. 2006. "Insitu Electrical Sensing and Material Health Monitoring in Concrete Structures." PhD: Purdue University: West Lafayette, Indiana.

The proposed solution supports FHWA's AMRP[7] by developing and enhancing tests and processes related to the PEM initiative for concrete pavements. Specifically, this topic seeks to evaluate the durability of concrete materials. It will also contribute to the Department's strategic objective of improving the performance of the Nation's infrastructure. This can be achieved through research and accelerating development and deployment of innovative technologies and practices by the continued refinement of techniques of accurately assessing the durability of concrete pavements and structures.

The opportunity for commercialization in the U.S. is high. There are many agencies that are transitioning to electrical property evaluation of their concrete mixtures, and this solution would be a simple way to implement the evaluation and correlate measurements with durability performance. In the future, an effective solution could make its way into other markets such as bridge construction or commercial construction where the concrete would be in an exposure category that would require assessment of its durability properties.

Overall, this SBIR topic seeks to create a sensor, an array of sensors, or a sensor system that could be embedded into a concrete element and be able to able to determine the concrete's pore solution electrical properties. The solution should include either 1) a consumer level mobile measuring device, or 2) the ability to be measured using low-cost (less than approximately $10k) commercially available mobile equipment. If needed, the post-processing of the data to convert measurements to the electrical properties should be limited to that which could be implemented in a spreadsheet or be conducted by a workforce with skills similar to that of an American Concrete Institute (ACI) certified field technician. The solution should be able to determine the electrical properties of a known reference solution within 5% or less, and shall be able to determine the electrical properties of the pore solution in a partially saturated concrete within 15% compared to the pore solution when expressed from companion test specimens. Specific stakeholders that could be involved in the evaluation and testing phase include the FHWA Office of Infrastructure R&D, one or more progressive SHA, and academic institutions that are interested in implementing this technology.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that describes the evaluation of materials proposed for the sensor, the market availability and costs of those materials, the proposed prototype(s), including information on measurement techniques and procedures. The report should include an estimated timeline for the prototype(s) production, evaluation, and accuracy verification. The Phase I report should discuss critical opportunities and obstacles to implementation, and a tentative plan for verification and demonstration to be conducted in Phase II.

[7] https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020

Expected Phase II Outcomes and Deliverables

Phase II will include the development and demonstration of a market-ready prototype for user testing and possible commercialization. Phase II shall perform further refinement of the concept, design, and fabrication of the prototype(s); and conduct analytical and experimental verification. The experimental verification will include verification with a wide range of equipment (e.g., scientific equipment and low-cost alternatives that an owner agency might purchase for field use) to increase the likelihood of effective implementation. Another final outcome is the delivery of some number of final prototype sensors to FHWA for evaluation on shadow projects with owner agencies. Actual number may be determined or negotiated as part of Phase II process.

21-FH3: Accelerating Performance Testing Using the Asphalt Mixture Performance Tester (AMPT) Equipment

The asphalt pavements community is moving rapidly towards mixture design and construction acceptance specifications which use laboratory performance tests to measure various properties that relate to field performance. The Asphalt Mixture Performance Tester (AMPT) equipment previously developed for pavement structural analysis is performance test equipment now capable of analyzing materials during mix design. The current laboratory performance tests are well-suited for mixture design verification applications, where testing time is manageable because asphalt construction has not started. However, further implementation can be experienced if the tests can expedite the performance testing and Balanced Mixture Design (BMD) concepts.

FHWA is soliciting proposals to develop methods of rapidly securing test specimens without epoxy (or other glue) and with contactless deformation measuring sensors for use in performance tests, such as the AMPT Cyclic Fatigue Test (standardized as AASHTO TP 107 & TP 133) for both full-size (100 mm diameter x 130 mm height) and small-size (38 mm diameter x 110 mm height) test specimens and the Texas Overlay Test (standardized as Texas DOT Tex-248-F). This could be accomplished by developing; 1) a standalone rugged and repeatedly used field test equipment based on AMPT requirements or; 2) developing reasonably priced fixtures and measurement technologies, or other innovative methods, for the existing AMPT equipment to help accelerate methods which require epoxy (or other glue) and mounted deformation measurement systems. These advancements are needed to minimize specimen preparation and instrumentation time, such as attaching end plates and re-equilibrating temperature due to attachment of deformation sensors. Proposers may also include other innovations to accelerate testing time. An expedited test specimen preparation and instrumentation procedure will be useful to measure performance-related properties to assess impacts of volumetric variability, assess mixture quality, and long-term performance. Successful development of these technologies could apply to a wide range of performance tests used for research and mix design applications.

The proposal would support FHWA's AMRP[8] by developing and enhancing tests and processes related to performance and innovation initiatives for asphalt pavements. This project will also contribute to the Department's strategic objective of improving the performance of the Nation's infrastructure through research and accelerating development and deployment of innovative technologies and practices by the continued refinement of techniques to accurately assess the performance of asphalt pavements.

The opportunity for commercialization in the U.S. is high. There are many agencies that started the transition to performance-driven testing and evaluation of their asphalt mixtures, and this solution would be a simple way to implement AASHTO standardized tests, cracking performance evaluations, and help improve long term pavement performance. In the future, an effective solution could make its way into other markets such as airfield/airport markets, ports or trucking distribution markets, other commercial construction markets, or international markets where asphalt pavement performance is deemed critical to project success, facility operations, and economic viability.

