



U. S. Department
of Transportation

6913G620QSBIR1
FY 2020

Small Business Innovation Research (SBIR) Program

PHASE I PROGRAM SOLICITATION

NAICS CODE: 541715

Issue Date: February 6, 2020

Closing Date: March 9, 2020 5:00 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 6, 2020	Solicitation Open Date with amended topics
	Pre-solicitation Questions & Answers (Q&A) available on the U.S. DOT SBIR website
February 11, 2020	Pre-Offer Webinar (see below)
March 2, 2020	Administrative and Contract Pricing Worksheet (Appendix C) Questions Due (see Section I.D)
March 9, 2020	Solicitation Closing Date (See Section V)
On or about May 21, 2020	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 FY20 Phase I Solicitation as follows:

- Topic FA1, Nondestructive Evaluation (NDE) of Critical Nickel Turbine Engine Parts, has been withdrawn. No offers will be accepted on this topic.
- Topic FH2, Innovative Layered Composite Metal Deck System, has been updated with clarifications.
- Topic FR2, Artificial Intelligence (AI)-Aided Machine Vision for Grade Crossing Safety, has been updated with clarifications.

Pre-Offer Webinar

The Pre-Offer Webinar will be held on Tuesday, February 11, 2020 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 a new feature to the solicitation - 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=ee00587f412d6b407dff394bf1776d2eb>.

Upon receipt of your registration, you will receive information for connecting to the webinar. The webinar recording will be posted to the Solicitations section of the U.S. DOT SBIR Program website (<https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/solicitations>).

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Closing Date

Offers must be received through the U.S. DOT's automated proposal website, no later than **5:00 PM ET on Monday, March 9 2020**. The U.S. DOT's automated proposal website is located at: https://usg.valideval.com/teams/USDOTSBIR_FY20/signup.

PLEASE NOTE: The submission website will open for submission of offers on or about February 13, 2020. The website will not allow offers to be submitted until such time. Please check back on [our website](#) for updates.

Pitch Day

This year, the U.S. DOT has added a Pitch Day where offerors who submitted offers that receive the highest rating(s) for the respective research topics will have an opportunity to make an in-person (or virtual) oral presentation to the Government promoting its offer. Pitch Day is scheduled on or around May 21, 2020 to be held in Washington, D.C. 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

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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, Phase II and IIB 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 Phase I, Phase II and IIB, 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.

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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 2, 2020. Questions received after 5:00 PM ET on March 2, 2020 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.

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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 technical questions and answers, visit: <https://www.volpe.dot.gov/work-with-us/small-business-innovation-research/technical-and-administrative-questions-us-dot-sbir-20>.
- 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

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- 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.

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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

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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_FY20/signup.

PLEASE NOTE: The submission website will open for submission of offers on or about February 13, 2020. The website will not allow offers to be submitted until such time. Please check back on [our website](#) for updates.

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,

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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 three 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, Offer 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 a PDF and must contain the required supporting information described in the below table. This section does not count towards the 15 page limit for the technical section. There is no limit on the number of pages for Appendix C and its supporting data. SBCs **must** use the template provided by the U.S. DOT SBIR Program Office in order to be considered responsive.
3. **Offer File Names** – Offer file names for each of the three 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).
4. **Offer Submission Deadline** – Offers must be received no later than **5:00 PM ET on Monday, March 9, 2020** through the U.S. DOT’s automated proposal website at: https://usg.valideval.com/teams/USDOTSBIR_FY20/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

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submit their offers as early as possible.

- a. **PLEASE NOTE: The submission website will open for submission of offers on or about February 13, 2020. The website will not allow offers to be submitted until such time. Please check back on [our website](#) for updates.**

5. **Duplicate Offers** – Only one offer shall be submitted. 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.

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

Technical Section File (PDF)

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

<p><i>SBA Company Registry Confirmation (does not count toward the 15 page limit)</i></p> <p><i>Page 1 of PDF</i></p>	<p>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.</p>
<p><i>Technical Section (not to exceed 15 pages)</i></p>	<p>Submitted offers must include the following headings in bold (in cases where a section does not apply, please state “Not Applicable”):</p> <ol style="list-style-type: none"> 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

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>7. Facilities. Provide a detailed description of the availability and location of instrumentation and physical facilities proposed for Phase I.</p> <p>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.</p> <p>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.</p> <p>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:</p> <ul style="list-style-type: none">• The name and address of the agencies to which offers were submitted or from which awards were received;
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	<ul style="list-style-type: none"> • 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. <p>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.</p>
<p><i>Prior SBIR Phase II Awards (does not count toward the 15 page limit)</i></p>	<p>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.</p>

Appendices A and B File (PDF)

<p><i>Signature Page (Appendix A)</i></p>	<p>Complete the signature page in Appendix A.</p>
<p><i>Page 1 of PDF</i></p>	
<p><i>Project Summary (Appendix B)</i></p>	<p>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</p>

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<p><i>Page 2 of PDF</i></p>	<p>not contain classified or proprietary information.</p> <p>The Project Summary must include at a minimum:</p> <ol style="list-style-type: none"> 1. A technical abstract with a brief statement of the problem or opportunity, project objectives, and description of the effort. <ol style="list-style-type: none"> 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.
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Appendix C (Contract Pricing Worksheet) File (PDF)

<p><i>Appendix C is available on our website here in Microsoft Excel 2016 format.</i></p> <p><i>See a sample worksheet here.</i></p>	<p>A Phase I Contract Pricing Worksheet must be submitted in detail using the template provided in Appendix C. 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:</p> <ul style="list-style-type: none"> • 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. <p>Please fill out the spreadsheets as directed, then save the entire workbook as a PDF. To do this, click on the ‘Acrobat’ tab in the main ribbon of Excel, then choose “entire Workbook” from the Conversion Range option at the top of window. If you have any trouble accessing the Appendix C spreadsheet or saving it as a PDF please contact the U.S. DOT SBIR Program Office at 617-494-2051 between the hours of 9:00 AM and 5:00 PM ET any time during the open solicitation period and no later than March 2, 2020.</p>
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	Offers that exceed the Phase I Estimated Award Amount listed in Section VIII will not be considered for award.
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7. Specific Instructions for Pitch Deck

PITCH DECK (FOR INVITED OFFERORS ONLY)

Not part of the initial offer submission.

