STATEMENT OF WORK (SOW)

Title: "Technology Infusion Study for DO-333, the Formal Methods Supplement to DO-178C and DO-278A"

1.0 Background:

NASA's Aviation Safety Program is conducting research directed at improving the safety of current and future aircraft operating in the National Airspace System. The research focus includes the System-wide Safety Assurance Technologies[1] (SSAT) project. Under SSAT, there is a technical challenge area known as Assurance of Flight Critical Systems (AFCS).[2] A primary thrust of AFCS research is advancing formal methods technology so it can serve the needs of the avionics community.

In January 2012, RTCA released several documents, products of RTCA special committee SC-205,[3] that are key to the future of certification of avionics software. Foremost among these are DO-178C, Software Considerations in Airborne Systems and Equipment Certification,[4] and DO-278A, Software Integrity Assurance Considerations for Communication, Navigation, Surveillance, and Air Traffic Management (CNA/ATM) Systems.[5] As the long-awaited successors to DO-178B and DO-278, these documents provide updated guidance for developers of airborne and ground-based software.

SC-205 also created four supplements to accompany DO-178C and DO-278A. One of these, Formal Methods Supplement to DO-178C and DO-278A, has been published as DO-333.[6] For the first time, avionics developers will have extensive guidance on applying formal methods technology to produce evidence that certification authorities can accept for certification credit. This will provide a pathway for the gradual introduction of formal methods into the development life cycle and the eventual certification of aircraft and engines whose software airworthiness is assured (in part) by formal methods.

While the release of DO-333 is an important event, there remain significant challenges to the successful infusion of formal methods into development and certification workflows. At a minimum, the level of formal methods expertise within the aviation workforce needs to be raised. Moreover, there exists a need for case studies to explore more fully the application of formal methods in realistic settings and demonstrate how the results can be mapped to the objectives of DO-333. Although DO-333 represents a carefully reasoned approach, the wide variety of formal methods tools and techniques poses the challenge of fitting them within a unified framework. The goal of this study task is to produce more detailed guidance and worked examples to help bridge the gap between the promise of DO-333 and the current level of preparedness within industry and government. Bridging this gap is vital for the successful infusion of formal methods into civil aviation.

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[1] http://www.aeronautics.nasa.gov/programs_avsafe.htm
[2] Previously named Verification and Validation of Flight Critical Systems.
[3] SC-205 (Joint with EUROCAE WG-71), Software Considerations (http://www.rtca.org/comm)
[4] DO-178C, Software Considerations in Airborne Systems and Equipment Certification (http://www.rtca.org)
[5] DO-278A, Software Integrity Considerations for Communication, Navigation, Surveillance, and Air Traffic Management (CNA/ATM) Systems (http://www.rtca.org)
[6] DO-333, Formal Methods Supplement to DO-178C and DO-278A (http://www.rtca.org)

2.0 Scope and Objectives:

The scope of this task order is to conduct a study that will summarize the state of the art in formal methods applicable to the aviation domain. The study will include one or more case studies on the use of DO-333 and formal methods in realistic applications to avionics software.

The objective of this task is to deliver a set of documents that together will constitute a "guidebook" on formal methods suitable for those undertaking software development using techniques having DO-333 relevance. The resulting guidebook should be regarded as a compendium of technical advice and informed recommendations. It should not be construed as having any official connection to DO-333 because it will not be subjected to the RTCA consensus process. Because the documents produced under this task are intended for open, public distribution, the Contractor shall ensure that they are free of proprietary, sensitive, or restricted information of all kinds. It is expected that some software tools to be described will require the purchase of a license from a tool vendor. If there are additional intellectual property issues involved, such as the use of patented algorithms or techniques, they should be clearly described in the reports.

3.0 Description of the Work/Tasks to be Performed:

The Contractor shall conduct a study on the problem of infusing formal methods technology into the domain of aviation software. The relevant context is the use of formal methods in the life cycle for software produced in accordance with DO-178C or DO-278A with the addition of supplement DO-333. The study shall culminate in the production of several documents suitable for publication as NASA contractor reports. Although they may be separately titled and numbered, the documents are intended to serve as a single multi-volume collection. Following are the specific tasks that shall be performed:

3.1 Survey applicable formal modeling and analysis methodologies.

The Contractor shall survey and document applicable methodologies and tools for formal modeling and analysis. Applicable in this case means plausibly usable for the development and verification of DO-178/278-class software. There are many languages, tools and analysis techniques that fall under the heading of formal methods. Most of these lack one or more attributes to make them viable for serious consideration. They may be too immature or insufficiently comprehensive or less than industrial quality. Although the intention is not to pick winners, there is nevertheless a practical need to focus on those methodologies most likely to be adopted in the short term. The Contractor's survey shall include summaries of the formal methods' features, pointers to their tools and documentation, and any non-proprietary information about where and how they have been used in avionics or other safety-critical domains. The Contractor shall include entries for any tools that are expected to undergo DO-330 tool qualification,[7] although no promising candidates should be excluded on this basis. A draft of the survey shall be included in **Deliverable item 4.3**. The final survey results shall be included in **Deliverable item 4.5**.

[7] DO-330, Software Tool Qualification Considerations (http://www.rtca.org)

3.2 Conduct and document one or more realistic case studies.

The Contractor shall select one or more representative sample problems to serve as case studies for trial applications of the DO-333 processes. The case studies shall represent realistic avionics software components, although they may be artificially created. The case studies shall be more substantial than the examples shown in DO-333 Appendix FM.B. All formal methods used for the case studies shall be selected from those described in the survey results of Task 3.1. The case studies shall be free of proprietary software, analyses, and other information that could impede publication.

The Contractor shall illustrate the use of all three types of formal methods cited in DO-333: (1) deductive (theorem-proving) techniques, (2) model checking, and (3) abstract interpretation.

The Contractor shall document all of the development and analysis artifacts, including the formal models, the formal analyses, and the interpretation of the tool results.

The Contractor shall show how the models and analysis results can be used to satisfy the objectives contained in DO-333 section FM.6.0, Software Verification Process.

The Contractor shall also deliver all of the files used in the case studies so that guidebook readers can reproduce the results. A draft of the document describing the identified case studies and progress towards the development and analysis shall be included in **Deliverable item 4.3**. The final document describing the case studies shall be included in **Deliverable item 4.5**.

The Contractor shall deliver, in electronic form, all source files, formal models and specifications, libraries, scripts, and any other inputs necessary to reproduce the analyses/verifications in the above case studies. Additionally any voluminous analysis results shall be delivered electronically. NASA will make these files publicly accessible to accompany the Final Guidebook. **(Deliverable item 4.6)**

3.3 Create a formal methods guidebook for practitioners and interested parties.

During the 1996-97 timeframe, NASA created a Formal Methods Guidebook[8] to aid developers of spacecraft avionics software. The NASA guidebook appeared in two volumes, a detailed one for practitioners and a less technical one for other parties. The Contractor shall create an analogous guidebook tailored to the DO-333 processes, terminology and life cycle, while simultaneously introducing updated information on current formal methods and their tools. The guidebook shall include the survey results produced during Task 3.1 and the case study results of Task 3.2. The Contractor shall use a multi-volume approach to address the needs of different audiences, being mindful that guidebook resources are intended for developers and certifiers alike. Other organizational aspects are left to the Contractor's discretion. The Contractor may reuse any of the existing NASA Guidebook material and augment it with fresh content as appropriate. The Contractor shall deliver a draft of the guidebook **(Deliverable item 4.3)** and a Final Guidebook **(Deliverable item 4.5)**.

[8] http://eis.jpl.nasa.gov/quality/Formal_Methods/ and http://www.hq.nasa.gov/office/codeq/doctree/87398.htm

3.4 Planned Presentations / Meetings / Telecons

The Contractor shall be required to participate in and/or travel to the presentations/ meetings/telecons as specified below:

TASK	MEETING	FREQUENCY / DATE	ESTIMATED DURATION PER TRIP / TELECON	PLANNED LOCATION
3.4.1	Kick-Off Presentation	Within 30 days after task order award. Date and time to be mutually agreed upon by the Contractor and TM.	1 day or less	Contractor's Facility or Via WebEx / Telecon
3.4.2	Project Status Meetings	Quarterly. Date and time to be mutually agreed upon by the Contractor and TM.	1-2 hours	Via WebEx / Telecon
3.4.3	Final Review Presentation	During last month of task order. Date and time to be mutually agreed upon by the Contractor and TM.	1 day or less	NASA LaRC, Hampton, VA

3.4.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products. An electronic version of the Presentation shall be delivered to the Task Monitor (TM), Contracting Officer's Technical Representative (COTR) and Contracting Officer (CO) via email one day prior to the briefing. **(Deliverable Item 4.2)**

3.4.2 For the **Project Status Meetings**, the Contractor shall participate in quarterly teleconferences to discuss the status of ongoing work.

3.4.3 For the **Final Review Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of accomplishments for the entire task. An electronic version of the presentation shall be delivered to the TM and COTR at the time of the briefing. A copy shall also be delivered to the CO (preferably via email) not later than a week after the presentation. The Final Review Presentation shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. **(Deliverable Item 4.4)**

NOTE: This briefing will be attended by NASA civil servants and NASA on-site contractors and possibly other government personnel such as FAA representatives.

3.5 Monthly Technical Letter Progress Reports: (Deliverable Item 4.1)

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: The Contractor shall submit an individual letter report for each individual task order. Multiple Task Orders shall not be summarized in one letter report.

3.6 Final Report

~~In accordance with Contract Exhibit A, the Contractor shall submit a Final Report, which is prepared in accordance with the contract clause entitled "Final Scientific and Technical Reports" (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.~~

NOTE: Due to the nature and requirements of this Task Order, a Final Report is not required.

4.0 Deliverables:

The Contractor shall deliver the following items FOB Destination. All deliverables shall be delivered with unlimited rights and unrestricted rights as defined under FAR 52.227-14 (Rights in Data - General), as modified by NFS 1852.227-14.

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.5	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to TM, COTR, and CO electronically (preferably via email).
4.2	3.4.1	Kick-Off Presentation.	1 EA	Within 30 days after task order award.	See Task.
4.4	3.1, 3.2, 3.3	Draft Guidebook, including formal methods survey and case study candidates.	1 EA	6 months after task order award.	Delivered to TM, COTR and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235-73 and contract.
4.3	3.4.3	Final Review Presentation.	1 EA	During last month of task order.	See Task.
4.5	3.1, 3.2, 3.3	Final Guidebook	1 EA	Task order expiration	Delivered to TM, COTR and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235-73 and contract.
4.6	3.2	Electronic version of source files, formal models and specifications, libraries, scripts, analysis results.	1 EA	Task order expiration.	Delivered to TM, COTR and CO electronically (preferably via email attachment in a commonly used data compression format e.g., zip file).

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "NONE"

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1		"None"		

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE"

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **N/A** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"			

7.0 ADDITIONAL DATA RIGHTS: Reserved.

8.0 SECURITY CLEARANCE REQUIREMENTS: None.

9.0 Period of Performance: 12 months from date of Task Order award date.

10.0 Points of Contact:

Flight Critical Systems Research (FCSR)
Statement of Work (SOW)

TASK ORDER TITLE: "Regulatory Considerations for Adaptive Systems"

1.0 INTRODUCTION / BACKGROUND:

Adaptive systems, such as adaptive controls, have proven beneficial in some application domains in maintaining needed performance in the presence of uncertainty and in accommodating unanticipated environmental conditions and sensor input. The benefits afforded by adaptive technologies make them attractive for use in systems planned for the Next Generation Air Transportation System (NextGen) and the National Airspace System (NAS) air traffic control (ATC) system. NASA Langley Research Center (LaRC) is working with the Federal Aviation Administration (FAA) to ensure that potentially-planned adaptive approaches for NextGen, NAS ATC, and other safety-critical aircraft systems, comply with applicable safety regulations. The FAA and LaRC are jointly investigating the verification aspects of adaptive systems and identifying the differences between the current approach used for airborne software approval and the planned use of adaptive systems.