Specific stakeholders that could be involved in the evaluation and testing phase include the FHWA, one or more State Highway Agencies (SHA), and academic institutions that are interested in implementing this technology, testing, and evaluation.

For further information on past research related to this topic, please see the following technical resources:

- https://www.fhwa.dot.gov/pavement/asphalt/tester.cfm
- Cyclic Fatigue Index Parameter (S_{app}) for Asphalt Performance Engineered Mixture Design, FHWA-HIF-091, 2019[9]
- Equipment Specification for the Simple Performance Test System, Version 3.0, Prepared for National Cooperative Highway Research Program (NCHRP), October 16, 2007. Appendix E of NCHRP Report 629 (PDF, 6.20 MB) from Project 9-29[10] contains detailed equipment specifications for the AMPT and improvements for tension testing capabilities
- AASHTO R 83 Standard Practice for Preparation of Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC)
- AASHTO PP 99 Standard Practice for Preparation of Small Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC) or Field Cores; and improvements resulting from FHWA contract DTFH6117C00037[11]
- AASHTO TP 107 Standard Method of Test for Determining the Damage Characteristic

[8] https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/federal-highway-administration-2020
[9] https://www.fhwa.dot.gov/pavement/asphalt/analysis/
[10] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=963
[11] https://drive.google.com/file/d/1R1k5bATsw0lNV-DaS-COuwRbhdeg_pgZ/view

Curve and Failure Criterion Using the Asphalt Mixture Performance Tester (AMPT) Cyclic Fatigue Test; and improvements resulting from FHWA contract DTFH6117C00037[12]

- AASHTO TP 133 Standard Method of Test for Determining the Damage Characteristic Curve and Failure Criterion Using Small Specimens in the Asphalt Mixture Performance Tester (AMPT) Cyclic Fatigue Test

Additionally, FHWA has published four videos on our YouTube channel (which include the fabrication and AASHTO test standards performance testing; Stress Sweep Rutting and Cyclic Fatigue).

The videos are based on AASHTO standards:

- PP 99 - Preparation of Small Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor (SGC) or Field Cores
- TP 132 - Determining the Dynamic Modulus for Asphalt Mixtures Using Small Specimens in the Asphalt Mixture Performance Tester (AMPT)
- TP 133 - Determining the Damage Characteristic Curve and Failure Criterion Using Small Specimens in the Asphalt Mixture Performance Tester (AMPT) Cyclic Fatigue Test
- TP 134 - Stress Sweep Rutting (SSR) Test Using Asphalt Mixture Performance Tester (AMPT)

Video 1: Fabrication of Small and Large Specimens
https://youtu.be/raDoPi1jcag

Video 2: Dynamic Modulus Small Specimen Test
https://youtu.be/ZlCHD3Mf1z4

Video 3: Cyclic Fatigue Small Scale Specimen Test
https://youtu.be/MKN1ihZkWr0

Video 4: Stress Sweep Rutting Test
https://youtu.be/bUChELQ28c0

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that describes the development of the proposed solution; provides preliminary technical drawings, component parts, and proposed prototype(s); and discusses how to achieve the most effective

[12] https://drive.google.com/file/d/1R1k5bATsw0lNV-DaS-COuwRbhdeg_pgZ/view

implementation into standards and agency specifications. The report should include:

- An estimated timeline for the prototype(s) production, evaluation, and accuracy verification;
- A description of how test results using the proposed approach compare to current practice; and
- A tentative plan for verification and demonstration to be conducted in Phase II.

Phase I would include fixtures or other innovative methods to accelerate specimen preparation and instrumentation and/or a standalone device capable of executing test methods which currently use epoxy (or other glue) and mounted deformation measurement systems, conducting the tests, and recording deformations and responses. Part of demonstrating a successful proof-of-concept includes documenting how test results using the Phase I approach compare to current practice.

Expected Phase II Outcomes and Deliverables

Phase II will include the development and demonstration of a market-ready prototype for user testing and possible commercialization. Phase II shall perform further refinement of the concept, design, and fabrication of the prototype(s); and conduct analytical and experimental verification. Phase II efforts include fully developing and demonstrating a finalized fixture(s) and/or standalone device capable of executing test methods which currently use epoxy (or other glue) and mounted deformation measurement systems. This includes manufacturing, ruggedness and round-robin testing of the fixture(s) and standalone cyclic fatigue performance tester. Phase II will also seek at least 3 final prototypes, or as negotiated, to FHWA for evaluation on shadow projects with owner agencies.

21-FH4: Reference Hardware for Infrastructure GPS Abnormality Detector for Connected and Automated Vehicle Applications

As Connected and Automated Vehicle (CV/AV) technology continues to advance, there is a growing need to ensure accuracy in location, particularly when approaching intersections and other safety critical junctions. This is highly dependent on GPS accuracy. Any temporary issues or inaccuracies in the GPS can pose a huge safety risk. This project would develop the reference hardware for a low cost, robust receiver that can detect abnormality in GPS signal. This can be used to provide advanced warning of localized GPS issues to warn AVs in advance, or to provide a “no service” warning to CV drivers.

The hardware is intended for static installation on roadside infrastructures and must be able to monitor and detect errors in high precision GPS signal across one or more frequencies (such as L1 and L5) or GNSS location data generated from other combinations of multiple terrestrial and

space based signals[13,14]. This hardware would also use other signals or information to validate GPS availability and could include other ground-based signals or information to validate GPS status. The intended buyer would likely be State and local DOTs, while the users will be those that implement CV and AV applications that need GPS information to function.