<i>Pitch Deck (not to exceed 15 slides)</i>	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.
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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 (TABAs).** 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 per year for Phase I awards. This amount is in addition to the award amount for Phase I awards.

The purpose of TABAs, as defined by the SBA Policy Directive, is to assist SBIR awardees in: (1) making better technical decisions on SBIR projects; (2) solving technical

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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 intends to have a Blanket Purchase Agreement (BPA) in place with a vendor that will be capable of providing TABA services to its SBIR awardees. It is anticipated the BPA will be in place prior to Phase I awards made from this solicitation. The vendor will 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 vendor and services available and guidance on how to obtain these services at no cost to the small business.

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. Proposed TABA vendors must be registered in the System for Award Management (SAM); see details in Section II.D below.

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

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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 factors 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 Pitch Day event on or around May 21, 2020 at U.S DOT Headquarters, 1200 New Jersey Ave SE, Washington, DC 20590. 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 strongly encouraged that invited offerors present their pitch in-person in Washington, DC, however, a virtual option will be made available for those that cannot. Funding for travel to Pitch Day will not be provided. Due to the security process for access to Government facilities, it is recommended that no more than three individuals come to 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

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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 written feedback regarding their offer, and will 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 twelve 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.

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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, IIB, 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

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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.

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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 and Phase IIB 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.transportation.gov/administrations/assistant-secretary-administration/transportation-acquisition-regulation-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

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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. **Equal Opportunity.** The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.
7. **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.
8. **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.
9. **Officials Not to Benefit.** No Government official must benefit personally from the SBIR funding agreement.
10. **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.
11. **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.
12. **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).

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13. **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 <http://www.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.
14. **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.
15. **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 2020 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

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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 **5:00 PM ET on Monday, March 9, 2020** through the U.S. DOT's automated proposal website at:

https://usg.valideval.com/teams/USDOTSBIR_FY20/signup.

PLEASE NOTE: The submission website will open for submission of offers on or about February 13, 2020. The website will not allow offers to be submitted until such time. Please check back on [our website](#) for updates.

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)

20-FH1: Physical Intervention System for Wrong-way Driving on Ramps

“Wrong-Way Driving.” *Intersection Safety*, FHWA Office of Safety, 26 June 2019, https://safety.fhwa.dot.gov/intersection/other_topics/wwd/.

20-FH2: Innovative Layered Composite Metal Deck System

AASHTO LRFD Bridge Design Specifications. 8th ed., American Association of State Highway and Transportation Officials, 2017, <https://store.transportation.org/Common/DownloadContentFiles?id=1648>.

20-FH3: Real-time Monitoring and Modeling of Scour

“USGS Current Water Data for the Nation.” *National Water Information System*, U.S. Geological Survey, <https://waterdata.usgs.gov/nwis/rt>.

B. Federal Railroad Administration (FRA)

20-FR1: Autonomous Track Inspection Technology

Federal Railroad Administration. “Autonomous Track Geometry Measurement System: Technical Development & Short Line Demonstration.” 23 Jan. 2018, <https://railroads.dot.gov/elibrary/autonomous-track-geometry-measurement-system-technical-development-short-line>.

Federal Railroad Administration. “Autonomous Track Geometry Measurement Technology Design, Development, and Testing.” 9 Mar. 2018, <https://railroads.dot.gov/elibrary/autonomous-track-geometry-measurement-technology-design-development-and-testing>.

20-FR2: AI-Aided Machine Vision for Grade Crossing Safety

“Query by Location.” *Grade Crossing Inventory System*, FRA Office of Safety Analysis, <https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/crossing/xingqryloc.aspx>.

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49 C.F.R. § 179 App. B (2010).

https://www.ecfr.gov/cgi-bin/text-idx?SID=b10572ea47779ce9ed532eb9159679ee&mc=true&node=pt49.3.179&rgn=div5#ap49.3.179.0000_0nbspnbspnbspnbspnbspbsp.b.

49 C.F.R. § 179.200 (2011).

https://www.ecfr.gov/cgi-bin/text-idx?SID=b10572ea47779ce9ed532eb9159679ee&mc=true&node=pt49.3.179&rgn=div5#se49.3.179_1200.

“Section C Part III Specifications for Tank Cars, M-1002.” *Manual of Standards and Recommended Practices*, Association of American Railroads, 2014,

<https://aarpublications.com/section-c-part-iii-specifications-for-tank-cars-m-1002-2014g.html>.

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)

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A. Offer Signature Page (Appendix A)

**U.S. DEPARTMENT OF TRANSPORTATION
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
SOLICITATION NO. 6913G620QSBIR1, FY 2020
SIGNATURE PAGE**

Proposal Information		
Topic No. (see Solicitation):	Solicitation No.:	
Topic Title:		
Proposal Title:		
Company Information		
Company:		
Address:		
City:	State:	Zip:

Offeror Certification	
<p>By signing below and submitting this offer in response to Solicitation No. 6913G620QSBIR1, 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 <i>et seq.</i>); (3) double damages and civil penalties under the Program Fraud Civil Remedies Act (31 U.S.C. § 3801 <i>et seq.</i>); (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.</p>	
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. 6913G620QSBIR1 FY 2020
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. 6913G620QSBIR1, FY 2020
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, and then save the entire workbook as a PDF.

Additional information about the contract pricing worksheet and its requirements can be found in the Appendix C instructions in the last tab 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 2, 2020. Questions received after 5:00 PM ET on March 2, 2020 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. 6913G620QSBIR1, FY 2020
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.

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- _____ 10. The Contract Pricing Worksheet (Appendix C) has been completed and provides the necessary supporting information.