2.0 SCOPE / OBJECTIVE(S):

The scope of this task order is to examine the verification of adaptive systems and the means by which to ensure compliance of the software to RTCA/DO-178B[1], identify areas where compliance cannot be achieved, and propose alternative methods of compliance as necessary. This task will also review past results and current plans, as available, by the FAA Software and Digital Systems (SDS) Technical Community Representatives Group (TCRG) as related to deterministic and non-deterministic research. In addition, this task will also examine the use of tools to validate and verify adaptive systems. For this study, adaptive systems are considered to be systems that have the ability to change behavior at run-time in response to changes in their operational environment, system configuration, resource availability or other factors, and would include learning systems. Since the primary focus is on systems subject to DO-178B, piloted systems (including UAS) are the primary interest at this time. However, there are NextGen plans that propose adaptive systems for air traffic management applications that should also be considered in the study. This study is not expected to focus on one type of adaptive system (or application) before another, but consider the broad range of possible applications. Examples of envisioned adaptive NextGen systems include algorithms that provide for dynamically reconfiguring airspace boundaries to meet prevailing demand and optimize throughput; adaptive weather prediction; adaptive speed control to improve traffic flow management; and autonomous landing of a damaged UAS. Consideration of system development, safety assessment, and safety assurance processes that pertain to DO-178B are also appropriate for this study, as are system-level considerations that might be necessary to provide assurance of an adaptive system, including identification of issues and obstacles that adaptive systems pose to these processes.

[1] http://www.rtca.org/

The objective of this task order is to provide NASA with a recommended approach for assuring flight software that uses techniques such as adaptive control and machine learning to modify its behavior during operation. DO-178B and related guidelines have an underlying assumption that all aircraft systems with their software and its assurance artifacts are available for scrutiny at one time, and that the behavior of the software is fully determined at that time. Adaptive software – that is, software that adjusts its behavior during operation – violates this assumption and therefore likely requires some revision in the current approach to assurance for flight software.

3.0 DESCRIPTION OF THE WORK/TASKS TO BE PERFORMED:

NASA is currently documenting preliminary background information relative to terminology definitions (e.g., adaptive system, neural net, adaptive software, artificial intelligence, and deterministic), some underlying characteristics of adaptive systems, and safety issues that will be faced in fielding adaptive systems. This will be made available to the contractor in electronic form (see 5.0 Government Furnished Information [GFI]).

The Contractor shall:

3.1 Investigate applicability of RTCA/DO-178B to Adaptive Systems

The Contractor shall investigate the extent to which RTCA/DO-178B is applicable to adaptive systems, and, where aspects of adaptive systems cannot be approved using DO-178B, provide recommendations for alternate methods to be considered – including viability of these methods using current technology or as areas where additional research may be necessary.

3.2 Develop Recommendations for the Safe Use of Adaptive Systems

The Contractor shall make recommendations for the safe use of adaptive systems, and verifying the same, being planned for the potential future implementation of adaptive systems for the NextGen and NAS ATC.

3.3 Document Findings

The Contractor shall document findings and recommendations in the Final Report (See SOW Task 3.6). It is intended that the information contained the Final Report can be used by the FAA for the development of FAA policy, guidance, and training relative to the safe use of adaptive systems.

3.4 Planned Presentations/Meetings/Telecons

The Contractor shall be required to participate in the planned telecons/presentations as specified below:

Task	Meeting	Frequency / Date	Estimated Duration Per Trip / Telecon	Planned Location
3.4.1	Kick-off Presentation and Meeting	Within 3 weeks after Task Order Award.	1 day	FAA HQ (Washington D.C.) or NASA LaRC (Hampton VA)
3.4.2	Project Status Telecon.	Monthly. Date and time to be mutually agreed upon by the Contractor and TM.	~1 hour	Via WebEx / telecon
3.4.3	Final Presentation	During last month of task. Date and time to be mutually agreed upon by the Contractor and TM.	1 day	FAA HQ (Washington D.C.) or NASA LaRC (Hampton VA) or WebEx / telecon

3.4.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products.

An electronic version of the Presentation shall be delivered to the Task Monitor (TM) at the time of the briefing. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation. **(Deliverable Item 4.1)**

NOTE: This briefing will be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA).

3.4.2 For the **Project Status Telecon**, the Contractor shall participate in monthly telecons to discuss status of ongoing work.

3.4.3 For the **Final Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of research for the entire Task Order, including analysis, optimization, manufacturing, and test articles. An electronic version of the presentation shall be delivered to the TM at the time of the briefing. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation. **(Deliverable Item 4.3)**

NOTE: This briefing will be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA).

3.5 Monthly Technical Letter Progress Reports: (Deliverable 4.2)

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.

2. A statement of current and potential problem areas and proposed corrective action.

3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 working days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: The Contractor shall submit an individual letter report for each individual task order. Multiple Task Orders shall not be summarized in one letter report.

3.6 Final Report: (Deliverable 4.4)

In accordance with Contract Exhibit A, the Contractor shall submit a Formal Final Report, which is prepared in accordance with the contract clause entitled “Final Scientific and Technical Reports” (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.

4.0 DELIVERABLES:

The Contractor shall deliver the following items FOB Destination. All deliverables shall be delivered with unlimited rights and unrestricted rights as defined under FAR 52.227-14 (Rights in Data - General), as modified by NFS 1852.227-14.

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.4.1	Kick-off Presentation	1 EA	Within 1 month after Task Order Award.	See Task.
4.2	3.5	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to TM, COTR and CO electronically (preferably via email).
4.3	3.4.3	Final Presentation.	1 EA	During last month of Task Order.	See Task.
4.4	3.6	Final Report.	1 EA	At task order expiration.	Delivered to TM, COTR, and CO electronically (preferably via email or electronic media (e.g., CD or DVD) and in accordance with NFS 1852.235-73 and contract. Per Contract: Copy of formal final report cover letter to the Center STI Publication Manager, ATTN: Mail Stop 158 or EMAIL: Susan.H.Stewart@nasa.gov

5.0 GOVERNMENT FURNISHED INFORMATION (GFI):

The Government will provide the following GFI to the Contractor:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1	3.0	"Draft of terminology definitions, some underlying characteristics of adaptive systems, and safety issues that will be faced in fielding adaptive systems"	1 EA	2 weeks after task order award.

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE".

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **N/A** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245-1 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"		$	X months after award

7.0 ADDITIONAL DATA RIGHTS: Reserved.

8.0 SECURITY CLEARANCE REQUIREMENTS: None.

9.0 PERIOD OF PERFORMANCE: 8 Months from Task Order Award Date.

10.0 POINTS OF CONTACT:

STATEMENT OF WORK (SOW)

Task Title: "Assessing Verification and Validation Processes for Automation with Respect to Vulnerabilities to Loss of Airplane State Awareness"

1.0 Background

NASA's Aviation Safety Program[1] is conducting research directed at proactively identifying, developing, and maturing tools, methods, and technologies for improving the overall safety of new and legacy aircraft. Research is organized into three project areas: (1) System-Wide Safety and Assurance Technologies (SSAT), (2) Vehicle Systems Safety Technologies (VSST), and (3) Atmospheric Environment Safety Technologies (AEST). This SOW specifically addresses long-term technical challenges in both the SSAT and VSST projects.

- *SSAT, Assurance of Flight Critical Systems* – Development of verification and validation (V&V) techniques to establish confidence that new technologies are safe and provide a cost-effective basis for assurance and certification of complex civil aviation systems.
- *SSAT, Assuring Safe Human-Systems Integration* – Enable the development of robust human-automation systems by incorporating known limitations of human performance into analysis tools.
- *VSST, Improved Crew Decision Making and Response in Complex Situations* – Demonstrate capabilities that enable pilots to better understand and respond safely to complex situations.
- *VSST, Safe and Effective Aircraft Control Under Hazardous Conditions* – Develop integrated guidance, control, and system technologies that enable safe and effective crew/system aircraft control under hazardous conditions.

More specifically, within the *Assurance of Flight Critical Systems* challenge of SSAT, there is a sub-challenge related to the verification and validation of Authority and Autonomy (A&A) constructs. Authority, in the context of aircraft operations, refers to having the right, or power, to exercise controls that will change the position, velocity, and/or attitude of an aircraft. Autonomy refers to a function or system that can operate independently of pilot or controller intervention. For current aircraft operations, pilots and air traffic controllers are the authorities; however, they may, and do, delegate authority to automation for selected activities or functions (e.g., auto-land systems). In these cases, the pilot and/or air traffic controller is responsible for monitoring the performance of the automation to assure it performs its intended function, and to reclaim authority should it fail, or otherwise "de-couple" per its' design logic. This paradigm has worked well and has been demonstrated to be safe for many situations – due largely to established V&V processes for systems and procedures, as well as training. However, there remain situations that these processes cannot account for, or predict. The purpose of the research that this SOW contributes to is to study one class of such situations – those involving loss of airplane state[2] awareness by the flight crew and air traffic controllers.

[1] http://www.aeronautics.nasa.gov/programs_avsafe.htm

[2] Airplane state is defined here to include, at a minimum, airplane position, velocity, velocity rates, attitude, attitude rates, power setting, configuration, and system status (including automation mode)

2.0 Scope / Objective:

The scope of this effort is to examine methods for assessing whether, and how, operational constructs properly assign authority and autonomy in a safe and coordinated manner – with particular emphasis on assuring adequate airplane state awareness by the flight crew and air traffic controllers in off-nominal and/or complex situations. One outcome should be recommendations for improving design standards and V&V techniques to ensure that there is transparency of both authority transition mechanics (e.g., mode transitions and de-coupling), and their consequences.

The objective of this task is to deliver a Final Report that documents the following:

(1) Current processes used by the industry to conduct V&V activities to assure that airplane state awareness is maintained in cases where automated systems have been delegated the authority to change airplane state;

(2) results of an analyses of the role that testing using high fidelity simulation facilities linked with airborne test platforms can play in extending current V&V methods to check for sufficient airplane state awareness by the crew and air traffic controllers during complex off-nominal authority-management situations;

(3) an assessment of the anticipated impact that such simulation facilities linked with airborne test platforms might have on the existing and emerging V&V processes; and

(4) a detailed plan to demonstrate the linked-facility method for testing a set of complex off-nominal authority management situations.

The Contractor shall consider not only current commercial aviation operations, but also those anticipated for the FAA's Next Generation Air Transportation System (NextGen)[3].

3.0 Description of Task Requirements

The Contractor shall perform the following tasks:

3.1 Identify current processes used by the industry

The Contractor shall identify current processes used by the industry to conduct V&V activities to assure that airplane state awareness is maintained in cases where automated systems have been delegated the authority to change airplane state. The Contractor shall survey and document applicable Federal Aviation Regulations (FARs)[4], standards, FAA Advisory Circulars (ACs)[5], and NextGen plans that are pertinent to the V&V of operations involving the delegation of authority to automation, the re-establishment of authority by the pilot or air traffic controller (e.g., "taking

[3] http://www.faa.gov/nextgen
[4] http://www.faa.gov/regulations_policies/faa_regulations
[5] http://www.faa.gov/regulations_policies/advisory_circulars

over"), and the automation's intentional transfer of authority back to the pilot or controller (e.g., "auto-pilot de-coupling"). Industry best-practices shall be documented regarding how compliance to regulations and standards is demonstrated. For those cases where authority to change airplane state has been delegated to automation, the Contractor shall document in detail how the automation's performance is communicated to the flight crew or air traffic controller. Finally, the Contractor shall document the V&V processes employed to evaluate whether cues related to authority-sharing are sufficient.