The ability to monitor GPS constellation signal is critical, the proposer should not see this as a limiting consideration. We welcome solutions that can also monitor performance of other constellations.

Expected Phase I Outcomes

The Phase I proof of concept report should:

- Provide hardware proof of concept for GPS abnormality detector.
- Establish operational and design targets that consider cost of deployment, lifecycle cost, and ease of use and integration.
- Develop a hardware development plan for continuous testing and design refinement to meet project targets established at beginning of Phase 1.

Expected Phase II Outcomes and Deliverables

Phase II outcomes typically include further demonstration or validation of design/concept and/or prototype development. Deliverables may include prototype iterations, software capabilities, or test results. Deliverables are typically documented in reports and not physically delivered to the Government.

[13] https://www.gps.gov/technical/icwg/ (Interface Control Documents). ICD for L5 includes IS-GPS-705 and others as appropriate.
[14] https://www.gps.gov/technical/ps/ (Performance Standards and Specifications). Most recent version is 5th edition published on April 2020.

B. Federal Motor Carrier Safety Administration (FMCSA)

About us: The mission of FMCSA's Office of Analysis, Research, and Technology is to reduce the number and severity of commercial motor vehicle (CMV) crashes and enhance the efficiency of CMV operation by: 1) providing data, producing statistics, and conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding, and 2) identifying, testing, and supporting technology transfer activities and deployment of CMV safety technologies.

21-FM1: Automated Vehicles: Deployment of Traffic Warning Devices (Triangles)

A key strategic objective of the Federal Motor Carrier Safety Administration (FMCSA) is to prevent commercial motor vehicle (CMV) related fatalities and injuries. CMV safety is reflected in the current Federal regulation for drivers of commercial motor vehicles to place warning devices (reflective triangles, flares, other) around their vehicle in the event that the CMV is stopped upon the travel portion of the shoulder of a highway. The driver must place the warning devices as soon as possible, but in any event within 10 minutes. Title 49 USC 392.22(b)[15] calls for the driver of the CMV to place the warning devices in the following manner:

(i) One on the traffic side of and 4 paces (approximately 3 meters or 10 feet) from the stopped commercial motor vehicle in the direction of approaching traffic;

(ii) One at 40 paces (approximately 30 meters or 100 feet) from the stopped commercial motor vehicle in the center of the traffic lane or shoulder occupied by the commercial motor vehicle and in the direction of approaching traffic; and

(iii) One at 40 paces (approximately 30 meters or 100 feet) from the stopped commercial motor vehicle in the center of the traffic lane or shoulder occupied by the commercial motor vehicle and in the direction away from approaching traffic.

There are special rules regarding placement of warning devices if the vehicle is stopped within 500 feet of a curve, crest of a hill, or other obstruction, as well as special rules regarding placement on divided or one-way roads. Section 393.95(f)[16] defines warning devices for stopped vehicles as one of the following options: "(1) Three bidirectional emergency reflective triangles that conform to the requirements of Federal Motor Vehicle Safety Standard No. 125, §571.125 of this title; or (2) At least 6 fusees or 3 liquid-burning flares. The vehicle must have as many additional fusees or liquid-burning flares as are necessary to satisfy the requirements of §392.22. (3) Other warning devices may be used in addition to, but not in lieu of, the required warning devices, provided those warning devices do not decrease the effectiveness of the required warning devices."

[15] https://www.ecfr.gov/cgi-bin/text-idx?SID=6be86f66c4096ac034b4e1c9028c7585&mc=true&node=pt49.5.392&rgn=div5#se49.5.392_122

[16] https://www.ecfr.gov/cgi-bin/text-idx?SID=6511386912deb05af1f8ac8f6b8c119a&mc=true&node=pt49.5.393&rgn=div5#se49.5.393_195

FMCSA's Annual Modal Research Plan (AMRP)[17] highlights the need to evaluate the safety implications of automated and semi-automated vehicles prior to deployment of these technologies. During initial research into automated vehicle technologies, it has become apparent that there is a need for innovative solutions as to how automated vehicles without a driver present would be able to comply with Title 49 USC 392.22(b).

This topic seeks to inform the feasibility of various methods for automatically deploying the required warning devices in the event that an automated CMV must stop upon the traveled portion or the shoulder of a highway for reasons other than necessary traffic stops. The solution should have the capability to reliably and accurately deploy traffic warning devices without requiring the presence of a human driver with the vehicle and must deploy the traffic warning devices in such a way as to comply with Title 49 USC 392. The system should be cost-effective and technology neutral towards the automated CMV it would be deployed on. Additionally, the solution should follow best practices in mitigating potential IT securities and vulnerabilities. The potential buyers of this system include drivers, owner-operators, and motor carriers. Potential buyers also include original equipment manufacturers (OEMs) of automated vehicles who may choose to include this technology with the vehicle. The end user would ultimately be a carrier or owner-operator of automated commercial vehicles where Title 49 USC 392.22(b) requirements will be encountered.