- _____ 11. The offer must be submitted online and received by the U.S. DOT automated proposal website by 5:00 PM ET, March 9, 2020. **Offers received via email or any other means will not be accepted. Do not send duplicate offers via email or by any other means.**

PLEASE NOTE: The submission website will open for submission of offers on or about February 13, 2020. The website will not allow offers to be submitted until such time. Please check back on [our website](#) for updates.

VIII. RESEARCH TOPICS

The FY 2020 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)	20-FH1: Physical Intervention System for Wrong-way Driving on Ramps	\$150,000	\$1,000,000
	20-FH2: Innovative Layered Composite Metal Deck System	\$150,000	\$500,000
	20-FH3: Real-time Monitoring and Modeling of Scour	\$150,000	\$1,000,000
Federal Railroad Administration (FRA)	20-FR1: Autonomous Track Inspection Technology	\$150,000	\$300,000
	20-FR2: AI-Aided Machine Vision for Grade Crossing Safety	\$150,000	\$500,000
	20-FR3: Platform Edge Proximity Detection to Prevent Inadvertent Passenger Car Door Opening	\$150,000	\$400,000
	20-FR4: Crushed Aggregate Gradation Evaluation System	\$150,000	\$300,000
National Highway Traffic Safety Administration (NHTSA)	20-NH1: In-Vehicle Occupant Detection System	\$150,000	\$500,000

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U.S. DOT Operating Administration	Topic Number & Title	Estimated Award Amount Phase I*	Estimated Award Amount Phase II**
Pipeline and Hazardous Materials Safety Administration (PHMSA)	20-PH1: Development and Validation of Inline Inspection (ILI) Technologies for Circumferential Anomalies and Bending Stresses	\$150,000	\$1,000,000
	20-PH2: Internal Repair of Steel Transmission Pipelines	\$150,000	\$1,000,000
	20-PH3: Geohazard Identification and Quantification for Pipeline Risk Models	\$150,000	\$1,000,000
	20-PH4: Scaling up of Composite Metal Foam Manufacturing for HazMat Packaging	\$150,000	\$1,000,000

* 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 four sections:

- A. Federal Highway Administration (FHWA)
- B. Federal Railroad Administration (FRA)
- C. National Highway Traffic Safety Administration (NHTSA)
- D. Pipeline and Hazardous Materials Safety Administration (PHMSA)

A. Federal Highway Administration (FHWA)

About Us: The Federal Highway Administration's (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.

20-FH1: Physical Intervention System for Wrong-way Driving on Ramps

Wrong-way driving (WWD) is the act of driving a motor vehicle against the direction of traffic. It may occur due to driver inattention, impairment, purposely, insufficient or confusing road markings or signage. WWD is a serious problem on freeways because of the high speeds involved. In the United States, WWD crashes result in 300 to 400 people killed each year on average, representing approximately 1 percent of the total number of traffic related fatalities that occur annually.¹ While this is a small percentage overall, because WWD crashes involve head-on or opposite direction sideswipe crashes at high speeds, they tend to be relatively more severe than other types of crashes.

To date, mitigation activities have focused on passive enhancements, such as oversized and redundant static signs and pavement markings, and dynamic systems grounded in intelligent transportation systems (ITS) that provide positive detection and activation of flashers, blank-out signs, etc. There are also small geometric changes to ramp terminal intersections that can mitigate the potential for wrong way maneuvers. However, despite all of this, WWD crashes continue to occur. In the past, physical intervention has been dismissed due to myriad concerns, including system durability and reliability, as well as trading off one crash scenario for another. At this time, it would be worth reconsidering whether some type of physical intervention system that could stop a wrong-way vehicle before it enters the mainline is feasible and could function as the "last line of defense".

Such a system would:

- Be directed only at vehicles driving the wrong-way and at a high speed, since most drivers who enter a divided highway or ramp in the wrong direction correct themselves by turning around when they realize their travel direction; however, when there is impairment or drugged driving, drivers may not correct themselves.
- Need to ensure that it won't disable vehicles driving in the proper direction of traffic under any circumstances.
- Be able to be disconnected in case a ramp needs to be used to evacuate a freeway due to other circumstances and traffic would be directed to drive the wrong-way on purpose for evacuation purposes.
- Include some type of final warning system to the driver before deployment.

This topic would benefit safety, operations and law enforcement.

Potential buyers are owners of state and interstate roads. The traveling public would benefit from

¹ https://safety.fhwa.dot.gov/intersection/other_topics/wwd/

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this system as to avoid facing a wrong-way driving car.

Expected Phase I Outcomes

The expected outcome for Phase I is a proof-of-concept report that describes a framework of what the system would look like, along with a prototype design or sample to demonstrate technical feasibility.

Expected Phase II Outcomes

The Phase II outcome should feature a system that includes the development of a market ready prototype for testing at a minimum of two different locations. These locations should be jointly agreed upon by the selected offeror and FHWA. Documentation of the system's performance will also be part of Phase II.

20-FH2: Innovative Layered Composite Metal Deck System

This topic involves the development and verification of an innovative layered composite metal deck system that can be used in the next generation of bridge applications for transportation; including highway, railway, transit, and/or pedestrian. What is envisioned is a modular, prefabricated, manufacturable panel that can be mass-produced within the US, and implemented in bridges supporting any mode of transportation for people, vehicles, trains, wildlife, or multi-mode applications.

Modular construction of bridges with prefabricated decks will improve the resilience of our highway network. If a bridge is lost or damaged due to natural or man-made hazard, it can quickly be returned to service with a prefabricated “off the shelf” deck panel, akin to an “interchangeable part” for automobiles.