3.2 Analyze the role of linked ground/flight testing

The Contractor shall analyze the role that testing using high fidelity simulation facilities linked with airborne test platforms can play in extending current V&V methods to check for sufficient airplane state awareness by the crew and air traffic controllers during complex off-nominal authority-management situations. The Contractor shall perform a detailed analysis to determine operational situations that have occurred, or may be anticipated to occur within NextGen, for which augmenting current V&V methods to include linked ground-based simulation and flight testing may help to uncover previously unpredictable behaviors of authority-management functions. Particular emphasis shall be on identifying under what authority and autonomy allocations, or boundary conditions, can such a test environment provide unique V&V coverage. High-level capabilities and performance requirements for such an environment shall also be specified and documented.

3.3 Assess the anticipated impact of using linked ground/flight testing

The Contractor shall assess the anticipated impact that ground-based simulation facilities linked with airborne test platforms might have on existing and emerging V&V processes. The Contractor shall estimate the effect of augmenting traditional V&V processes (SOW Task 3.1) with a linked ground-based simulation and flight test capability (SOW Task 3.2). The Contractor shall consider and document the pro's and con's of this type of testing. The Contractor shall also perform a cost-benefit analysis to aid in determining when, and/or if, such testing may be warranted. Cost, in this case, shall not only include the financial cost, but also consideration of the potential affect on operational risk. Benefits shall consider V&V cost-savings (e.g., reducing time for in-service acceptance testing) as well as any side benefits (e.g., possible dual-use as a training environment).

3.4 Develop a detailed plan to demonstrate the linked ground/flight test method

The Contractor shall develop and document a detailed plan to demonstrate the linked-facility method for testing a set of complex off-nominal authority management situations. The use of existing facilities shall be leveraged in this plan wherever possible to allow for expeditious development and execution of the demonstration in the event that NASA requires a follow-on task order.

3.5 Planned Presentations / Meetings / Telecons

In support of the above tasks, the Contractor shall participate in and/or travel to the following meetings that may be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA) and/or FAA contractors:

TASK REF.	MEETING	FREQUENCY / DATE	EST. DURATION PER TRIP / TELECON	PLANNED LOCATION
3.5.1	Kick-Off Presentation	Within 30 days after task order award. Date and time to be mutually agreed upon by the Contractor and TM.	1 day	NASA LaRC, Hampton VA
3.5.2	Project Status Meetings	Bi-Monthly (i.e., every other month) Date and time to be mutually agreed upon by the Contractor and TM.	1 hour	Via WebEx / Telecon
3.5.3 *See Note below.	NASA AvSP Technical Meeting	Once. Date: TBD	3 days	TBD **For proposal purposes, Contractor should use Washington, DC**
3.5.4 *See Note below.	Mid-Term Technical Interchange Meeting (TIM)	During months 8 or 9 after task order award. Date and time to be mutually agreed upon by the Contractor and TM.	1 day	NASA LaRC, Hampton VA
3.5.5	Final Review Presentation	During last month of task order award. Date and time to be mutually agreed upon by the Contractor and TM.	1 day	NASA LaRC, Hampton VA

*** NOTE:** If the Mid-Term TIM (3.5.4) is estimated to fall within one month of the AvSP meeting, then the Mid-Term TIM shall be scheduled to occur as part of the 3-day AvSP meeting. If this is not the case, then the Contractor shall plan to attend the AvSP meeting with the Mid-Term TIM (3.5.4) to occur separately as a one-day meeting at LaRC.

3.5.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, schedule, milestones, and deliverables. As part of this presentation, the Contractor shall propose the list of complex off-nominal authority-management situations to be considered in the study (see SOW Task 3.2), and a mutually agreed-upon set, or sub-set, will be selected for the project going forward. Mutual agreement shall be between the NASA Task Monitor and the Contractor's Technical Lead and shall be documented via email, or as part of meeting minutes. An electronic version of the Presentation shall be delivered to the Task Monitor (TM) no later than one day prior to the briefing. A copy of this file and meeting minutes shall also be delivered to the COTR and CO (preferably via email) no later than one week after the presentation. **(Deliverable Item 4.2)**

3.5.2 For the **Project Status Meetings**, the Contractor shall participate in bi-monthly teleconferences to discuss the status of the project.

3.5.3 The purpose of attending the **Annual NASA AvSP Technical Meeting** is to facilitate technical interchange with NASA and its partners across the Aviation Safety Program (AvSP) who are working on related research.

3.5.4 The purpose of the **Mid-Term Technical Interchange Meeting (TIM)** is for the Contractor to participate in a discussion forum with NASA and its partners' subject matter experts to allow coordination with other related research, and to enable more effective collaboration.

3.5.5 For the **Final Review Presentation**, the Contractor shall prepare a presentation in PowerPoint, to include, at a minimum, a summary of accomplishments for the entire project. An electronic version of the presentation shall be delivered to the TM at the time of the briefing. A copy shall also be delivered to the COTR and the CO (preferably via email) no later than one week after the presentation. The Final Review Presentation shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. **(Deliverable Item 4.3)**

3.6 Monthly Technical Letter Progress Reports (Deliverable Item 4.1)

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: Task Orders shall not be summarized in one letter reports. The Contractor shall submit individual reports for each task.

3.7 Final Report (Deliverable Item 4.4)

In accordance with Contract Exhibit A, the Contractor shall submit a Final Report, which is prepared in accordance with the contract clause entitled “Final Scientific and Technical Reports” (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.

4.0 Deliverables

The Contractor shall deliver the following items FOB Destination. All deliverables shall be delivered with unlimited rights and unrestricted rights as defined under FAR 52.227-14 (Rights in Data - General), as modified by NFS 1852.227-14.

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.6	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to TM, COTR, and CO electronically (preferably via email).
4.2	3.5.1	Kick-Off Presentation and Meeting Minutes.	1 EA	See Task.	See Task.
4.3	3.5.5	Final Review Presentation.	1 EA	See Task.	See Task.
4.4	3.7	Final Report.	1 EA	Task order expiration	Delivered to TM, COTR, and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235-73 and contract.

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "NONE"

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1		"None"		

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE"

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **N/A** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"			

Proposal Note to Contractors: If limited rights data or restricted rights data are proposed or necessary, then this will be handled during negotiation.

7.0 ADDITIONAL DATA RIGHTS: "Reserved"

8.0 Security Clearance Requirements: None

9.0 Period of Performance: 16 months from date of Task Order award date.

10.0 Points of Contact:

Flight Critical Systems Research (FCSR)

Statement of Work (SOW)

TASK ORDER TITLE: "Safety Sufficiency for NextGen"

1.0 Background:

The current air transportation system is remarkably safe. It is so safe that traveling by airplane is often thought to be the safest means of travel possible today. A myriad of different reasons contribute to the current high level of safety, including conservative adoption of new technologies, careful introduction of automation to augment human capabilities, and thoughtful reliance on experience for establishing safety-ensuring processes and regulations. However, the complexity and inner-connectivity of the systems, procedures, and processes proposed for the Next Generation Air Transportation System (NextGen) cast doubts on whether these reasons will continue to apply, and thus on whether the current approaches to ensuring safety will continue to suffice.

Partially in response to these doubts, NASA's Aviation Safety Program began the System Safety Assurance Technologies (SSAT) Project. SSAT has identified a number of challenge problems, including the Assurance of Flight-Critical Systems (AFCS) which has motivated research designed to help ensure the safe deployment of flight critical systems for NextGen and beyond. Working towards the AFCS challenge problem, the Argument-Based Safety Assurance (ABSA) sub-element of SSAT is targeting three general areas: understanding safety requirements; determining needed evidence; and investigating arguments. This task addresses the safety requirements area.

2.0 Scope & Objective(s):

The scope of this task order is to evaluate the safety issues that are likely to arise during the implementation and deployment of NextGen systems, and assesses whether existing methods, tools, processes, and regulations are sufficient to address adequately each issue. A 'safety issue' is anything that may affect the safety of the public. A safety issue may be said to be 'addressed adequately' if (1) a suitably high degree of confidence can be justifiably obtained that the issue will not result in a decrease in the safety of air transportation, and (2) the cost of obtaining the requisite degree of confidence is tolerable.

The objective of this task is to:

1. Deliver a document that identifies proposed NexGen technologies, systems and procedures;
2. assesses their safety implications; and
3. identifies the sufficiency of existing tools, methods, procedures, and regulations to ensure that the current level of safety is not compromised through their deployment.

3.0 Description of the Work/Tasks to be Performed:

For this task order, the Contractor shall perform the following seven tasks. The sequential listing of these tasks is not intended to imply that the Contractor is required to perform them in a rigid sequential order.

3.1 Identify Planned and Proposed NextGen Technologies, Systems, and Procedures.

The Contractor shall survey the existing NextGen documents, plans, and presentations to develop a list of new technologies, systems, and procedures that are expected or envisioned to be implemented within the next 20 years. At a minimum, the Contractor shall include within this survey all of the documents contained in the FAA's NextGen library[1]. For each element of this list, the Contractor shall provide a brief description of its characteristics (concentrating on those characteristics that make it different from existing elements of the air transportation systems), and identify the document(s) on which the description is based.

3.2 Determine safety issues.

The Contractor shall analyze the possible safety affects of the elements identified in 3.1. For at least five of these elements[2], this analysis shall include a high-level hazard analysis that takes into consideration potential hardware, software, human, and environmental factors.

3.3 Assess sufficiency of existing methods, tools, processes, and regulations.

For the safety issues identified in 3.2, the Contractor shall assess whether current methods, tools, processes, and regulations are sufficient to (1) provide a suitably high degree of justifiable confidence that the issue will not result in a decrease in the safety of air transportation, (2) without intolerably high costs.

[1] See http://www.faa.gov/nextgen/library.
[2] Or, for all of the elements if the list identified in 3.1 shall contain four or fewer elements.

3.4 Planned Presentations/Meetings/Telecons:

The Contractor shall be required to participate in the planned telecons/ presentations as specified below:

Task	Meeting	Frequency / Date	Estimated Duration Per Trip / Telecon	Planned Location
3.4.1	Kick-off Presentation	Within 30 days after task order award. Date, time, and location to be mutually agreed by the Contractor and TM.	1 day or less.	Contractor's facility or via WebEx/ telecon
3.4.2	Project Status Meetings	Every other month. Date and time to be mutually agreed by the Contractor and TM.	1 hour or less.	Via WebEx/ telecon
3.4.3	Final Review and Presentation	During last month of task order award. Date, time, and location to be agree by the Contractor and TM.	1 day or less.	NASA Langley Research Center. Hampton, Virginia

3.4.1 For the **Kick-off Presentation**, the Contractor shall prepare and give a presentation that facilitates review and discussion of the project approach, expected outcomes, and tangible products. An electronic version of the presentation shall be delivered to the Technical Monitor via e-mail at least 24 hours before the scheduled start of the meeting. **(Deliverable Item 4.1)**

3.4.2 For the **Project Status Meetings**, the Contractor shall orally discuss the status of the work with the Technical Monitor at least every other month.

3.4.3 For the **Final Review and Presentation**, the Contractor shall prepare and give a presentation that includes at a minimum a summary of accomplishments for the entire task. An electronic version of the presentation shall be delivered to the TM at the time of the meeting with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. A copy shall also be delivered to the CO via e-mail not later than one week after the meeting. **(Deliverable Item 4.3)**

Note: Attendees at the meeting may include NASA civil servants, on-site contractors, and students.

3.5 Monthly Technical Letter Progress Reports. (Deliverable 4.2)

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 working days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: The Contractor shall submit an individual letter report for each individual task order. Multiple Task Orders shall not be summarized in one letter report.

3.6 Final Report. (Deliverable 4.4)

In accordance with Contract Exhibit A, the Contractor shall submit a Formal Final Report, which is prepared in accordance with the contract clause entitled "Final Scientific and Technical Reports" (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.