Expected Phase I Outcomes

The Phase I SBIR project outcome is a proof-of-concept report that describes the intended development of an automated deployment mechanism for traffic warning devices on commercial automated vehicles. The awardee should consider working with automated commercial vehicle developers to determine constraints and feasibility of the proposed approach. Additionally, the awardee shall also work closely with FMCSA staff to determine the feasibility of complying with current federal regulations regarding proper placement of traffic warning devices. The awardee shall produce a sample of the system to demonstrate the recommended approach, along with functional requirements regarding the sample's reliability, accuracy, expected cost, and considerations regarding cybersecurity or other potential IT vulnerabilities. . The report should also include potential benefits of the system and potential limitations to deployment of the system.

Expected Phase II Outcomes and Deliverables

The Phase II SBIR project will produce a prototype and test it in a limited operational setting. The system must be capable of reliably and accurately deploying and retracting traffic warning devices on an automated vehicle without the interaction of a human driver in various operational design domains (ODDs), including adverse weather or other unexpected situations when an automated vehicle may be required to cease operating. The system must be capable of

[17] https://www.transportation.gov/sites/dot.gov/files/2020-11/FMCSA%20AMRP%20FY2020%20Enacted.pdf

determining the correct placement of the warning devices in order to comply with Section 392.22 of Title 49. The system must be secure from cybersecurity or other potential software attacks or IT vulnerabilities which could impact the effectiveness or safety of the system. The awardee is expected to have a commercialization plan developed for the technology solution, as well as a final report documenting the results of the test event(s) and any system limitations or known vulnerabilities.

21-FM2: Readiness Assessment Technology

NHTSA estimates that in 2017, 91,000 police-reported crashes involved drowsy drivers. These crashes led to an estimated 50,000 people injured and nearly 800 deaths. However, there is broad agreement across the traffic safety, sleep science, and public health communities that this is an underestimate of the impact of drowsy driving. (NHTSA Traffic Safety Facts, Drowsy Driving, October 2017[18]). Drowsy driving's impact is even more pronounced among commercial vehicle drivers. Commercial vehicle drivers face many challenges that can increase fatigue including increased driving hours per day, nighttime driving, and health-related issues such as untreated obstructive sleep apnea.

An objective quantifiable measure, which can serve as a Readiness Assessment Technology, is needed to assess a driver's alertness before driving a commercial motor vehicle (CMV). Such a measure could be used to identify and mitigate driver fatigue. This project directly supports the Federal Motor Carrier Safety Administration's (FMCSA) strategic objective to produce safer commercial drivers, carriers, and vehicles described in FMCSA's Annual Modal Research Plan (AMRP)[19]. Additionally, the Readiness Assessment Technology developed through this process could potentially be useful to other Department of Transportation agencies. The technology could be applied to other modes as well as non-commercial drivers to address operator alertness.

The success of the Readiness Assessment Technology will rely on the product's ability to produce reliable, accurate and timely results when measuring driver readiness. Production of the end product must also be technically feasible and cost effective to produce. Additionally, the technology must comply with important security requirements such as confidentiality, integrity, privacy and security. Once successfully developed, the Readiness Assessment Technology will be marketable to prospective buyers such as CMV drivers and carriers who are challenged by drowsy driving and are interested in increasing driver safety. Overall, the results of this project will have strong potential to contribute to the overall reduction of crashes due to commercial drivers' alertness, thus furthering the strategic objectives set out in the FMCSA's 2020 AMRP.

[18] https://www.nhtsa.gov/risky-driving/drowsy-driving#:~:text=NHTSA%20estimates%20that%20in%202017,injured%20and%20nearly%20800%20deaths
[19] https://www.transportation.gov/sites/dot.gov/files/2020-11/FMCSA%20AMRP%20FY2020%20Enacted.pdf

Expected Phase I Outcomes

At the end of Phase I, the awardee will have successfully completed a thorough investigation of the product requirements with input from potential end users of the system. The proof of concept report should describe how the product will be designed and how it will be used in an operational environment. The awardee will also describe the results of any market research for the potential commercialization of the product and identify potential customers. The proof of concept report should seek to describe how the product can be developed in an accurate, timely, and secure manner.

Expected Phase II Outcomes and Deliverables

Phase II efforts will develop and test the prototype to ensure reliability, accuracy, and timeliness of the product while use in operations. At the end of Phase II, the awardee will have developed a system that can be tested in an operational environment with drivers and carriers. The awardee will recruit drivers and carriers for this testing phase. The intended goal is to begin commercialization of the product.

C. Federal Railroad Administration (FRA)

About Us: FRA's research, development, and technology (RD&T) mission is to ensure the safe, efficient, and reliable movement of people and goods by rail through basic and applied research, and development of innovations and solutions. Safety is U.S. DOT's primary strategic goal and thus, the principal driver of FRA's RD&T program. FRA's RD&T program also contributes to other U.S. DOT strategic goals because safety-focused projects typically yield solutions toward state of good repair, economic competitiveness, and environmental sustainability goals. The RD&T program also has an important role to play in workforce development.

FRA's RD&T program is founded on an understanding of safety risks in the industry. Hazard identification and risk analysis allows us to identify opportunities to reduce the likelihood of accidents and incidents, and to limit the consequences of hazardous events should they occur. Key strategies include stakeholder engagement and partnerships with other researchers such as the Association of American Railroads, prioritization of projects, and conducting research through cost-effective procurement.