Potential advantages of the envisioned deck system include: lightweight, prefab/modular, water-tight surface, minimization of deck joints, girder stiffening, durable/long lasting performance, rapidly constructible, and life cycle economy. In construction, potential advantages include improved safety for both the contractor personnel and the traveling public impacted by the construction, reduced traffic impacts during initial construction and in the future, and improved quality and durability as compared to conventional bridge deck construction techniques. When metal decks are combined with primary girder elements for modular, mechanized construction, further advantages can be realized. The pre-decked girders can be erected quickly and the deck can be paved without the need for any temporary formwork. There are no overhang forms to be erected and no cast-in-place concrete, which always slows construction and introduces quality control measures in current practice. Or, the wearing surface can be shop applied which can reduce duration of field work to the minimum possible. Also, since the bridge deck has a very low dead weight, it is most practical for preassembly of the entire bridge for rolling or sliding into place by automated construction techniques and even futuristic autonomous robotic assembly.

This SBIR topic supports the DOT’s strategic plan priorities in Infrastructure and Innovation, and the FHWA Modal Research Plan by focusing on new concepts for “Innovative Short Span Bridge Superstructures” and “Automation in Highway Construction.” In addition, this research will contribute to achievement of the Department’s Innovation goal through development of innovative new design alternatives for highway owners to consider when replacing highway bridges. In the longer term, it will contribute to the Department’s Infrastructure goal and State of Good Repair priority through the resulting opportunities for bridge owners to maximize the return on their infrastructure construction investments. The outcome of this work will be applicable to bridges throughout the nation, including those in rural communities.

The specific solution that is being sought is a new variation of a prefabricated modular deck system that has layered design with solid metal plate exterior and bonded wearing course on the top riding surface. The deck design should include metal plates for the outside layers, with separation and composite action provided by concrete or other domestically available, flowable casting material in the core. Additionally, solutions can consider other innovative materials and methods to achieve layered design, separation, connectivity, composite behavior, sufficient

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thickness, and wearing surface. A key requirement is that the deck must be capable to satisfy basic requirements for strength, service, fatigue, constructability, etc. as defined by AASHTO LRFD Bridge Design Specifications.²

A key challenge to address is the connection to the primary girder members and joints between panels, which will commonly be needed for bridge applications. These connections must be economical and achievable with U.S. fabrication and erection capability. Also, the deck and its connections must be able to accommodate variations in geometry (profile grade, camber, and superelevation) that are commonly encountered in bridges. The desire is to develop a deck system with minimal dead weight; no more than 75 PSF.

The opportunity for commercialization in the U.S. is very high. This system could potentially create a whole new product market for the steel, aluminum, and/or titanium industries. Further, metals material production and bridge fabrication industries could move toward mass-production and stockpiling of such materials for use on demand. The demand for this type of product could be consistent and sustain the new market since bridges for transportation infrastructure are funded through legislated, government programs. The investment into bridge infrastructure for the future will only increase from current levels. If only a small percentage of all new bridges were built with this deck system it could provide the motivation for these industries to make the commitments and capital investments necessary to mass-produce them at a cost that is competitive with current practice of concrete bridge deck.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that describes the evaluation of alternatives, the proposed prototype, detailed structural analysis, discussion of critical opportunities and obstacles to implementation, and a tentative plan for verification and demonstration to be done in Phase II.

Expected Phase II Outcomes

Phase II shall perform further refinement of the concept, design and fabrication of the prototype, and conduct analytical and experimental verification. The prototype will be developed using domestically available materials, resulting in a product that increases the potential for widespread commercialization and use in the United States.

² <https://store.transportation.org/Common/DownloadContentFiles?id=1648>

20-FH3: Real-time Monitoring and Modeling of Scour

Scour at highway structure foundations is a critical problem, often demanding situational assessments that drive decisions on structure resiliency during high water flows induced by extreme rainfall events. Autonomous Underwater Vehicles (AUVs) that can assess scour development during storm events and collect real time river bed profile data (i.e., bathymetry) are commercially available. Computational modelling tools can assess scour susceptibility of structures based on the combination of bathymetry, structural geometry, and flow rates. However, the marriage between the AUV and the modelling tools is lacking. Simply, tools to seamlessly convert the AUV bathymetry results into computational model input data are not available. Thus, today it is not possible to produce real time, accurate scour situational assessments.

An analogous situation is commonplace within the meteorological prediction of hurricane attributes. Real time weather data, from airplanes, buoys, satellites, and other sources, is fed into sophisticated atmospheric models. The outcome is a set of probabilistic results that indicate in near real time key attributes of the hurricane. This information is critical to decision makers charged with protecting citizens and property.

The goal of this research is to develop a working system that transfers real-time river bed (scour) and streamflow data during storm events to a computer model that can then predict critical scour development at bridge foundations. AUVs have the capability to monitor scour development during storm events and collect real time bathymetric data. Computational Fluid Dynamics (CFD) models offer the capability to model scour and predict “final” bathymetries. The challenge is to link the real-time field bathymetric data obtained by AUVs with high speed CFD models to compute erosion forces and determine probable final scour bathymetries during the storm event to inform decisions concerning infrastructure safety.

This topic is within the scope of FHWA’s Geotechnical and Hydraulics Research and Technology Program. It is specifically aligned with the Scour functional area of the program.

Expected Phase I Outcomes

The Phase I project is expected to result in a proof-of-concept report that describes how bridge scour bathymetric and streamflow data during storm events collected from AUVs can be processed and used by a CFD scour model in real time. For example, the data may be sent to a national cluster computing center that operates a CFD scour model to predict river bed deformation (scour) at bridge foundations. The algorithms developed must demonstrate how large amounts of AUV bathymetric and streamflow data can be processed in real time. The data processing algorithms of the sonar data must be compatible for CFD scour modeling. The offeror must also identify which bridge owner or bridge sites will be studied for this project, including detailed knowledge of their foundation elements, USGS gage data (via <https://waterdata.usgs.gov/nwis/rt>), and river bathymetric data that will be used for this research.

Expected Phase II Outcomes

Phase II requires further development and refinement of the concept described in Phase I. This will include creating algorithms to convert UAV sonar data to a format that can be meshed by a CFD scour model in real time. It is projected that UAV data will also include streamflow data such as velocities and flow depths needed for the CFD scour model. Additionally, processes will be developed where multiple sequential UAV sonar scans will be used to update a CFD scour model to continuously refine the bed deformation (scour) prediction.