4.0 Deliverables:

The Contractor shall deliver the following items FOB Destination. All deliverables shall be delivered with unlimited rights and unrestricted rights as defined under FAR 52.227-14 (Rights in Data - General), as modified by NFS 1852.227-14.

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.4.1	Kick-off Presentation.	1 EA	Within 1 month after Task Order Award.	See Task Ref.
4.2	3.5	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to TM, COTR, and CO electronically (preferably via email).
4.3	3.4.3	Final Review and Presentation.	1 EA	During last month of Task Order.	See Task Ref.
4.4	3.6	Final Report.	1 EA	NLT Task Order Expiration.	Delivered to TM, COTR, and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235.73 and contract.

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "None"

The Government will provide the following GFI to the Contractor:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
-	-	None	-	-

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE".

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at _**N/A**_ and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245-1 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"		$	X months after award

7.0 ADDITIONAL DATA RIGHTS: Reserved.

8.0 SECURITY CLEARANCE REQUIREMENTS: None.

9.0 PERIOD OF PERFORMANCE: 9 Months from Task Order Award Date.

10.0 POINTS OF CONTACT:

Flight Critical Systems Research (FCSR)

Task Order Statement of Work (SOW)

TASK ORDER TITLE: "Human Factors Issues & Operational Experiences in Merging & Spacing for NextGen Operations"

1.0 BACKGROUND:

The Federal Aviation Administration's (FAA) planned Next Generation Air Transportation System (NextGen) will reduce aircraft separation and implement a shift towards flight deck separation assurance responsibilities. These changes will, in turn, significantly alter existing collision avoidance and separation assurance roles, responsibilities, displays and alerts. New methods of separation assurance require delegation or sharing of separation assurance functions between the Air Navigation Service Provider (ANSP) and the flight deck for certain portions of a flight segment and/or for specific aircraft. Additionally, collision avoidance algorithms may require some alteration or consideration of intent information in order to match collision avoidance alerting criteria with reduced separation standards.

The FAA's experience from recent implementation of advanced procedures like Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR) suggests that intended benefits provided by new procedures may be negated by human factors issues such as frequent pilot errors in matching of procedures to runways and pilot challenges responding to Air Traffic Control directions. Achieving intended levels of reduced separation requires research that identifies relevant human performance parameters, information needs, human error potential and methods for validating operational procedures. While limited merging and spacing operations are currently conducted in the US National Airspace System (*e.g.*, United Parcel Service operations at Louisville, KY), additional research is required to investigate human factors issues that may arise when extending these operations to multiple aircraft operators and types.

2.0 SCOPE / OBJECTIVES:

The scope of this effort is to conduct reviews, surveys, and workshops for establishing a basis for developing requirements for NextGen Human Factors Collision Avoidance and Separation Assurance systems for Merging & Spacing operations. Specific objectives include:

- Establishing human capabilities and limitations that affect human error potential and impact.
- Developing information needs for displays, alerts and procedures.
- Evaluating supporting technologies and procedures.

3.0 DESCRIPTION OF TASK REQUIREMENTS:

The Contractor shall conduct reviews, surveys, and workshops that provide the basis for developing requirements for NextGen Human Factors Collision Avoidance and Separation Assurance systems for Merging & Spacing operations.

The Contractor shall perform the following tasks:

3.1 Literature Review:

The Contractor shall develop a comprehensive, macro-level review and summary of completed, ongoing, and /or planned human factors research relevant to merging and spacing operations that includes a description of new enabling technologies (including display formats and symbols) used to accomplish merging & spacing operations. The review and summary shall consider research conducted by federal agencies, universities, and private industry in both the US and foreign institutions.

The Contractor shall deliver a Draft Literature Review Report (**Deliverable 4.6)** which includes a compilation of source documents used and a formal reference section in American Psychological Association (APA) citation format. The NASA Technical Monitor (TM) will provide written comments via email to the Contractor within 10 business days. The Contractor shall incorporate the NASA TM's comments and deliver a Final Literature Review Report which includes a compilation of source documents used and a formal reference section in APA citation format. **(Deliverable 4.7)**

3.2 Operations Review & Operator Perspectives Document:

This task assesses industry and government best operational practices relevant to problems in Merging & Spacing and identifies user community concerns. These best practices and concerns must consider operational experience for both US and foreign airspace operations.

3.2.1 The Contractor shall develop and administer a survey of relevant airspace user communities to determine their Merging & Spacing concerns as well as their evaluation of current and emerging practices. This survey shall be advertised to individuals and user communities representing, minimally: domestic general aviation pilots, business jet pilots, commercial pilots, military pilots, dispatch operators, and air traffic managers; and foreign (minimally, Europe, Canada, Mexico, and Caribbean Isles) commercial pilots, dispatch operators and air traffic managers. The survey shall remain open until either the NASA TM issues, through email record, a call for it to end or when there are at least: 20 domestic

general aviation pilot, 20 business jet pilot, 40 commercial pilot, 20 dispatch, 20 Air Traffic Management (ATM), and 20 foreign (10 airborne side/10 ground side) responses. The survey shall require users to identify their user community group and type of operations[1], allow them to provide contact information, and ask them if it would be acceptable to associate their contact information with their responses to facilitate follow up discussions.

A Draft Report of the Distribution Approach and Survey Methodology shall be delivered **(Deliverable 4.4)**. The NASA TM will provide written comments via email to the Contractor within 10 business days. The Contractor shall incorporate NASA comments into a Final Report of the Distribution Approach and Survey Methodology **(Deliverable 4.8)** prior to the administration of the survey. At the conclusion of the survey, a Summarized Survey Results and Compiled Raw Data Report shall be delivered **(Deliverable 4.9)**.

3.2.2 The Contractor shall develop and conduct two workshops (see also SOW Tasks 3.5.4 and 3.5.5 for meeting requirements) that provide a forum for in-depth discussion and technical interchange within and across the relevant user communities. Workshop agenda topics shall include, but are not limited to, relevant merging & spacing practices, concerns in existing operations and proposed operations, and anticipated human/system interaction errors.

The Contractor shall deliver the Workshop Invitee Information and Workshop Approach **(Deliverable 4.5)** containing the contact information for issuing participant invitations (minimally 5 participants per session and 2 workshop sessions, with constituency focused on domestic commercial air carrier pilots) and candidate workshop approach. The NASA TM will use this list for developing the composition of the workshops and corresponding invitation list.

The Contractor shall co-lead the workshops with NASA, record minutes of workshop sessions, and deliver the Summarized Workshop Results and Compiled Raw Notes and Recordings of Workshop Sessions **(Deliverable 4.11)**. To participate in this survey data collection, the Contractor shall have a current Institutional Review Board (IRB) certification[2].

[1] Part 91 – General Operating and Flight Rules
Part 97 – Standard Instrument Approach Procedures
Part 119 – Certification: Air Carriers and Commercial Operators
Part 121 – Operating Requirements: Domestic, Flag, and Supplemental Operations
Part 125 – Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Payload Capacity of 6,000 Pounds or More
Part 135 – Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons on Board Such Aircraft
[2] https://www.citiprogram.org/default.asp

3.2.3 The Contractor shall develop an Operational Perspectives Document that describes the results of the survey (Task 3.2.1) and workshop sessions (Task 3.2.2), and, based on the survey and workshop results, summarizes best practices and concerns as they pertain to specific operational characteristics. Where applicable, links to web-hosted documents or files included in the electronic submission of the report shall be an Appendix to this report.

A Draft Operational Perspectives Document shall be delivered **(Deliverable 4.12)**. The NASA Technical Monitor (TM) will provide written comments via email to the Contractor within 10 business days. The Contractor shall incorporate the NASA TM's comments into a Final Operational Perspectives Document **(Deliverable 4.13)**.

3.3 Contacts List:

The Contractor shall create an Excel spreadsheet that identifies individuals that have an operational or research interest in identifying human factors issues in merging and spacing. At a minimum, this list shall contain contact information for the individuals participating in either the survey or the workshops under task 3.2. The spreadsheet shall identify: name, title, institution, address, phone, email, and a link to relevant work.

A Draft Key Contacts List shall be delivered **(Deliverable 4.3)**. The NASA Technical Monitor (TM) will provide written comments via email to the Contractor within 10 business days. The Contractor shall incorporate the NASA TM's comments into the Final Key Contacts List **(Deliverable 4.14)**.

3.4 Human Factors Issues & Future Work:

The Contractor shall summarize the key human factors issues identified in Tasks 3.2, identify key personnel with whom future collaborations would be most fruitful (both as user representatives and research partners), and identify research focus areas in light of projected needs for NextGen based on a review of relevant NextGen operational concepts[3] and architectural roadmaps[4].

A Draft Human Factors Issues & Future Work Document shall be delivered **(Deliverable 4.15)**. The NASA Technical Monitor (TM) will provide written comments via email to the Contractor within 10 business days. The Contractor shall incorporate the NASA TM's comments into the Final Human Factors Issues & Future Work Document **(Deliverable 4.16)**.

[3] http://www.jpdo.gov/
[4] https://nasea.faa.gov/

3.5 Planned Presentations/Meetings/Telecons:

The Contractor shall be required to participate in and/or travel to the presentations/ meetings/telecons as specified below:

TASK	MEETING	FREQUENCY / DATE	ESTIMATED DURATION PER TRIP	LOCATION
3.5.1	Kick-Off Presentation	Within 1 month after Task Award. Date and time to be mutually agreed upon by the Contractor and TM.	1 to 2 Days	NASA LaRC Hampton, VA
3.5.2	Project Status Telecon	Monthly Date and time to be mutually agreed upon by the Contractor and TM.	~1 hour	Via telecon
3.5.3	Survey Results Presentation and Meeting	Date and time to be mutually agreed upon by the Contractor and TM.	1 day	Location to be mutually agreed upon by the Contractor and TM **(consider Hampton, VA for proposal purposes)**
3.5.4	Workshop 1 Meeting	Date and time to be mutually agreed upon by the Contractor and TM.	3 days	Location to be mutually agreed upon by the Contractor and TM **(consider Hampton, VA for proposal purposes)**
3.5.5	Workshop 2 Meeting	Date and time to be mutually agreed upon by the Contractor and TM.	3 days	Location to be mutually agreed upon by the Contractor and TM **(consider Hampton, VA for proposal purposes)**
3.5.6	Final Presentation	During last month of Task. Date and time to be mutually agreed upon by the Contractor and TM.	1 Day	NASA LaRC Hampton, VA

3.5.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products. An electronic version of the Presentation shall be delivered to the Technical Monitor (TM) at the time of the briefing. A copy of the Kick-Off Presentation shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation **(Deliverable 4.2)**.

3.5.2 For the **Project Status Telecon**, the Contractor shall participate in monthly telecons to discuss the status of ongoing work. During the telecon, the Monthly Technical Letter Progress Report shall also be discussed.

3.5.3 For the **Survey Results Presentation and Meeting**, the Contractor shall prepare a presentation in PowerPoint **(Deliverable 4.10)**, which includes at a minimum a summary of the findings for SOW Task 3.2.1 (i.e., Summarized Survey Results and Compiled Raw Data Report, Deliverable 4.9). An electronic version of the presentation shall be delivered to the TM at the time of the presentation. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation.

In addition, the Contractor shall participate in a meeting to discuss the findings from SOW Task 3.2.1 and participate in technical interchange.

3.5.4 For the **Workshop 1 Meeting** requirements, see SOW Task 3.2.2**.**

3.5.5 For the **Workshop 2 Meeting** requirements, see SOW Task 3.2.2**.**

3.5.6 For the **Final Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of accomplishments for the entire task. An electronic version of the presentation shall be delivered to the TM at the time of the presentation. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation. The Final Presentation shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. **(Deliverable 4.17)**

3.6 TECHNICAL REPORTS:

In addition to the "Contract Documentation Requirements" listed in Contract Exhibit A, the Contractor shall submit the following reports:

3.6.1 **Monthly Technical Letter Progress Reports**: **(Deliverable Item 4.1)**

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: Task Orders shall not be summarized in one letter report. The Contractor shall submit individual reports for each task.