21-FR1: Passenger Train Exterior Side Door Safety

The Federal Railroad Administration (FRA) is seeking a technological solution to improve passenger train exterior side door safety. The proposed research will improve passenger safety by developing technology that can determine whether the exterior doors of a passenger train are closed and communicate this information to the train operator. The system should be capable of performing the following:

- Detecting a door that is opened by 3/8"
- Classifying "gaps" of 3/8" as an open door
- Identifying open doors on both sliding and swinging exterior side doors

One example of an approach to this problem (although not the only solution this topic is seeking) could include an appropriate camera mounted to the locomotive side view mirror which could monitor the status of manual or power doors to determine whether doors closed or were prevented from closing. The technological solution envisioned should be most applicable to passenger equipment not already equipped with advanced door safety systems (that is, railroads that operate older (legacy) equipment that does not employ a door safety system). Additionally, the research should include an assessment to determine the extent to which this technology can be applied to other transportation modes.

Interested proposers are invited to familiarize themselves with following reference documents on passenger train exterior side door safety for more information:

- FRA Final Rule on Passenger Train Exterior Side Door Safety: https://www.federalregister.gov/documents/2015/12/07/2015-30488/passenger-train-exterior-side-door-safety

- Federal regulation §238.131 - Exterior side door safety systems—new passenger cars and locomotives used in passenger service: https://www.ecfr.gov/cgi-bin/text-idx?SID=38f57bf84ee49d55bd6d556cea7dc8a0&mc=true&node=pt49.4.238&rgn=div5#se49.4.238_1131
- APTA standard PR–M–S–18–10, Standard for Powered Exterior Side Door System Design for New Passenger Cars: https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-PR-M-S-018-10.pdf

Expected Phase I Outcomes

Through the Phase I proof-of-concept report, Phase I will seek to demonstrate how the features of the proposed advanced door safety system will be addressed in the prototype. The proposed technology and means of application will be determined, developed and demonstrated using a mock-up passenger car doorway consisting of both sliding and swing-type exterior side doors. The prototype system will be assessed in terms of door-open detection accuracy. For the purposes of this demonstration, FRA will assist successful proposers by identifying a passenger railroad operator(s) with legacy rolling stock with door systems described above to permit familiarization with the car arrangement.

Expected Phase II Outcomes and Deliverables

Phase II outcomes will include the development of a market-ready prototype (developed during Phase I) suitable for successful demonstration of its capabilities on a representative passenger train (or trains) and possible commercialization.

The prototype technology and means of application will be demonstrated using a mock-up train consisting of four passenger cars whose doors will be randomly prevented from closing when so commanded. The prototype system will be assessed in terms of door-open detection accuracy. The mock-up train consists will be comprised of both sliding and swing-type exterior side doors. For the purposes of this demonstration, FRA will provide assistance by identifying a passenger railroad operator(s) with legacy rolling stock with door systems described above to permit familiarization with the car arrangement and to identify any existing physical constraints which might impede operation of the prototype.

The relationships developed during Phase I will be leveraged to facilitate these demonstrations. The research team will also develop a final report which will document all Phase II activities including the results of the demonstration test(s).

21-FR2: Wheel Measuring Device

Federal regulations and industry standards impose requirements on railroad wheel geometry to improve safety and avoid derailments. In order to ensure compliance with these requirements, railroads periodically take certain measurements to determine whether wheels and wheelsets remain fit for service. These measurements include:

- Wheel Diameter
- Wheel back-to-back spacing (the distance between the back-face of wheels on an axle)
- Wheel profile (the shape of the portion of the wheel that contacts the rail from back face to field side rim)
- Out of roundness (deviations from uniform wheel diameter)
- Length and width of wheel defects (e.g., flat spots)

Other attributes are derived from these measurements, such as wheel flange angle (see APTA PR-M-S-015-06, Rev. 1, Wheel Flange Angle for Passenger Equipment[20]).

Current manually operated devices used to measure wheel profiles have limited functionality with respect to the above list of measurements and can be subject to operator error. Improved techniques for measuring railroad wheel geometry will contribute to the overall improvement of railway safety.

FRA seeks development of a portable wheel geometry measuring device that can be used in the shop and the field by a single operator. The device should be able to capture the relevant measurements listed above, and should meet the following technical requirements:

- The device must be lightweight, handheld, fit in tight spaces, and easy to use by a single operator.
- Measurements are produced quickly (including taking and displaying measurements and set up and dismantling of the device), accurate to within 0.0005 inches, and repeatable to within 0.0001 inches.
- The device is able to operate in a wide range of temperatures and lighting conditions, while also being capable of functioning without external power for a minimum of two hours.
- Measurement data must be able to be identified and stored, and included software must allow for the export of data into American Standard Code for Information Interchange (ASCII) format.
- The device must be capable of performing calculations with the measurement data to derive non-measured features such as wheel flange angle, calculated in accordance with the APTA Standard referenced above.
- Production cost must be low and use off the shelf technology to the extent possible.

[20] https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-PR-M-S-015-06.pdf

Expected Phase I Outcomes

This Phase I project will seek to produce a detailed proof-of-concept that demonstrates how the attributes listed above will be addressed in a prototype wheel-measuring device. The final Phase I report will contain a description of the proof-of-concept, identify any impediments to actual prototype development and describe the potential commercialization path forward.

Expected Phase II Outcomes and Deliverables

Phase II outcomes will include the development of a near-market-ready prototype for user testing and possible commercialization. Partnerships with a railroad operator(s) during Phase II prototype development is strongly encouraged to help the research team better understand the needs of the end-users. In addition to delivering a near-market ready prototype, the research team will draft a comprehensive Phase II report that will capture the details of the design, development and testing of the prototype.