Another outcome of Phase II would be the development of a working system where post-processed UAV data are processed by CFD scour models in real time and provide data to inform decisions concerning infrastructure safety. The prototype system should be further demonstrated and validated either in a laboratory setting or under controlled field conditions and then finally tested at the bridge sites identified in Phase I. The final product would be a validated working system that can be used to inform bridge owners when critical scour develops during storm events. It is anticipated that the validated working system will require the collaboration with a cluster computer that operates the CFD scour model.

In summary, the final deliverable should be a validated working system that facilitates interpretation and transfer of scour bathymetries and streamflow data from an UAV during storm events to enable real time to run CFD scour predictions. The development of this system will move the state-of-the-practice toward real-time scour assessments in potentially life critical situations.

B. 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 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 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.

20-FR1: Autonomous Track Inspection Technology

FRA's strategic objectives include the expansion of autonomous inspection methods to provide more frequent and cost-effective measurements and quality assessments of track condition. This Phase I SBIR topic seeks innovative railroad track inspection technologies suitable for deployment on autonomous inspection rail vehicles.

FRA has recently developed and deployed Autonomous Track Geometry Measurement (ATGMS) technology on FRA inspection vehicles DOTX225 and DOTX226, and variations of ATGMS technology are now available from commercial vendors. Additional information describing FRA ATGMS technology development and demonstration is available in the FRA e-library at:

<https://railroads.dot.gov/elibrary/autonomous-track-geometry-measurement-system-technical-development-short-line>

<https://railroads.dot.gov/elibrary/autonomous-track-geometry-measurement-technology-design-development-and-testing>

Autonomous inspection technologies offer greatly improved operational efficiency compared to traditional, manned inspection vehicles, but there are significant challenges that must be overcome to effectively deploy inspection technologies on an autonomous freight-service rail platform. These challenges include limited power availability, extended maintenance intervals, and data transfer bandwidth restrictions. As detailed in the documents referenced above, the FRA's ATGMS requires less than 200 watts of electrical power, can run for weeks without human intervention for maintenance, and uses the commercial cellular network for data transfer. The ATGMS and its power system (solar panels, batteries, and fuel cell) occupy approximately one half the volume of the boxcars (DOTX225/226) and one half of the available roof area. The remaining space is available for additional systems.

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This SBIR topic seeks additional, service-proven, track safety inspection technologies for deployment on the DOTX 225/226 platform. FRA is particularly interested in non-contact technologies that will provide data to enhance the value of the track geometry data currently collected on these railcars. Examples include, but are not limited to:

- Optical imagery or LiDAR data documenting the in-situ track condition that is suitable for post processing
- Rail Fastener detection and inspection
- Rail rolling contact fatigue (RCF) detection and severity quantification (scaling)
- Rail defect detection
- Joint bar and/or weld integrity assessment
- Ballast and/or subgrade condition assessment, including ballast height, fouling condition, mud spot detection, and track moisture content

Successful offeror(s) will demonstrate a clear understanding of the limitations and challenges associated with autonomous technology deployment in the railroad environment and will have identified a single, high value technology for integration into the autonomous platform.

Expected Phase I Outcomes

Phase I of this research will complete preliminary engineering activities necessary to assess the viability of the new technology for autonomous operation on DOTX 225/226 platforms. The proof-of-concept report will include a feasibility analysis, including risk assessment, a conceptual system design and integration plan, and a refined plan for continued development.

Expected Phase II Outcomes

Phase II will progress the technology development through design and prototype development, including laboratory and early field testing. Component and systems level testing will be completed using contractor-supplied resources. It is expected that Phase II efforts will include system integration on the DOTX 225/226 platform along with some field testing on railroad track. FRA will provide access to vehicles and rail track facilities for integration and field testing.

20-FR2: Artificial Intelligence (AI)-Aided Machine Vision for Grade Crossing Safety

A vehicle or person is struck by a train every three hours³. Highway-rail grade crossing safety is of the utmost importance to both the Federal Railroad Administration (FRA) as well as the Federal Highway Administration (FHWA). Additionally, strategic objectives of the FRA include the expansion of autonomous inspection methods to provide more frequent and cost-effective assessments of railroad infrastructure, including highway-rail grade crossings. This Phase I SBIR topic seeks an innovative artificial intelligence (AI) aided approach for autonomous highway-rail grade crossing inspections using locomotive forward-facing cameras.

Locomotives are equipped with forward-facing cameras that provide a clear view of what is in front of the locomotive as it is in operation. The video obtained from these cameras can provide an opportunistic source of information regarding the current condition of infrastructure as it relates to highway-rail grade crossings, including crossing gates and pavement markings as well as other safety-related characteristics, such as unhindered line of sight in either direction. It is critical for pedestrian and driver safety that warning devices are properly functioning and in a state of good repair. This topic seeks to develop an advanced machine-vision approach using commercially available AI-based technologies for inspecting these crossings to ensure compliance with regulations under 49 CFR Part 234 – Grade Crossing Safety. The objective is to apply such an approach to video footage from the locomotive forward-facing cameras to observe and report on the current state of infrastructure at highway-rail grade crossings. Various characteristics of the grade crossings should be detected and assessed, including, but not limited to: presence and condition of crossing gates, other warning devices, required signage, pavement markings, adequate sight distance for pedestrians and drivers alike, etc. It is expected that the technology will accurately and precisely geolocate the crossing and will reference information (e.g., DOT crossing inventory number) in the Grade Crossing Inventory System⁴ as necessary. This technology development project aligns with the U.S. Department of Transportation’s strategic goals⁵ for Safety and Innovation by advancing technology that improves the efficiency of safety inspections on our nation’s highways and railways.

Successful offeror(s) will demonstrate a clear understanding of not only the regulations associated with highway-rail grade crossings but also the limitations and challenges associated with autonomous technology deployment in the railroad environment. The selected offeror(s) will have identified a single, high-value technology for development and will be expected to partner with an operating railroad for access to relevant data and resources necessary for the successful completion of this project.