3.6.2 Final Report: (Deliverable Item 4.18)

In accordance with Contract Exhibit A, the Contractor shall submit a Formal Final Report, which is prepared in accordance with the contract clause entitled "Final Scientific and Technical Reports" (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.

4.0 DELIVERABLES:

The Contractor shall deliver the following items FOB Destination:

ITEM NO.	TASK REF	DELIVERABLE DESCRIPTION	QTY.	DUE DATE	DELIVERY INSTRUCTIONS
4.1	3.6.1	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to COTR, TM, and CO. (Preferably via email).
4.2	3.5.1	Kick-Off Presentation.	1 EA	See Task.	See Task.
4.3	3.3	Draft Key Contacts List.	1 EA	1 month after award date	Via email to the COTR, TM, and CO.
4.4	3.2.1	Draft Report of the Distribution Approach and Survey Methodology.	1 EA	3 months after award date	Via email to the COTR, TM, and CO.
4.5	3.2.2	Workshop Invitee Information and Workshop Approach.	1 EA	3 months after award date	Via email to the COTR, TM, and CO.
4.6	3.1	Draft Literature Review Report.	1 EA	Due 6 months after award date	Via email to the COTR, TM, and CO.
4.7	3.1	Final Literature Review Report.	1 EA	Due 7 months after award date	Via email to the COTR, TM, and CO.
4.8	3.2.1	Final Report of the Distribution Approach and Survey Methodology.	1 EA	7 business days after comments received	Via email to the COTR, TM, and CO.

ITEM NO.	TASK REF	DELIVERABLE DESCRIPTION	QTY.	DUE DATE	DELIVERY INSTRUCTIONS
4.9	3.2.1	Summarized Survey Results and Compiled Raw Data Report.	1 EA	7 months after award date	Via email to the COTR, TM, and CO.
4.10	3.5.3	Survey Results Presentation	1 EA	See Task.	See Task.
4.11	3.2.2	Summarized Workshop Results and Compiled Raw Notes and Recordings of Workshop Sessions.	1 EA	8 months after award date	Via email to the COTR, TM, and CO.
4.12	3.2.3	Draft Operational Perspectives Document.	1 EA	9 months after award date	Via email to the COTR, TM, and CO.
4.13	3.2.3	Final Operational Perspectives Document.	1 EA	7 business days after comments received	Via email to the COTR, TM, and CO.
4.14	3.3	Final Key Contacts List.	1 EA	9 months after award date	Via email to the COTR, TM, and CO.
4.15	3.4	Draft Human Factors Issues & Future Work Document.	1 EA	11.5 months after award date	Via email to the COTR, TM, and CO.
4.16	3.4	Final Human Factors Issues & Future Work Document.	1 EA	7 business days after comments received	Via email to the COTR, TM, and CO.
4.17	3.5.6	Final Presentation.	1 EA	See Task.	See Task.
4.18	3.6.2	Final Report.	1 Ea	Task Order Expiration	Via email or electronic media (e.g., CD or DVD) in MS Word, Excel, PowerPoint, or Adobe PDF to the COTR, TM, and CO (see "Report Distribution" below). Per Contract: Copy of formal final report cover letter to the Center STI Publication Manager, ATTN: Mail Stop 158 or EMAIL: Susan.H.Stewart@nasa.gov

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "NONE"

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1		"None"		

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE"

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at _**TBD**_ and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"			

7.0 SECURITY CLEARANCE REQUIREMENTS: None

8.0 PERIOD OF PERFORMANCE: 12 Months from Task Order Award Date.

9.0 POINTS OF CONTACT:

Flight Critical Systems Research (FCSR)

Task Order Statement of Work (SOW)

TASK ORDER TITLE: "Flight Test of Synthetic And Enhanced Vision Systems Technologies for NextGen"

1.0 BACKGROUND:

The Integrated Intelligent Flight Deck (IIFD) project, under NASA's Aviation Safety Program (AvSP), is conducting research, development, test, and evaluation (RDT&E) of displays and decision support technologies which may proactively overcome aircraft safety barriers that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen). Part of this research effort involves the use of synthetic and enhanced vision systems as enabling technologies to meet these safety challenges.

Equivalent Visual Operations (EVO) are defined as operations where an electronic means provides sufficient visibility of the external world and other required flight references on a flight crew's cockpit displays that the safety, operational tempos, and visual flight rules (VFR)-like procedures are replicated in all weather conditions. Synthetic and enhanced vision system technologies are critical enabling technologies to EVO with the ultimate objective of EVO, being one component of a "Better Than Visual" (BTV) operational capability – replicating the capacity of today's VFR flight and more importantly, meeting and improving on the safety of today's VFR flight in all-weather NextGen operations.

As an initial step in meeting these NextGen goals, collaborative research between NASA and the Federal Aviation Administration (FAA) was been established to ensure effective development and implementation of regulatory guidance and procedures to support the introduction and use of synthetic and enhanced vision system technologies. This work builds from and extends current operational use and certification of existing synthetic and enhanced vision systems technologies to serve as building blocks toward all-weather, low visibility operations for NextGen.

2.0 SCOPE/OBJECTIVE:

This Task Order is part of a collaborative NASA and FAA program.

The objective of this Task Order is to conduct a flight test activity to obtain pilot-in-the-loop operational test data using synthetic and enhanced vision systems. The data from this flight test will be used by the Government for flight-validation /-verification/-demonstration of selected synthetic and enhanced vision operational and system-level performance test points.

The flight test is designed to complement analysis and ground simulation activities being conducted by NASA for RDT&E of synthetic and enhanced vision systems technologies. This overall program of analysis, ground simulation, and flight test may be used by the Government for effective development and implementation of regulatory guidance and procedures to support the introduction and use of synthetic and enhanced vision system technologies in current-day and NextGen operations.

3.0 DESCRIPTION OF TASK REQUIREMENTS:

The Contractor shall perform the following tasks:

3.1 Flight Test:

3.1.1 The Contractor shall conduct a flight test in accordance with the Flight Test Plan provided by NASA **(See GFI Item 6.1).** As identified in SOW Task 6.1, NASA will be responsible for the development and delivery of the Flight Test Plan which will describe the specific test points, recording equipment, and test procedures. The Contractor shall assist NASA in the development of the Flight Test Plan, as described in SOW Task 3.2.2.

Background: This work will serve as a complementary part of a NASA-led research and development activity. The flight test activity provides crucial flight-validation /-verification of the foundational principles and operating concepts for the effective development and implementation of regulatory guidance and procedures for use of synthetic and enhanced vision system technologies in low visibility NextGen operations.

3.1.2 The Contractor shall provide an instrumented test aircraft, equipped with an FAA-approved and/or certified Synthetic and Enhanced Vision Systems (SEVS). The EVS installed on this aircraft shall have also received approval and/or certification as an Enhanced Flight Vision System (EFVS) for descent below the published decision altitude down to 100 ft. height above the touchdown zone.

Background: NASA prefers that certified SEVS equipment be used in this test. The test data will be used for subsequent industry and government use in establishing minimum aviation system performance standards for this SEVS through RTCA Sub-Committee (SC)-213 (See www.rtca.org for additional information on SC-213 activities).

3.1.3 The Contractor-provided instrumented test aircraft shall be operated by two pilots in a side-by-side configuration with one pilot serving as an Evaluation Pilot (EP) and the other pilot serving as a Safety Pilot (SP). The SP shall be employed or sub-contracted by the Contractor and type-rated and highly experienced in the aircraft and in low-visibility operations with SEVS.

Background: Experience has shown that the primary determinant of safety-of-flight in this type of testing is the knowledge and experience of the SP.

3.1.4 The Contractor-executed flight test shall use EPs, provided by NASA or the FAA, who may or may not be type-rated in the aircraft, but shall serve as the test subjects. Institutional Review Board (IRB) approvals for human subject research will be the primary responsibility of NASA; the Contractor shall ~~assist and~~ support this process with inputs ~~to the IRB process as necessary and appropriate~~ if requested, through the Flight Test Plan development process identified under SOW Task 3.2.2. Additionally, the Contractor shall create adequate provisions in the test aircraft (e.g., seating, audio and visual interfaces) so that NASA and/or FAA engineering personnel may be on-board

during the test flights to assist in engineering and human factors data collection as necessary and appropriate for this flight test.

Background: The EPs will be NASA, FAA, or other government agency, manufacturer test pilots, or industry pilots, whose qualifications and suitability are determined by mutual agreement between the Contractor, the FAA, and NASA. The EPs will give assessments of the operational utility, acceptability, and suitability of the SEVS equipment as tested in accordance to the Flight Test Plan. NASA and/or FAA personnel will take part in the engineering and human factors data collection and analysis; their presence on-board the test aircraft should measurably assist in this process.

3.1.5 The Contractor-provided instrumented test aircraft shall be nominally operated in an Airport Approach Category C or D as per the Department of Transportation/FAA Aeronautical Information Manual, Section 5-4-7 ("Instrument Approach Procedures").

Background: The higher operating speeds in Category C or D will provide more demanding test conditions from which to establish minimum aviation system performance standards. This requirement will not, however, preclude the operation of the aircraft in Airport Approach Category A or B for build-up flight test purposes.

3.1.6 The flight test and associated Flight Test Plan shall be ~~based on a minimum of 30 hours to a maximum of 36 hours~~designed to maximize the ~~of~~ flight test time in the desired testing conditions (e.g., combinations of runway and approach lighting configuration, weather and visibility, and SEVS configuration)~~, conducted in 8 to 12 flights~~.

Background: ~~This~~ From the flight time estimate, ~~is derived by assuming that~~ approximately 9 configurations can be flown in closed-pattern approach, landing, and surface operations, within a nominal 3-hour flight duration. ~~This estimated flight test time is for planning purposes only and does not include the flight time for ferry, build-up flight test, necessary fuel reserves, or contingency (see SOW Tasks 3.2.4 and 3.2.6).~~ Although the test details will be established under the Flight Test Plan development process identified under SOW Task 3.2.2, it is planned that the SEVS experimental configurations will be created by procedural, operational, or available EFVS controls which may, for example, effect the presence, absence, or dynamics of a flare cue, vary the angular alignment of the EFVS sensor, or modulate the presence or absence of other existing HUD symbology.

3.1.7 The Contractor shall conduct a flight test in accordance to the Flight Test Plan (see SOW Task 6.1) to evaluate pilot-in-the-loop performance and operational concepts associated with the use of enhanced (flight) vision systems operating below the published decision altitude, down to landing, roll-out, and taxi, in weather and visibility where this operation would currently be prohibited.

Background: The overarching objective of the flight test, which will be defined and delineated in the Flight Test Plan, is the validation and verification of emerging NextGen operational concepts and technologies for the use of SEVS. Flight testing in actual low visibility conditions will serve as a complement to on-going ground simulation testing. The desired weather and visibility flight test

conditions may be as high as 2,400 foot runway visual range (RVR) and as low as 500 foot RVR.

3.1.8 The flight test shall also include evaluation of pilot-in-the-loop performance and operational concepts associated with the use of synthetic vision systems operating below the published decision altitude, down to 100 feet height above the touchdown zone elevation, in weather and visibility where this operation would currently be prohibited.

Background: Validation and verification of emerging NextGen operational concepts for the employment of SEVS requires actual low visibility condition testing as a complement to the associated ground simulation.

3.1.9 The flight test shall also include evaluation of pilot-in-the-loop performance and operational concepts associated with the use of SEVS for obstacle and object detection, including the potential for head-up display attention capture and clutter/obscuration during surface operations in low visibility conditions.