D. Federal Transit Administration (FTA)

About us: The Federal Transit Administration's (FTA) mission is to improve public transportation in America's communities. In support of this mission, FTA's research vision is to advance public transportation by accelerating innovation that improves mobility, enhances transit operations, and ensures safety for all. The goal of FTA's SBIR program is to help small businesses grow by funding product development research in strategic areas such as safety, infrastructure, mobility, and other topics important to transit. The program helps invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

21-FT1: Robots for Unmanned Disinfection and Decontamination of Transit Assets

The current COVID-19 pandemic has presented many challenges to the safety of transit riders and operators. Along with social distancing and wearing mask, a need for safe and efficient methods and processes for disinfection and decontaminant of transit assets including buses, trains and transit facilities has emerged. Autonomous robots and unmanned systems have been used for a variety of emergency response operations in other industries in recent times. These robots have the potential to find use in the transit industry to reduce risk of exposure to transit riders and operators and is especially relevant in the context of the COVID-19 pandemic.

The proposed research explores the use of robots for disinfection and decontamination of transit assets including buses, trains, transit facilities, etc.

The main objectives of this research in Phase I is to conduct a feasibility-study of the potential solutions to develop, prototype and test robot(s) to disinfect and decontaminate transit assets including assessing the use of spray or light technologies in such applications and methods.

Phase II outcomes will include the development of a market-ready prototype that can be deployed in a variety of disinfection and decontamination operations and are capable of working autonomously and collaboratively.

This proposed project aligns with the DOT Innovation strategic goal: "Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System."

Expected Phase I Outcomes

Outcomes expected from Phase I include development of a concept of operations and a set of detailed requirements for a fully autonomous robot(s) that performs disinfection and decontamination operations in automatic mode while monitoring the level of the sprayed/light solutions, coverage area, and battery charge including return to station for refills or battery recharge. The awardee is expected to work with a transit agency to refine a concept of operations and a set of detailed requirements, develop use case and scenarios, and create performance criteria.

Expected Phase II Outcomes and Deliverables

Phase II outcomes will include the development of a market-ready prototype for testing that:

- Is convenient and efficient for scheduling disinfection tasks, monitoring the progress of disinfection, and planning/mapping a set of application/maintenance over a period of time);
- Can operate independently or in a team based on an assigned map and tasks for small or large operations;
- Can be demonstrated at a transit agency; and
- Can collect the necessary data to validate the technology based on the performance criteria set under Phase I.

21-FT2: Using Artificial Intelligence (AI) to Inspect, Repair and Sanitize Transit Vehicles

The preferred method of keeping transit vehicles in working order has been schedule-based. In many cases, transit vehicle maintenance (bus and rail) are performed at regular schedule intervals based on unit mileage. Meanwhile, there has been an incredible amount of new sensor technologies, artificial intelligence (AI), and machine learning innovations in the last 10 years. With these combined, many industries have been moving toward condition-based maintenance by leveraging new sensors, machine learning algorithms, and AI to analyze the data stream.

The inspection, repair and sanitation of a transit agency's vehicle fleet could use these innovations to improve the efficiency and effectiveness of their operations, especially as proper fleet cleaning and sanitation becomes even more critical due to the COVID-19 pandemic.

The successful offeror should provide a detailed description of the following:

- Technology proposed;
- How the technology will be applied;
- What type of issue(s) the technology is trying to solve (inspection, repair or sanitation);
- What data can be supplied to provide a level of confidence that this approach will work;
- Feasibility of the technology; and
- An approach in solving the problem or improving the maintenance of transit vehicles.

Expected Phase I Outcomes

The proof-of-concept report should describe how the prototype would be designed and evaluated to determine its effectiveness in improving in improving transit vehicle inspection, maintenance or cleaning and sanitation of transit vehicles. It is expected that the awardee will work with a transit agency to refine the proof-of-concept.

Expected Phase II Outcomes and Deliverables

Phase II is focused on the development of a market-ready prototype for testing at a transit agency, with the collection of all necessary data to validate the technology based on the performance criteria set under Phase I.

E. National Highway Traffic Safety Administration (NHTSA)

About Us: NHTSA research efforts are primarily comprised of programs within the Office of Vehicle Safety Research (VSR) and Office of Behavioral Research and support U.S. DOT's and NHTSA's safety goals by conducting research and safety testing of motor vehicles and motor vehicle equipment as well as research supporting behavioral countermeasures to reduce the occurrence of traffic crashes. VSR performs testing and research related to vehicle electronics and emerging technologies, advanced driver assistance systems for crash avoidance, human factors, and crashworthiness/human injury research. The Office of Behavioral Safety Research directly supports the Department and Agency goals of reducing traffic crashes, fatalities, and injuries by providing the scientific basis for the development of effective behavioral countermeasures to reduce the occurrence of traffic crashes.

21-NH1: Securing Safe Passage when Crossing a Roadway to Board Buses

One of the greatest threats to school children arriving safely to school or home is not riding a bus, but boarding or disembarking a bus safely. There is an alarming amount of stop-arm violations where a vehicle illegally passes a school bus with their stop arm engaged. On a single day in 2019, 130,963 school bus drivers reported that 95,319 vehicles passed their busses illegally (National Association of State Directors of Pupil Transportation Services, 2019). The number of violations is likely far greater, since not all school bus drivers participated in this voluntary survey. These numbers indicate that more than 17 million stop-arm violations occur a year, putting children in significant danger every day. With the number of stop-arm violations increasing, and several recent fatalities, preventing deaths and injuries resulting from these violations has become a priority for NHTSA. After investigation of a recent fatal crash by the National Transportation Safety Board, they recommended a greater use of technologies to prevent these tragic events, including vehicle-to-everything (V2X) and school bus safety enhancements, since there will continue to be some routes where students must cross a roadway (NTSB, 2020). In addition, most of these fatalities have occurred while it was dark, in unlit areas suggesting that visibility is an issue.