Expected Phase I Outcomes

Phase I of this research will complete preliminary engineering activities necessary to assess the viability of the new technology for autonomous operation on locomotive-based platforms. The

³ <https://www.fra.dot.gov/Media/File/1179>

⁴ The Grade Crossing Inventory System data can be accessed via <https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/crossing/xingqryloc.aspx>.

⁵ DOT Strategic Plan for FY2018-2022: <https://www.transportation.gov/sites/dot.gov/files/docs/mission/administrations/office-policy/304866/dot-strategic-planfy2018-2022508.pdf>

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proof-of-concept report will include a feasibility analysis, including risk assessment, a conceptual system design and integration plan, and a refined plan for continued development. Offerors planning to utilize recorded video from locomotive-based forward-facing cameras must demonstrate a confirmed partnership with an operating railroad for access to such data for research purposes. Alternatively, other feasible means of safely and legally obtaining video footage necessary for successfully accomplishing the objectives of this project are acceptable.

Expected Phase II Outcomes

Phase II will focus on the design and development of a market-ready prototype for laboratory and early field testing (to establish operational capabilities and limitations) and possible commercialization. It is expected that the laboratory and early field testing will be undertaken by the selected offeror in partnership with an operating railroad, which can potentially provide access to equipment and an appropriate field location for testing purposes. Alternatively, the FRA maintains the Transportation Technology Center in Pueblo, Colorado, which houses grade crossing equipment adjacent to non-revenue railroad track allowing for safe, controlled testing of new technology.

20-FR3: Platform Edge Proximity Detection to Prevent Inadvertent Passenger Car Door Opening

FRA and passenger railroad operators share concern for the safety of the travelling public. Recent incidents have occurred in which a passenger train is stopped at a station with high-level platforms and the side doors have opened on the incorrect side, resulting in at least one passenger falling out of a train onto a live track. Other similar circumstances can occur when long trains stop at stations with short platforms. In this case, side doors may open where no platform exists. Since 2014, one of the more frequent reports received by one passenger railroad operator via the Confidential Close Call Reporting System (C3RS)⁶ has been related to side doors opening in cars positioned beyond the platform limits. These situations clearly pose safety risks, the mitigation of which is the subject of the proposed research.

FRA seeks technology (low-cost and possibly off-the-shelf) which could be adapted to permit detection of a platform edge and interface with door control circuitry and/or trainline to permit doors to open only when a platform or temporary “bridge plate” is present. The hardware will be required to be sufficiently robust to function properly under the adverse conditions (snow/ice/dirt/cold/heat) present in the railroad environment. Since the door control function is safety-critical, the proposed system will be required to be fault-tolerant, experience low rates of false detections and be able to be overridden should the need exist. The proximity detection system should be conceived with the goal of eventually interfacing with modern rolling stock with digital trainlines, although FRA expects that the detection features of the system will also be compatible with legacy equipment that uses discrete (analog) trainlines.

FRA has identified one passenger railroad operator who will provide controlled access to stations, platforms and rolling stock to permit familiarization of a successful offeror with the typical layout and arrangement of trains, track and platforms to facilitate understanding of the operating environment and existing physical constraints.

Expected Phase I Outcomes

Phase I of this research will complete preliminary engineering activities necessary to identify, assemble, configure and assess the viability of the new technology to detect the presence of platform edges and temporary “bridge plates”. Outcomes will include a bench prototype of the hardware and a proof-of-concept report which provides an analysis of the feasibility for installation on in-service rolling stock, including a risk assessment, a conceptual system design and integration plan, and a refined plan for continued product development.

Expected Phase II Outcomes

Phase II will advance the prototype to a state in which it could be mounted on hi-rail equipment for the purposes of demonstrating the detection capability and identifying any environmental or physical barriers which might impede detection performance. Once successful, the prototype will be installed on an actual railcar and subjected to field testing on an out of service segment of

⁶ <https://railroads.dot.gov/library/confidential-close-call-reporting-system-c3rs-lessons-learned-evaluation-final-report>

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track. FRA will facilitate access to an appropriate site and rail vehicles for these demonstrations. The site will be located in the New York/New England geographical area.

20-FR4: Crushed Aggregate Gradation Evaluation System

Crushed aggregate is used as railroad ballast, road base, drainage layers, and embankment stabilization material. The gradation affects the performance of the aggregate in each of these applications. From fouled ballast to contaminated and plugged drainage systems it is often necessary to assess the gradation and level of contamination during inspections. Contamination of uniformly graded crushed stone is often detrimental to the material's performance and is the focus of this SBIR topic.

Once uniformly graded aggregates are contaminated with finer material, the ability to drain water is inhibited leading to reduced shear strength when saturated. An optical system or other rapid, hand-held imaging, photographic or other sensing technology is sought to quantify the level of contamination or percent of void space filled to help estimate the degree of gradation change. The technology sought is the development of a combined sensor and smart phone application that can analyze the data and develop an estimate of change in void space or other parameters that can be associated with change in gradation. Ideally, but not limited to, this technology would utilize the camera in the smart phone to make an initial assessment using the application developed. Other measurements or alternative measurements may also be utilized as needed.

Expected Phase I Outcomes

During Phase I, the outcomes expected from this topic would be the proof-of-concept and design for the (1) development of the application and (2) linking the application to the smartphone camera for initial testing. The logic to associate various levels of contamination to change in void space or gradation must also be defined. At the end of Phase I, it is expected that the application would be developed and the recommendation for any other measurements in addition to the camera would be made.

A report and presentation describing the technology, the correlation of the system response to aggregate performance, and a description of the envisioned field unit and applications will be required.

Expected Phase II Outcomes

The expected Phase II outcomes include finalizing the measurement technology and logic linking the measurements to the gradation changes. In the final system, the application will locate the measurement using GPS technology and store the location with the test data and results. The final system will be demonstrated on several unknown aggregate conditions in a blind evaluation and the system will be demonstrated in the field at appropriate test sites. The awardee will be encouraged to have a railroad participate in the testing.