Background: True operational evaluation of a Head-Up Display (HUD) requires flight testing since actual HUD operational effects cannot be reliably replicated in ground simulation.

3.1.10 The Contractor shall perform modifications, as appropriate and necessary, to enable selected system-level SEVS variations for flight test evaluation.

Background: The specific test points associated with variations in SEVS performance will be defined in the Flight Test Plan (see SOW Task 6.1). The flight test data from these test points will be used by NASA as validation and verification to the complementary ground simulation work. The modifications will exercise, as possible and practical, the minimum aviation system performance standards under RTCA SC-213, as published in “Minimum Aviation System Performance Standards (MASPS) for Enhanced Vision Systems, Synthetic Vision Systems and Enhanced Flight Vision Systems,” RTCA DO-315 (see www.rtca.org). The SEVS experimental variations will be created by available controls or readily accessible modifications which may, for example, effect the presence, absence, or dynamics of a flare cue, vary the angular alignment of the EFVS sensor, impact the accuracy of the SVS depiction, or modulate the presence or absence of other existing HUD symbology.

3.1.11 The Contractor shall provide the instrumented test aircraft and assist NASA in ground testing to quantify the installed equipment system performance, as per quantitative RTCA DO-315 standards, for EFVS latency and image conformality.

Background: Ground testing will measure the installed system performance for analytical and documentation purposes.

3.1.12 The Contractor-provided instrumented test aircraft shall be equipped so the EP can use the synthetic vision system information displayed on a color, head-down primary flight display, with primary flight display information, following RTCA DO-315.

Background: The flight test data will be used by the Government to evaluate system-level performance and operational concepts associated with the use of synthetic vision systems operating below the published decision altitude, down to 100 feet above the touchdown zone elevation, in weather and visibility where this operation would currently be prohibited. The equipment and flight test data will be compared against existing minimum aviation system performance standards.

3.1.13 The Contractor-provided instrumented test aircraft shall be equipped so the EP can use the enhanced (flight) vision system information displayed on a monochromatic, HUD, with conformal symbolic information and flight information, following RTCA DO-315.

Background: The flight test will be used by the Government to evaluate system-level performance and operational concepts associated with the use of enhanced (flight) vision systems operating below the published decision altitude, down to landing, roll-out, and taxi, in weather and visibility where this operation would currently be prohibited. The equipment and flight test data will be compared against existing minimum aviation system performance standards.

3.1.14 The Contractor shall deliver on-board instrumentation records from each test flight in a mutually-agreeable format between the Contractor and NASA within 24 hours following the completion of the test flight. The recordings shall include, at a minimum, the data identified in SOW Task 3.1.16. **(Deliverable Item 5.4)**

Background: Data recording will be critical to the testing/verification and validation process. Prompt data retrieval will assist in timely flight planning. These data will also be critical for subsequent use by the government and by industry for the development and employment of safe and effective low visibility technologies and operations.

3.1.15 The Contractor shall deliver independent, recorded aircraft position data with accuracy and available equal to or better than Wide Area Augmentation System / Global Positioning System (WAAS/GPS). **(Deliverable Item 5.4)**

Background: The independent, recorded aircraft position data will serve as a stand-alone accurate source of aircraft navigational information which, in addition to other recorded data, will provide an independent source of aircraft positioning data.

3.1.16 The Contractor-provided instrumented test aircraft shall have the capability to record (at a minimum) the following data:

1) Video recording of the primary flight display and EVS-equipped head-up display, including time code, and with audio which includes the ship's intercom and selected Very High Frequency radio audio;
2) EP yoke and throttle inputs;
3) Take-off/Go-Around mode initiation;
4) Display configuration information (including HUD declutter condition and experimental variation condition);
5) Toe-brakes and tiller inputs;
6) Aircraft pitch, roll, and yaw rates and attitudes, body axis accelerations, and inertial rates and accelerations; and

7) Independent aircraft positioning system data (see SOW Task 3.1.15) and ship's positioning system data driving the SEVS information.

Background: These data will be used by the Government, post-flight, to analytically assess and qualify the pilot-in-the-loop flight performance.

3.1.17 The Contractor shall conduct real-time performance monitoring, as necessary and appropriate, to establish safety-of-flight controls.

Background: Real-time flight performance monitoring will be necessary as effective flight test procedural controls.

3.2 Flight Test Planning and Reviews:

3.2.1 The Contractor shall participate in a Kick-Off Meeting as defined under SOW Task 4.1.

3.2.2 The Contractor shall assist NASA in the development of the Flight Test Plan (see SOW Task 6.1) by providing flight test aircraft-specific and SEVS-specific expertise at scheduled technical interchange meetings, for periodic telephone conferences, and for specific test development activities as necessary and appropriate based on these technical interchange activities. The Contractor shall provide the SP(s) who will execute this program, and other engineering and flight test personnel as necessary, to assist in this flight test plan development.

Background: NASA will be responsible for the development of test objectives, and human factors and engineering analysis, using FAA and contractor inputs. Contractor flight deck and test engineers, and pilots with aircraft- and SEVS-specific expertise will be critical for effective test development. The Flight Test Plan will be developed by NASA with inputs as necessary and appropriate from the Contractor and the FAA and provided as GFI under SOW Task 6.1. NASA prefers that the Contractor SP and flight test engineer(s) participate in the NASA ground simulation work to gain familiarity and promote continuity between the ground simulation and flight test aspects of the program.

3.2.3 In accordance with Contract Clause "H.11 FLIGHT TEST OPERATIONS AND SAFETY REPORT (FTOSR) INFORMATION (LaRC 52.223-91) (OCT 2004)", the Contractor shall perform all analyses and develop all documentation necessary to obtain cognizant safety authority approval as determined by the LaRC Airworthiness and Safety Review Board (ASRB). The Contractor shall support the Technical Point of contact (POC) and/or COTR in submitting a Flight Test Operations and Test Safety Report (FTOSR) to obtain the appropriate Flight Safety Release letter. The Contractor shall be responsible for obtaining any other approvals, such as FAA approval, to conduct this flight test. The Contractor shall ensure that the SP(s) who will execute this program, and other engineering and flight test personnel as appropriate, to attend/participate in presentation of the FTOSR to the NASA approving authorities.

Background: NASA and FAA review and approvals for this flight test will be required. Since this work is being conducted as a cooperative FAA-NASA test, NASA and FAA personnel have been identified to assist in this process.

3.2.4 The Contractor shall develop appropriate flight test mitigations, present and defend these mitigations, and conduct a build-up program of ground simulation, and flight testing to reduce the inherent risk and establish safety-of-flight for this test.

Background: The safety of the operation is the foremost concern in this test, but if appropriate risk mitigation and operational procedures are in place, this test may be safely executed. A build-up test procedure is critical to this process.

3.2.5 The Contractor shall host a Flight Test Readiness Review Meeting where the safety of flight and flight test mitigations are reviewed prior to the start of the flight test. The review meeting shall identify the flight test hazards and provide evidence that the hazard mitigations have been put into effect, completed, and/or otherwise resolved to an appropriate level.

Background: The safety of the operation is the foremost concern in this test and the Flight Test Readiness Review is prudent as a final check before testing begins.

3.2.6 The Contractor shall conduct flight test planning and efficient execution, including rapid deployment with minimum notice and minimum crew for operations, ground support, and maintenance, to be able to fly in the desired weather conditions and at airport facilities to meet the flight test objectives.

Background: Weather, visibility conditions, and airport lighting and other infrastructure will be critical determinants in the performance of the SEVS performance and will be tested accordingly. Flight test efficiency will be dependent upon planning and the need/requirement for aircraft maintenance and ground support/ ground support equipment, as necessary and appropriate for the aircraft and operation.

3.2.7 The Contractor shall gather flight data which completes the safety and operations build-up portion of the flight test.

Background: The build-up flight test must be successfully completed before testing with EPs can start.

3.2.8 The Contractor shall pre-position the aircraft and personnel as necessary and appropriate to conduct testing in the desired weather and runway configurations. The Contractor shall plan and conduct all flights in accordance with the Flight Test Plan, which will include safety-of-flight procedures and fuel reserve requirements.

Background: Pre-positioning or deployment to locations based on weather forecasting or known geographical/weather phenomenology can improve operational efficiency.

3.3 Monthly Technical Letter Progress Reports: **(Deliverable Item 5.1)**

This report shall be prepared and delivered in accordance with Contract Exhibit A.

3.4 Final Report: **(Deliverable Item 5.5)**

The Contractor shall submit a Final Report, which is prepared in accordance with the contract clause entitled "Final Scientific and Technical Reports" (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. In addition, this report shall include, as a minimum, the Qualitative and quantitative pilot commentary data, logs, and results as per the Flight Test Plan (See SOW Task 6.1).

4.0 PLANNED PRESENTATIONS/MEETINGS/TELECOMS:

The Contractor shall be required to participate in and/or travel to the presentations/ meetings/telecoms as specified below:

Item No.	MEETING	FREQUENCY / DATE	DURATION	LOCATION
4.1	Kick-Off Presentation	Within 3 weeks after Task Award. Date and time to be mutually agreed upon by the Contractor and TM.	1 to 2 Days	LaRC Hampton, VA
4.2	Project Status Telecom	Biweekly (i.e., every 2 weeks) Date and time to be mutually agreed upon by the Contractor and TM.	~1 hour	Via telecom
4.3	Test Plan Development	Within 45 days after Task Award. Date and time to be mutually agreed upon by the Contractor and TM.	3 Days	LaRC Hampton, VA
4.4	FTOSR	Within ~~6~~ 3 months after Task Award. Date and time to be mutually agreed upon by the Contractor and TM.	1 Days	LaRC Hampton, VA
4.5	Flight Test Readiness Review Meeting	Within ~~7~~ 5 months after Task Award. Date and time to be mutually agreed upon by the Contractor and TM.	1 to 2 Days	Contractor's Facility
4.6	Final Presentation	During last month of Task. Date and time to be mutually agreed upon by the Contractor and TM.	1 to 2 Days	Contractor's Facility

4.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products.

An electronic version of the Presentation shall be delivered to the Technical Monitor (TM) at the time of the briefing. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation. **(Deliverable Item 5.2)**

NOTE: This briefing will be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA).

4.2 For the **Project Status Telecom**, the Contractor shall participate in biweekly teleconferences to discuss the status of ongoing work. During the telecom, the Monthly Technical Progress Report shall also be discussed.

4.3 For **Test Plan Development**, see SOW Task 3.2.2 for details.

4.4 For the **FTOSR**, see SOW Task 3.2.3 for details.

4.5 For the **Flight Test Readiness Review Meeting**, see SOW Task 3.2.5.

NOTE: This briefing will be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA).

4.6 For the **Final Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of research for the entire Task, including analysis, optimization, manufacturing, and test articles. An electronic version of the presentation shall be delivered to the TM at the time of the briefing. A copy shall also be delivered to the CO and COTR (preferably via email) not later than a week after the presentation. **(Deliverable Item 5.3)**

NOTE: This briefing will be attended by NASA civil servants, NASA in-house contractors, and other government agency representatives, such as the Federal Aviation Administration (FAA).