We are seeking either vehicle-to-everything (V2X) technologies to alert oncoming vehicles of children in the roadway or school bus safety-enhancing technologies to illuminate children in the roadway, particularly when visibility is limited due to low light conditions. V2X is communication between a vehicle and any entity it may interact with, typically using cellular networks. In the case of V2X, the technology for this proposal must automatically alert oncoming drivers when children are in the roadway without input from the bus driver. Technologies based upon school bus safety enhancements to illuminate children need to be capable of being operated by school bus drivers and must meet the Federal Motor Vehicle Safety Standards for school buses. Commercialization potential includes buyers like school districts, individual schools, and private transportation school contractors. Possible applications to other markets include other bus types such as city buses, tour buses, and others. As such, the technology may be of interest to the Federal Transit Administration and the Federal Motor Carrier Safety Administration.

Expected Phase I Outcomes

Phase I should result in a proof-of-concept report that describes the specific technological approach selected and include a testing plan to determine how well the device works in alerting oncoming drivers to a child in the roadway. At a minimum, the testing plan should evaluate the device's sensitivity, validity, and reliability. For V2X technologies, the testing plan must include determining how quickly a vehicle detects and alerts a driver to a child's presence and whether it does so in a consistent manner. For school bus safety-enhancing technologies, the testing plan must include determining the distance at which an oncoming driver can consistently see an ongoing crossing. The paper should also discuss the feasibility of use by school bus drivers and describe mounting to school buses if applicable.

Expected Phase II Outcomes and Deliverables

Conditional on the outcomes of Phase I, Phase II will produce a working prototype. This device will be tested using the testing plan developed in Phase I for determining how well the device works in alerting oncoming drivers to a child in the roadway. The working prototype will also be tested with school buses, including any required mounting or hardware. The device must be affordable for most school districts and, if applicable, feasible for a school bus driver to use with a reasonable amount of training. The expected outcome is a demonstration of the working prototype as well as a report that documents the testing results and contains a marketing plan.

References

National Association of State Directors of Pupil Transportation Services. 2019. *2019 Survey on Illegal Passing of School Buses –Summary Results.* https://nasdpts.org/resources/Documents/2019%20NASDPTS%20Illegal%20Passing%20Results%20Summary-7-24-19-v2-Updated%201-3-20%20to%20Include%20DC.pdf

National Transportation Safety Board (NTSB). 2020. *Vehicle Collision with Student Pedestrians Crossing High-Speed Roadway to Board School Bus, Rochester, Indiana, October 30, 2018.* Highway Accident Report NTSB/HAR-20/02. NTSB. https://www.doe.in.gov/sites/default/files/transportation/ntsb-full-final-report-rochester-fatalities-2018-april-2020.pdf

21-NH2: Ignition Interlock Device Data-Integrated Mobile Device App

Driving under the influence of alcohol is a serious problem, with alcohol-impaired drivers involved in 29% of all motor vehicle crash fatalities in 2017 (NHTSA, 2018)[21]. Recidivism is of particular concern, given that individuals with a history of alcohol-impaired driving violations are more likely than those without such a history to drive while intoxicated (DWI) in the future (Rauch et al., 2010)[22]. One effective sanction for reducing recidivism among DWI offenders is ignition interlock devices (IIDs)—devices installed in vehicles to prevent alcohol-impaired individuals from starting their vehicles. The effect of IIDs is further enhanced when offenders' IID performance is closely monitored and they are provided with frequent feedback. Unfortunately, this is often absent despite being a key factor in offenders' success on IIDs because of time-, cost-, or other logistical-constraints of the sanctioning agent/agency (Zador, Ahlin, Rauch, Howard & Duncan, 2011[23]).

To address this limitation, this SBIR project aims to provide a time- and cost-effective approach to close monitoring and frequent feedback by developing an IID data-integrated mobile device application (app) to be used in conjunction with IIDs. Mobile device apps have become a common, easily-accessible, and widely-used approach to help individuals monitor and change a range of health and safety behaviors (Burke et al., 2011[24]; Bricker et al., 2014[25]; Juarascio et al., 2015[26]; Hoeppner et al., 2017[27]). However, to date, no app has been designed specifically for IID-sanctioned DWI offenders, despite their high risk for recidivism and the availability of IID data offering critical insight into their drinking and driving patterns.

The goal of this IID data-integrated mobile device app is (1) to enhance the effectiveness of IIDs at reducing recidivism while the IID is on the vehicle and (2) to retain that benefit once the IID is removed from the vehicle. To achieve this, the app would need to be able to "communicate" seamlessly with IIDs to capture and monitor offenders' IID performance in real-time and analyze overall patterns. The app would then utilize a variety of evidence-based approaches to behavior modification, including: providing frequent, immediate, detailed and tailored feedback; highlighting desirable/undesirable behavior; identifying and increasing users' awareness of their patterns of behavior, particularly their high-risk days/times and; preemptively offering reminders and alternatives prior to high-risk days/times. In addition, this approach will also address logistical and financial barriers to close monitoring and frequent feedback (e.g., time- and cost-constraints) by shifting the burden of this enhanced level of monitoring and feedback away from the sanctioning agents/agencies.

[21] https://crashstats.nhtsa.dot.gov/#!/
[22] https://ajph.aphapublications.org/doi/pdfplus/10.2105/AJPH.2008.154575
[23] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3153731/
[24] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3268700/?referringRepId=225798
[25] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4201179/
[26] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4847127/
[27] https://www.sciencedirect.com/science/article/abs/pii/S0740547217301691

This innovative approach to providing evidenced-based close monitoring and frequent feedback of DWI offenders' IID performance fits in with NHTSA modal priorities on impaired driving. Further, it would benefit all DOT modes involved with, or concerned about, surface transportation safety, including the National Highway Traffic Safety Administration (NHTSA), Federal Motor Carrier Safety Administration (FMSCA), and Federal Highway Administration (FHWA). In addition, other interested agencies/entities may include the Association of Ignition Interlock Program Administrators (AIIPA), State Highway Safety Offices (SHSOs), State and local law enforcement agencies, and technology companies whose mobile operating systems would potentially be compatible with this new app.

Expected Phase I Outcomes

A Phase I outcome would be a proof-of-concept report that describes the proposed prototype, including:

1. How it will enhance IIDs by providing closer monitoring and feedback to IID users about their IID performance in real-time;
2. How it will incorporate evidence-based interactive and personalized/tailored features to support short- and long-term behavior change;
3. Document approaches and provide recommendations regarding IID/app interoperability; and
4. Document any potential challenges and mitigation strategies regarding users/stakeholders, including: IID users (e.g., acceptance, use of app, data privacy concerns), legal issues, IID sanctioning agents/agencies (e.g., parole officers, State Dept. of Motor Vehicles), and technology companies/operating system companies.

The report shall also outline a plan for the development and demonstration of the app, particularly the app's "communication" with the IID, and its interactive and personalized features. Further, a Phase I outcome would include a mock-up of the app.

Expected Phase II Outcomes and Deliverables

The Phase II outcome will include the development of a market-ready prototype for user testing and possible commercialization. The final product should be able to "communicate" with an IID by receiving and storing IID data in real-time; be personalized; be interactive and; incorporate evidence-based features that support short- and long-term behavior change (e.g., identify users' patterns, provide feedback about performance and patterns; provide tailored messages based on performance (congratulatory/praise, reminders, alternative options), utilize a motivational-interviewing tone and goal-setting approach).

F. Pipeline and Hazardous Materials Safety Administration (PHMSA)

About Us: The Pipeline and Hazardous Materials Safety Administration (PHMSA) operates in a dynamic and challenging environment where advances in technology, manufacturing, and energy production impact transportation safety. PHMSA's mission is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives.

PHMSA's Office of Hazardous Material Safety regulates the transportation of hazardous materials by air, rail, highway, and water. Over 1.3 million hazardous material products are transported daily over the various transportation modes. Because of the ubiquity of hazardous material movements, supporting the safe transport of these products will have a positive impact on safety and performance. The Office of Hazardous Material Safety seeks to improve the safety and reliability of hazardous material transportation through topic PH1.

21-PH1: Lithium Ion Battery Packaging

Lithium ion battery (LiB) failures pose potentially serious hazards for the transportation industry. As the volume of LiB powered devices increases, so too have the number of incidents. Thermal runaway events can produce significant smoke, fires and explosions. In 2010, a LiB fire in the cargo hold of a Boeing 747 operated by UPS crashed in Dubai 22 minutes after take-off. It is suspected that thermal runaway of LiBs in the cargo hold led to a fire that generated substantial smoke in the cockpit, causing the pilots to crash (UAE General Civil Aviation Authority Case Reference: 13/2010). The surface of LiB cells can approach 1000°C during thermal runaway, which is more than sufficient to ignite flammable packaging materials on contact and propagate thermal runaway amongst the other batteries in close proximity. Consequently, there is a need for improved LiB packaging that can prevent and mitigate LiB fires during transport.

For this topic, PHMSA is looking for the offeror to design a novel packaging design that can minimally contain but preferably extinguish thermal runaway in LiBs. PHMSA is seeking efficient and cost-effective extinguishing agent(s) and packaging design(s) for battery fires. PHMSA is interested in a packaging technique that is optimally designed for the physical size and electrical energy capacity of the battery to prevent its propagation among an array after a single battery proceeds into thermal runaway. The packaging solution shall prevent and mitigate thermal runaway. The hazard solution shall be for a specific LiB form-factor that must be delineated in the proposal.

The commercialization potential of this proposal is high. Hundreds of millions of LiBs are manufactured and shipped every year. Potential customers for this new packaging/mitigation technology include the shipping and battery industry, amongst others. This topic will benefit all modes of transportation, particularly the air and highway modes.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of concept report that describes the proposed prototype that will be developed in Phase II. Desired deliverables for this technology would include research to demonstrate technical feasibility during Phase I and show a path toward Phase II full prototype development.

Expected Phase II Outcomes and Deliverables

During Phase II, the offeror should proceed to full-scale development of a packaging design. The new packaging must be tested in-house or by a contract lab using industry accepted testing techniques. Deliverables should include a report on the final packaging design and the results of package testing.