A report and presentation at FRA is expected during Phase II along with two (2) technical papers documenting the test results.

C. National Highway Traffic Safety Administration (NHTSA)

About Us: NHTSA research efforts are primarily comprised of programs within the Office of Vehicle Safety Research 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.

The Office of Vehicle Safety Research (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. Research efforts include technologies that aim to address common crash problems on U.S. roadways as well as research addressing unsafe driver behavior including distracted and impaired driving. In addition, VSR conducts testing and research on the reliability of complex safety-critical electronic control systems, vehicle cybersecurity, and develops new test tools and countermeasures to improve vehicle crashworthiness. 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. The Office focuses on unsafe driving behaviors that contribute significantly to death and injury from crashes on the Nation's highways, evaluates the relative effectiveness of programs to reduce highway fatalities and injuries, and assesses existing and emerging highway safety problems.

20-NH1: In-Vehicle Occupant Detection System

There are isolated systems that currently provide incomplete information about vehicle occupants. For example, load cells in the seats, belt use sensors, and seat position sensors can estimate the occupant size and position to a limited degree. A single high-resolution camera could address much of what is unknown about occupant size, position, and safety belt use or misuse. This information could be used in automated driving systems (ADS) to customize the passive safety systems (re-position seats, deploy custom inflatable restraints). In the transition to full ADS systems, when some driver input is required, the video analysis can detect driver distraction.

This effort will focus on technical feasibility and developing capabilities towards understanding the vehicle interior environment, leading to short- and long-term benefits described below.

Approximately 40 children die each year as a result of being left unattended in vehicles, especially in summer. A vision-based system (or alternative systems proposed by the vendor) that detects occupancy and movement at all seating locations is an example of a technology that could be implemented in the short-term to address this critical safety need.

In the longer-term, the technology developed for road vehicles can be used to monitor the environment in all modes of transportation, like aircraft, surface transport, control centers for key infrastructure like building security, powerplant control room, etc. Wide applicability of image processing, refined by machine learning using diverse data collected from naturalistic driving

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studies, will open this to the possibility of commercialization once societal concerns on data privacy and security have been addressed.

Using high resolution in-vehicle camera views (or alternative systems proposed by the vendor), this topic seeks the development of a comprehensive in-vehicle system capable of addressing a variety of functions beyond the single factor (e.g., weight sensors) detection of unattended children. Possible functions may include:

- Detect occupant(s) presence: prevent lockout (don't lock the doors with engine running and no occupancy), lock-in of children (don't lock the door with engine running and only children in the vehicle)
- Detect and warn for unattended children
- Recognize occupants: adjust personalized interior settings
- Detect seat belt (non)-use, misuse
- Detect out-of-position occupants (leg on dash!)
- Detect drowsy driver
- Detect distraction: eyes/hands
- Detect medical condition: cardiac (cameras can detect heart rhythm).

Prior experience in image analysis or other occupant detection systems will be considered in selecting the vendor.

Expected Phase I Outcomes

The Phase I proof-of-concept report should include market research and a feasibility study of available technologies that can be integrated for development of a comprehensive in-vehicle occupant detection system including features of: data/image/video collection, real-time analysis, storage, and verification. Data/image/video quality, CPU requirements, data sources, and software capabilities should be examined with the proof of concept report presenting the recommended approach.

Expected Phase II Outcomes

Phase II will fund the development of the in-vehicle systems. The hardware will be installed on a government provided vehicle. The awardee will collect the video data for training and machine learning. The performance of the hardware and software will then be evaluated by the awardee in some limited controlled environments.

D. 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 Pipeline Safety regulates products going through the nation's pipeline infrastructure. The U.S. pipeline infrastructure is the oldest and largest in the world, spanning over 2.8 million miles, and is the primary means of transporting natural gas and liquid petroleum products in the U.S. Because of the significant economic importance and safety consequences of energy pipelines, research projects to improve safety and performance are necessary. Engaging stakeholders- including the public, academia, and industry- is imperative to ensuring such research is effective. The Office of Pipeline Safety funds research improving safety, supply reliability, productivity, and security and mitigate environmental impact. The Office of Pipeline Safety is seeking to support these efforts through topics PH1, PH2, and PH3.

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, support 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 PH4.

20-PH1: Development and Validation of Inline Inspection (ILI) Technologies for Circumferential Anomalies and Bending Stresses

Collectively, PHMSA and industry have invested heavily in improvements to inline inspection (ILI) technology in order to identify accidents or incidents before they occur. However, preliminary research funding was limited for circumferential cracking detection and characterization cracking in dents (particularly bottom side), creating a gap for additional R&D, due to the costs to bring circumferential crack technology to market. PHMSA is preparing regulatory requirement for pipeline operators to be able to detect several features, including circumferential cracking. This technology will help support that requirement.

This project should develop and validate advanced ILI technology in compliance with American Society of Mechanical Engineers B31G⁷ and RSTRENG⁸ to fill this gap. The project should also quantify bending stresses, including those contributions from geotechnical and environmental conditions. To ensure proper application of a solution, the analysis of government and industry data to benchmark current practice should factor into ILI pull tests with non-destructive testing and destructive testing. The effects of temperature changes and thermal variability on pipelines

⁷ <https://www.asme.org/codes-standards/find-codes-standards/b31g-manual-determining-remaining-strength-corroded-pipelines>

⁸ <https://www.technicaltoolboxes.com/products/rstreng/>

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with regard to stress added should also be evaluated.

Expected Phase I Outcomes

The Phase I proof-of-concept report is expected to describe the feasibility of and methodology for development of an instrument/tool deployable for field testing solutions that can obtain circumferential anomaly and bending stresses. A methodology to validate results is expected.

Expected Phase II Outcomes

The Phase II outcomes will result in a prototype and validation that is expected to lead to full scale initial field tests of a commercially feasible solution in terms of manufacturing and implementation. This should include the completion of a field deployable prototype.