5.0 DELIVERABLES:

The Contractor shall deliver the following items FOB Destination:

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
5.1	3.3	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Contract.	Delivered in accordance with Contract Exhibit A distribution via email (preferred) or electronic media (e.g., CD or DVD) in MS Word, Excel, PowerPoint, or Adobe PDF.
5.2	4.1	Kick-Off Presentation.	1 EA	See Task.	See Task.
5.3	4.6	Final Presentation.	1 EA	See Task.	See Task.
5.4	3.1.13	Recorded Flight Data	1 EA	24 hours after Completion of Data Flight	Via email or electronic media (i.e., CD-ROM) delivery to TM. Copy of submittal letter to CO and COTR via email.
5.5	3.4	Final Report.	2 EA	At Task Order Expiration.	Delivered to TM, COTR, and CO electronically (preferably via email or electronic media (e.g., CD or DVD) and in accordance with NFS 1852.235-73 and contract. Per Contract: Copy of formal final report cover letter to the Center STI Publication Manager, ATTN: Mail Stop 158 or EMAIL: Susan.H.Stewart@nasa.gov

6.0 GOVERNMENT FURNISHED INFORMATION (GFI):

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
6.1	3.2.2	Flight Test Plan	1 EA	NLT 60 Days ~~Months~~ After Task Award

6.1 The Flight Test Plan will be defined by NASA with the Contractor participating in its development. The Flight Test Plan will contain the following guidance and direction:

1) Test Objectives;
2) Pre-Flight SEVS Ground Test and Calibration Data;
3) Flight Test Points, as defined by combinations of combinations of runway and approach lighting configuration, weather and visibility, and SEVS configuration(s),
4) Data recording requirements; and,
5) Data Collection Methods and Procedures.

7.0 GOVERNMENT FURNISHED PROPERTY (GFP): NONE

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **the Contractor's Facility in "TBD"** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item	Item Description	Qty.	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
8.1	N/A	N/A	$ N/A	N/A

8.0 PERIOD OF PERFORMANCE: From the effective Task Order date thru 7/12/11.

9.0 SECURITY CLEARANCE REQUIREMENTS: None

10.0 POINTS OF CONTACT (POC):

STATEMENT OF WORK (SOW)

Title: "Assessing the Impact that Software Health Management Technology will have on Qualifying and Certifying Flight-Critical Aeronautics Software"

1.0 Background:

NASA's Aviation Safety Program is conducting research directed at improving the safety of current and future aircraft operating in the National Airspace System. The research focus is on the way vehicles are designed, built, operated, and maintained, and is organized into four project areas: (1) Integrated Vehicle Health Management, (2) Integrated Intelligent Flight Deck, (3) Integrated Resilient Aircraft Control, and (4) Aircraft Aging and Durability. This research Statement of Work specifically addresses the Integrated Vehicle Health Management (IVHM) project which is pursuing research directed at developing concepts, tools, techniques, and methodologies for assessing the health of flight-critical aircraft software. This effort is being conducted under the IVHM "Software Health Management" sub-element which is described in version 2.0 of the IVHM Technical Plan[1]. Software Health Management seeks to perform the foundational research needed to develop technologies that will detect, diagnose, predict, and mitigate adverse events that occur during flight. Adverse events include those that arise from system, subsystem, or component faults or failures due to damage, degradation, or environmental hazards (such as turbulence, electromagnetic fields, and lightning). Foundational research provides the "building blocks" of a technology base to successfully address the stated goals and objectives. While detection, diagnosis, prognostics, and mitigation technologies have been successfully employed in hardware system and components, application of these technologies to software is a new concept recently added to the IVHM research portfolio.

The potential safety benefits afforded by the envisioned software health management concept led to the 2008 NASA Research Announcement Topic 5.1 Software Health Management Tools and Techniques (http://www.aeronautics.nasa.gov/nra.htm) which specifically targets the development of foundational tools and techniques to enable the detection, diagnosis, prognosis, and mitigation of errors and related adverse events caused or contributed to by software in on-board systems.

These in-progress research activities are addressing many of the foundational technical challenges posed by software health management. There are, however, significant challenges with regards to planning for the potential disruption such technology may introduce to airworthiness certification for software-based systems and equipment. This task seeks to characterize the impact that new software health management technologies may have on current and emerging airworthiness certification procedures. Establishing this characterization is vital for the successful infusion of software health management technologies into civil aviation.

2.0 Scope of Work:

This effort will result in a published research paper directed at characterizing the anticipated impact that new IVHM-developed Software Health Management Technology will have on current and emerging airworthiness certification procedures for flight-critical aeronautics software. The Contractor shall identify existing regulatory guidance for flight-critical civil aviation software, identify existing system level safety assessments and certification considerations, identify new initiatives for assuring the safety of flight-critical software anticipated for the FAA's Next Generation Air Transportation System (NextGen), and perform an analysis of anticipated impact to Federal Aviation Regulations and Advisory Circulars. NextGen is the FAA's plan to modernize the National Airspace System (NAS) through 2025 in order to handle a predicted two to three times growth while ensuring that future safety, capacity, and environmental needs are met.

[1] http://www.aeronautics.nasa.gov/nra_pdf/ivhm_tech_plan_c1.pdf

3.0 Description of Task Requirements:

The Contractor shall perform a literature survey of existing documents and studies that provide the basis for assessing the impact of software health management technologies on current and emerging airworthiness certification procedures. The approach shall include a survey of current and emerging software assurance and system-level dependability frameworks, followed by a consideration of how those frameworks might be impacted by the adoption of new health management technologies. Following are the tasks that shall be performed:

3.1 Identify existing regulatory guidance for flight-critical civil aviation software.

The Contractor shall survey and document applicable Federal Aviation Regulations (FAR)[2] and related Advisory Circulars (AC) that are pertinent to the adoption of software health management technologies. At a minimum, the Contractor shall identify the applicable processes and activities from Radio Technical Commission for Aeronautics (RTCA)/DO-178B "Software Considerations in Airborne Systems and Equipment Certification"[3] and DO-278 "Guidelines for Communication, Navigation, Surveillance, and Air Traffic Management (CNA/ATM) Systems Software Integrity Assurance"[4].

3.2 Identify existing system level safety assessments and certification considerations.

The Contractor shall survey and document applicable system-level safety standards to include standards pertaining to systems that perform, or contribute to, multiple aircraft-level functions. At a minimum, the Contractor shall identify the applicable sections from Society of Automotive Engineers (SAE) Aerospace Recommended Practices (ARP) 4761 "Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment"[5] and SAE ARP 4754 "Certification Considerations for Highly-Integrated or Complex Aircraft Systems"[6].

3.3 Identify new initiatives for assuring the safety of flight-critical software in NextGen.

The Contractor shall survey and document the state-of-the-art in new software assurance approaches for flight-critical software. This shall include, but is not limited to, new assurance approaches considered for the FAA's Next Generation Air Transportation System (NextGen) as well as technology-specific supplements under development for the planned release of an updated DO-178B document (DO-178C) under preparation by RTCA special committee SC-205[7]. SC-205 is addressing, among other things, new and emerging software trends and technologies that were not considered under DO-178B which was adopted in 1992.

3.4 Assess the anticipated impact that software health management technologies might have on the existing and emerging assurance frameworks identified in tasks 3.1, 3.2, and 3.3.

The Contractor shall perform an analysis of anticipated impact to FARs, ACs, and system level safety assessments, and identify possible changes that may allow for alternative and/or streamlined assurance frameworks enabled by the incorporation of software health management technology. This shall include the documenting of assumptions relative to the FARs, ACs, and system-level safety assessments as well as the software health management technology itself. This assessment shall include a postulated software health management capability as applied to a hypothetical software system, the details of which to be established via joint review with NASA personnel.

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[2] http://www.faa.gov/regulations_policies/
[3] DO-178B, Software Considerations in Airborne Systems and Equipment Certification (http://www.rtca.org)
[4] DO-278, Guidelines for Communication, Navigation, Surveillance, and Air Traffic Management (CNA/ATM) Systems Software Integrity Assurance (http://www.rtca.org)
[5] http://www.sae.org/technical/standards/ARP4761
[6] http://www.sae.org/technical/standards/ARP4754
[7] SC-205 (Joint with EUROCAE WG-71), Software Considerations (http://www.rtca.org/comm)

3.1 Planned Presentations / Meetings / Telecoms

The Contractor shall be required to participate in and/or travel to the presentations/ meetings/telecoms as specified below:

TASK	MEETING	FREQUENCY / DATE	ESTIMATED DURATION PER TRIP	LOCATION
3.5.1	Kick-Off Presentation	Within 30 days after task order award. Date and time to be mutually agreed upon by the Contractor and TM.	1 day or less	Contractor's Facility or Via WebEx / Telecom
3.5.2	Project Status Meetings	Bi-Monthly (i.e., every other month). Date and time to be mutually agreed upon by the Contractor and TM.	1 hour	Via WebEx / Telecom
3.5.3	Annual NASA AvSAFE Technical Meeting	Date TBD	3 days or less	TBD
3.5.4	Participate in Technical Interchange Meeting (TIM)	Date TBD	1 day or less	TBD (anticipated to be held jointly with NASA's annual AvSAFE meeting – see task 3.5.3)
3.5.5	Final Review Presentation	During last month of Task. Date and time to be mutually agreed upon by the Contractor and TM.	1 day or less	NASA LaRC, Hampton, VA

3.5.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products. An electronic version of the Presentation shall be delivered to the Contracting Officer's Technical Representative (COTR) and Contracting Officer (CO) via email one day prior to the briefing. **(Deliverable Item 4.2)**

3.5.2 For the **Project Status Meetings**, the Contractor shall participate in bi-monthly (i.e., every other month) teleconferences to discuss the status of ongoing work.

3.5.3 The purpose of attending the **Annual NASA AvSAFE Technical Meeting** is to facilitate technical interchange across the Aviation Safety program.

3.5.4 The purpose of the **Technical Interchange Meeting (TIM)** is to provide an in-depth forum for interacting with subject matter experts within IVHM's Software Health Management research focus area to further develop the impact assessment.

3.5.5 For the **Final Review Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of accomplishments for the entire task. An electronic version of the presentation shall be delivered to the COTR at the time of the briefing. A copy shall also be delivered to the CO (preferably via email) not later than a week after the presentation. The Final Review Presentation shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14. **(Deliverable Item 4.5)**

NOTE: This briefing will be attended by NASA civil servants and NASA on-site contractors.

3.6 Monthly Technical Letter Progress Reports:

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due. **(Deliverable Item 4.1)**

NOTE: Task Orders shall not be summarized in one letter report. The Contractor shall submit individual reports for each task.

3.7 American Recovery and Reinvestment Act – Reporting Requirements (FAR Clause 52.204-11):

In accordance with this clause, the Contractor shall delivery the required American Recovery and Reinvestment Act (ARRA) reporting. **(Deliverable Item 4.3)**

3.8 NASA Form 533 Reporting Requirements (Deliverable Item 4.4):

In accordance with NFS Clause 1852.242-73 (NASA Contractor Financial Management Reporting) and Contract Exhibit A (Contract Documentation Requirements), Item A. Monthly Financial Management Report, requirements for financial reporting are outlined.

For this task, the Contractor shall segregate Recovery Act funds from non-Recovery Act funds on the NASA Form 533, Financial Management Reporting using the following detailed reporting categories.

(TO BE FILLED IN AS PART OF PROPOSAL AND NEGOTIATION PROCESS.)

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3.9 Final Report (Deliverable Item 4.6):

In accordance with Contract Exhibit A, the Contractor shall submit a Final Report, which is prepared in accordance with the contract clause entitled "Final Scientific and Technical Reports" (NFS 1852.235-73). The Final Report shall be delivered with unlimited rights under FAR 52.227-14, as modified by NFS 1852.227-14.

4.0 Deliverables:

The Contractor shall deliver the following items FOB Destination:

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.6	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to COTR and CO electronically (preferably via email).
4.2	3.5.1	Kick-Off Presentation.	1 EA	See Task.	See Task.
4.3	3.7	ARRA Reporting.	1 EA	Per Clause.	Per Clause.
4.4	3.8	NASA Form 533 Reporting.	1 EA	Per Contract.	Per Contract.
4.5	3.5.5	Final Review Presentation.	1 EA	See Task.	See Task.
4.6	3.9	Final Report.	1 EA	Task order expiration	Delivered to COTR and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235-73 and contract.