20-PH2: Internal Repair of Steel Transmission Pipelines

External repairs are made today by excavating around a damaged or leak site, preparing the pipe surface, and mechanically installing a repair product such as a clamp or wrap on the outside of the pipe. Welding is also a common form of repair which requires shutting off the gas to customers. Currently, repairs are performed by shutting off the gas, cutting open the pipe, and manually replacing the pipe. Some companies perform a repair using a motorized system driven through the open end of the pipe for installing an internal repair sleeve or liner. Most repairs are costly in terms of time and resources and disruptive to customers. For example, the Centreville, Virginia pipeline failure resulted in accident related expenses over \$16 million.

This topic seeks solutions to perform internal inline repair of pipeline anomalies. Proposal activities should include investigation of internal repair methods for cracks: stress corrosion cracks, fatigue cracks, and weld cracks.

Expected Phase I Outcomes

The proof-of-concept report should include a study of the following:

- Pipeline types (hazardous liquid or gas) that would be appropriate for the internal repair solution,
- The state of the internal pipeline wall,
- The flow conditions the tool could operate in,
- The diameters of the pipe,
- The timeframe the repair would be valid,
- The feasibility of such a tool, and
- How internal pipeline anomalies are identified and ranked for urgency of repair.

Expected Phase II Outcomes

In Phase II, a prototype tool should be developed that can be tested and validated, informed by the anomaly ranking and identification. The demonstration should include pipe with different anomalies to be repaired, different wall conditions, and different positions on the pipeline wall. Ideally, a pressure test to benchmark the quality of the internal repair would be performed.

20-PH3: Geohazard Identification and Quantification for Pipeline Risk Models

Pipelines operate in a variety of conditions, and are subject to many risks which can be mitigated. The routes into which these pipelines are placed is a result of the operating needs, resource locations, and point of delivery, making geological hazards unavoidable. For example, there have been at least seven pipeline failures since 2016 due to geological related conditions, tens of thousands of barrels of hazardous liquids have been spilled and over 200,000 Million Cubic Feet (MCF) of natural gas released.

This research topic seeks to holistically account for the geological hazards (geohazards) facing operating pipelines and result in actionable information from threat identification. The method by which these threats are identified and the contributing risk profile to the pipeline must be considered and include leading indicators of pipeline failure, location, and contributing factors, with industry standards such as ASME B31.8S Managing System Integrity of Gas Pipelines⁹ for threat identification as a reasonable basis.

Expected Phase I Outcomes

The proof-of-concept report should describe methods of data acquisition and frequency, factors identified, and their interaction to create a risk model. The report should also include a data supported framework for how the solutions would be utilized, discussion of a commercialized product, and a qualitative hazard identification by location.

Expected Phase II Outcomes

The Phase II outcomes will result in a prototype and validation that is expected to lead to a packaged risk identification system, including the model and data acquisition services to inform end users of threats and threat ranking. A field demonstration to validate the risk identification and ranking system is also expected.

⁹ <https://www.asme.org/codes-standards/find-codes-standards/b31-8s-managing-system-integrity-gas-pipelines>

20-PH4: Scaling up of Composite Metal Foam Manufacturing for HazMat Packaging

Several derailments have occurred with DOT-111 railcars transporting various hazardous materials (hazmat) that resulted in casualties or destruction. When pipeline capacity is insufficient, railcars are often used to transport flammable liquids in bulk quantities. If an incident such as a collision occurs this can lead to the destruction of people, property and the environment. While reducing derailments and collisions is certainly one half of the issue, there remains a need to improve the puncture and thermal performance of railcars and other hazmat packaging.

Tank car designs are currently constructed of traditional steels. While thicker steel tank car designs can increase puncture resistance, increased thicknesses would be heavy and cost prohibitive for rail lines. Composite metal foams (CMFs) have shown incredible promise as a potential material for railcars that transport hazmat as they exhibit excellent impact and thermal resistance at a light weight when compared to traditional steel. However, this material has only begun to be developed and further development requires more resources for it to be manufactured on a larger scale. The technology requires manufacturing scale up before it can be produced on a mass scale for railcars. Additionally, railcars may not be the only application for CMFs. The offeror can propose other hazmat packaging that may be suitable for CMFs. Since CMFs exhibit excellent impact and thermal resistance while being lightweight, their use in other packaging types may be of value.

Expected Phase I Outcomes

The Phase I proof-of-concept report is expected to describe the methodology, feasibility and commercial potential of a manufacturing line that can produce 3'x3' CMF specimens that can obtain thermal performance as described in:

- Appendix B to 49 CFR Part 179 – Procedures for Simulated Pool and Torch-Fire Testing;
- The impact resistance outlined in 49 CFR 179.200 and Appendix A to Part 179 – Procedures for Tank-Head Puncture-Resistance Test; and
- other general requirements as specified in the Association of American Railroads' Manual of Standards and Recommended Practices, Section C Part III Specifications for Tank Cars, M-1002.

If the offeror proposes to use CMFs to design another packaging type, then the report shall describe how specimens/panels will be manufactured to meet the performance requirements for that packaging type as outlined in 49 CFR Part 178 or 179. The report should include a feasibility analysis of the material's acceptance by the rail industry (or other applicable industry), to include an economic analysis of current tank car material and manufacturing costs to that of possible CMF designs. This report shall also specify on which part of the railcars (or other packaging type) the CMFs would be applied to for maximum prevention of puncture and heat transfer.

Expected Phase II Outcomes

Phase II outcomes seek a manufacturing process that can produce CMFs at a large scale, making

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3'x3' panels that meet the thermal performance as described in Appendix B to Part 179- Procedures for Simulated Pool and Torch-Fire Testing; the impact resistance as outlined in 49 CFR 179.200 and Appendix A to Part 179 – Procedures for Tank-Head Puncture-Resistance Test; and other general requirements as specified in AAR M-1002 Manufacturing, Standards, Recommended, Practices for Tank Cars.