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "NONE"

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1		"None"		

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE"

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **_Fill-in_** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"			

7.0 PERFORMANCE STANDARDS, PERFORMANCE METRICS, AND ACCEPTANCE CRITERIA

7.1 Performance Standard: Deliverables are submitted in a timely manner.

Performance Metrics:

- EXCEEDS: All deliverables are complete and delivered in advance of the due date.
- MEETS: All deliverables are complete and delivered on the due date.
- FAILS: At least one deliverable is not complete or delivered on the due date.

7.2 Performance Standard: Required status reporting is complete, understandable, and provided on the due date.

Performance Metrics:

- EXCEEDS: Status reporting is error free, complete, and provided on or before the due date.
- MEETS: Monthly status reporting is complete with only minor errors and provided within 8 business hours after the due date.
- FAILS: One or more required monthly status reports are not available, or errors are noted, or later than 24 business hours after the due date.

7.3 Performance Standard: Product quality meets customer's documented requirements and expectations.

Performance Metrics:

- EXCEEDS: Product quality exceeds customer's documented requirements and expectations. Customer provides written or verbal communication indicating the same.
- MEETS: The product quality is as documented in the requirements and meets customer needs. Customer is satisfied with product and uses in the manner intended.
- FAILS: Product does not meet documented requirements and customer expectations are not met. Customer is not satisfied with product and cannot use in the manner intended.

7.4 Performance Standard: The Contractor delivers product within costs and schedule.

Performance Metrics:

- EXCEEDS: The Contractor delivers application to the customer prior to scheduled delivery date and under cost.
- MEETS: The Contractor delivers application to the customer on scheduled delivery date and within cost.
- FAILS: The Contractor delivers application to the customer after scheduled delivery date and/or exceeds stated cost by more than 10 percent.

7.5 Acceptance Criteria: Acceptance of a deliverable is determined by the Government assessing that the deliverable is in accordance with the terms and conditions of the Task Order and/or Contract.

8.0 Security Clearance Requirements: None

9.0 Period of Performance: 10 months from date of Task Order award date.

10.0 Points of Contact:

STATEMENT OF WORK (SOW)

Task Title: "Flight deck Interval Management Display Elements, Information, & Annunciations"

1.0 Introduction / Background:

There are numerous human factor issues associated with Flight Deck Interval Management (FIM)[1] operations in the Federal Aviation Administration's (FFA's) Next Generation Air Transportation System (NextGen)[2] environment that need to be examined. In the proposed FIM operations, an ADS-B[3] equipped aircraft is cleared by a controller to achieve and/or maintain an interval relative to another aircraft. Pilots are provided with a speed target and a location at which to achieve this speed (the achieve-by point), and a traffic-to-follow (TTF) aircraft identifier in order to achieve this interval. FIM operations are purported to: increase throughput, reduce tactical maneuvering (especially vectoring), reduce controller workload, and reduce environmental impact by enabling Optimized Profile Descents (aka Continuous Descent Arrivals). Future concepts of operations envision reduced interaction with controllers and increased automation. These future concepts include: CPDLC (Controller/Pilot Datalink Communications) clearance delivery, clearance autoload into flight management systems (FMS), and self-separation responsibility increasingly allocated to the flightdeck.

The FAA has noted from experience that the benefits of advanced procedures, such as Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR)[4], can be negated by human factors challenges (e.g., frequent pilot errors in matching of procedures to runways, pilot challenges responding to Air Traffic Control ATC). Fully achieving FIM's promulgated performance benefits is likely to be contingent on consideration of relevant human performance issues, information requirements, and human error potential. Therefore, the question at hand is how technology, procedures, and pilot training should be designed to effectively support FIM operations.

2.0 Scope and Objectives

The scope of this task order is to conduct a survey of displays and annunciations that support FIM domestically and internationally, spanning high and low technology readiness levels.

The objective of this task is to deliver the following:

1. A bibliography of display features, information, and annunciations that aim to support FIM.
2. A catalog, in Microsoft Office Access[5], of the display elements and annunciations that have been developed to support FIM operations. The result of this effort will support hardware-in-the-loop (HITL) investigations of a proposed set of FIM-supporting features, information, and annunciations.
3. A document describing the contextual conditions for FIM display features.

[1] http://www.faa.gov/nextgen/implementation/media/nextgen_operator_and_airport_enablers.pdf
[2] http://www.faa.gov/nextgen
[3] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=7131
[4] http://www.faa.gov/air_traffic/publications/ATPubs/AIM/aim.pdf
[5] Access is a database management system from Microsoft (http://office.microsoft.com/en-us/access/)

3.0 Description of the Work/Tasks to be performed

The Contractor shall perform the following tasks:

3.1 Bibliography of sources addressing FIM Pilot Interface:

The Contractor shall identify display features, information, and annunciations that aim to support FIM operations in commercial and business jet operations, foreign and domestic. Minimally this compilations shall include the work conducted at NASA Langley, NASA Ames, MITRE, UPS, Fedex, Volpe, National Aerospace Lab of Netherlands (NLR), FAA Technical Center, and as sponsored by FAA and Eurocontrol. Where literature incompletely specifies interface features, and authors are contacted, the compilation shall include these additional details**.** **Deliverable Item 4.4.a.** is the bibliography of these sources (Endnote[6] is preferred) and a compendium of electronic versions of the sources linked by filename to the bibliographic reference.

3.2 Database of FIM-related Display Features, Information, and Annunciations:

The Contractor shall construct a database in Microsoft Access containing a picture of the feature in context and a Waveform Audio File Format (WAV)[7] file of the annunciation, and contextualized by, minimally: the display surface(s) in which the feature/annunciation appears; if it is always present or must be navigated to (and then the "page" it occurs on); the conditions under which it occurs/is extinguished/changes formatting (e.g., color); what information it conveys, action or decision it supports; a label for the avionics concept these are present in and citation/source information associated to the bibliography in task 3.1.

Deliverable Item 4.4.b. is the electronic Microsoft Access database noted above and electronic documentation of contextual variables included and user guide to navigating it.

3.3 Document Contextual Conditions for FIM Display Features:

In the conduct of this compilation, the Government recognized that certain display features and annunciations may only be presented conditionally, for example in off nominal conditions; and then the abiding of conditions will extinguish these. Similarly, changes in conditions may alter formatting of display elements/information available. These contextual conditions shall be fully described in a separate document **(Deliverable Item 4.4.c.)** which is indexed according to the contextual variable names provided in the database.

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[6] http://office.microsoft.com/en-us/word-help/about-footnotes-and-endnotes-HP005189477.aspx?CTT=3
[7] http://www.digitalpreservation.gov/formats/fdd/fdd000001.shtml

3.4 Planned Presentations / Meetings / Telecons

The Contractor shall be required to participate in and/or travel to the planned presentations/ meetings/telecons as specified below:

TASK	MEETING	FREQUENCY / DATE	ESTIMATED DURATION PER TRIP / TELECON	PLANNED LOCATION
3.4.1	Kick-Off Presentation	Within 1 month after Task Order Award. Date and time to be mutually agreed upon by the Contractor and TPOC.	1 day or less	NASA LaRC, Hampton, VA or Via WebEx / Telecon **(For proposal purposes, use LaRC, Hampton, VA)**
3.4.2	Project Status Meetings	Monthly. Date and time to be mutually agreed upon by the Contractor and TPOC.	1-2 hours	Via WebEx / Telecon
3.4.3	Final Review Presentation	During last month of Task Order. Date and time to be mutually agreed upon by the Contractor and TPOC.	1 day or less	NASA LaRC, Hampton, VA

3.4.1 For the **Kick-Off Presentation**, the Contractor shall prepare a presentation in PowerPoint that facilitates review and discussion of the project objectives, approach (i.e., project schedule, milestones, deliverables), and the desired outcomes and tangible products. An electronic version of the Presentation shall be delivered to the Technical Point of Contact (TPOC), Contracting Officer's Representative (COR) and Contracting Officer (CO) via email one day prior to the briefing. **(Deliverable 4.2)**

3.4.2 For the **Project Status Meetings**, the Contractor shall participate in monthly teleconferences to discuss the status of ongoing work.

3.4.3 For the **Final Review Presentation**, the Contractor shall prepare a presentation in PowerPoint, which includes at a minimum a summary of accomplishments for the entire task. An electronic version of the presentation shall be delivered to the TPOC and COR at the time of the briefing. A copy shall also be delivered to the CO (preferably via email) not later than a week after the presentation. **(Deliverable 4.3)**

NOTE: This briefing will be attended by NASA civil servants and NASA on-site contractors and possibly other government personnel such as FAA representatives.

3.5 Monthly Technical Letter Progress Reports: (Deliverable Item 4.1)

In accordance with Contract Exhibit A, the Contractor shall submit monthly technical letter reports for each task order describing progress of the task to date, noting all technical areas in which effort is being directed and indicating the status of work within these areas. Tasks may be summarized in one letter report, unless otherwise stipulated in individual task orders. Reports shall be in narrative form, brief and informal in content. These reports shall include:

1. A narrative statement of work accomplished during the report period.
2. A statement of current and potential problem areas and proposed corrective action.
3. A discussion of work to be performed during the next report period.

The monthly progress report shall be submitted within 10 days after the end of each calendar monthly report period. A monthly report shall not be required for the period in which the final report is due.

NOTE: The Contractor shall submit an individual letter report for each individual task order. Multiple Task Orders shall not be summarized in one letter report.

3.6 Final Report (Deliverable Item 4.5)

In accordance with Contract Exhibit A, the Contractor shall submit a Final Report, which is prepared in accordance with the contract clause entitled “Final Scientific and Technical Reports” (NFS 1852.235-73).

4.0 Deliverables:

The Contractor shall deliver the following items FOB Destination. All deliverables shall be delivered with unlimited rights as defined under FAR 52.227-14 (Rights in Data – General), as modified by NFS 1852.227-14, unless otherwise specifically specified herein.

Item No.	Task Ref.	Deliverable Description	Qty.	Due Date	Delivery Instructions
4.1	3.5	Monthly Technical Letter Progress Reports.	1 EA	Monthly per Task Ref.	Delivered to TPOC, COR, and CO electronically (preferably via email).
4.2	3.4.1	Kick-Off Presentation.	1 EA	See Task.	See Task.
4.3	3.4.3	Final Review Presentation.	1 EA	See Task.	See Task.
4.4.a. 4.4.b. 4.4.c.	3.1, 3.2, 3.3	a. Bibliography. b. Microsoft Access Database. c. Contextual Conditions.	1 EA	Task Order Expiration.	Delivered to TPOC, COR, and CO electronically (preferably via email or DVD).
4.5	3.6	Final Report.	1 EA	Task Order Expiration.	Delivered to TPOC, COR, and CO electronically (preferably via email or DVD), and in accordance with NFS 1852.235-73 and contract.

5.0 GOVERNMENT FURNISHED INFORMATION (GFI): "NONE"

The Government will provide the following to the Contractor as follows:

Item No.	Task Ref.	ITEM	QTY.	Date to be Furnished to the Contractor (on or before)
5.1		"None"		

6.0 GOVERNMENT FURNISHED PROPERTY (GFP): "NONE"

List of Government-Furnished Property (NFS 1852.245-76) (OCT 1988)

For performance of work under this contract, the Government will make available Government property identified below on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract at **N/A** and at other location(s) as may be approved by the Contracting Officer. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

Item No.	Task Ref.	Item Description	Qty	Acquisition Cost	Date to be Furnished to the Contractor (on or before)
6.1		"None"			

7.0 ADDITIONAL DATA RIGHTS: N/A.

Only Unlimited rights as defined under FAR 52.227-14 (Rights in Data – General), as modified by NFS 1852.227-14 applies to this task order.

8.0 SECURITY CLEARANCE REQUIREMENTS: None.

9.0 Period of Performance: 6 months from Task Order award date.

10.0 Points of Contact: