

ANNEX NO. 1  
BETWEEN  
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
LANGLEY RESEARCH CENTER  
AND  
SIERRA SPACE CORPORATION  
UNDER  
NONREIMBURSABLE SPACE ACT UMBRELLA AGREEMENT SAA1-40017  
FOR  
ACOUSTIC LINER DESIGN FOR LIFE HABITAT FAN NOISE REDUCTION

ARTICLE 1. PURPOSE

This Annex shall be for the purpose of National Aeronautics and Space Administration Langley Research Center ("NASA" or "NASA LaRC") and Sierra Space Corporation ("Sierra Space") evaluating a combination of bulk absorbers and local-reacting tonal liners for reduction of fan noise on the Large Integrated Flexible Environment (LIFE) habitat. In addition to gaining Sierra Space's real-world expertise in aeronautic acoustics, through this collaboration, NASA will gain access to uniquely sized and shaped fan and duct units, which will allow NASA to continue to explore acoustic liner concepts and demonstrate manufacturing readiness level for some novel concepts. NASA will gain the ability to generate a true "fan source" rather than mimicking that sound spectrum with acoustic drivers and study noise reduction concepts applicable to auxiliary power units for conventional aircraft. The size of the provided ducts will give NASA the opportunity to explore alternative applications in the future.

This annex aligns with NASA's Strategic Objective 2.3: Develop capabilities and perform research to safeguard explorers and Strategic Objective 3.2: Drive efficient and sustainable aviation.

The legal authority for this Annex, consistent with the Umbrella Agreement, is in accordance with the Space Act, Other Transactions Authority (OTA), 51 U.S.C. § 20113(e).

ARTICLE 2. RESPONSIBILITIES

A. NASA LaRC will use reasonable efforts to:

1. Provide guidance regarding where to place two in-duct microphones in each fan/duct system (FDS) provided by Partner.
2. Design and evaluate at least two treatments (tonal and/or broadband) per FDS.
  - a) Conduct analysis to determine optimum impedance spectra for each FDS liner over the desired frequency range (wide enough to allow for nominal fan operating speed with tolerance band).
  - b) Design at least two samples to target the optimum impedance spectra for each FDS.
  - c) Fabricate samples noted in (b) to fit in the Langley Normal Incidence Tube (NIT) or High Intensity Modal Impedance Tube (HIMIT).
  - d) Test each sample in the NIT or HIMIT.
  - e) Provide comparisons of predicted and measured impedances.

3. Fabricate and test at least one acoustic treatment for at least two of the four FDS.
  - a) Fabricate circumferential liners with axial length of at least one fan diameter.
  - b) Acquire data with up to seven microphones, two flush-mounted in the walls of the duct downstream of the treatment and five mounted in an arc external to the duct exhaust.
  - c) Provide comparisons of predicted and measured sound pressure level profiles and attenuation spectra.
  - d) Treatments will also be evaluated in the other two FDS contingent upon the ability of Partner to fabricate the samples as per NASA requirements.
4. Provide a summary of the analysis.
  - a) Provide a summary of final recommendations.
  - b) Provide estimates of weight and cost for each treatment configuration based on best available information.
5. Coordinate with Partner regarding possible joint publication(s) based on the computational and experimental results of this study.

B. Partner will use reasonable efforts to:

1. Provide information for NASA to perform liner designs for up to four FDS to simulate the aeroacoustics environment present in Partner's LIFE Habitat air control system.
  - a) Each FDS includes a fan (to provide the mean flow and noise source) and a duct (nominally 6" diameter with length no greater than 5 ft).
  - b) Provide geometry information: basic geometry parameters will be sufficient for straight, circular ducts, but CAD drawings will be required for more complex configurations.
  - c) Provide information regarding expected flow conditions (preferably CFD analysis if it is available), nominal fan operating speed and range of fan operating speeds. Targeted attenuation spectra is as much as possible to reduce downstream transmission.
2. Provide up to four FDS.
  - a) Each duct will contain ports suitable for installation of two in-duct microphones (locations and sizes to be provided by NASA) and an acoustic liner insert (location and size representative of that to be used in LIFE Habitat system; actual geometry to be determined via collaboration with NASA).
3. Collaborate with NASA regarding possible joint publication(s) based on the computational and experimental results of this study.

### ARTICLE 3. SCHEDULE AND MILESTONES

The planned major milestones for the activities for this Annex defined in the "Responsibilities" Article are as follows:

1. Partner will provide information necessary for NASA to perform liner designs for up to four fan/duct systems.	Within 2 months after the Effective Date.
2. NASA will perform analysis regarding placement of in-duct microphones in each fan/duct system.	Within 1 month after completion of Milestone 1.
3. Partner will provide up to four fan/duct systems and corresponding flow conditions required for analysis of these systems. Partner will include ports for in-duct microphones at locations provided under Milestone 2.	Within 2 months after completion of Milestone 2.
4. NASA will conduct analysis to determine optimum impedance spectra for each duct geometry. NASA will use this information to design at least two (tonal and/or broadband) acoustic treatment configurations for each fan/duct system.	Within 3 months after completion of Milestone 3.
5. NASA will fabricate and test at least two acoustic treatments per fan/duct system in the NIT or HIMIT and will provide comparisons of predicted and measured impedances for each liner.	Within 3 months after completion of Milestone 4.
6. NASA will fabricate and test at least one acoustic treatment configuration within at least two fan/duct systems. NASA will test treatments in the other two fan/duct systems contingent upon Partner supplying those treatments.	Within 3 months after completion of Milestone 5.
7. NASA will provide comparisons of predicted and measured SPL profiles and attenuation spectra for each test conducted under Milestone 6.	Within 3 months after completion of Milestone 5.
8. NASA will provide final recommendations and treatment weight and cost estimates.	Within 2 months after completion of Milestone 7.

#### ARTICLE 4. FINANCIAL OBLIGATIONS

There will be no transfer of funds between the Parties under this Agreement and each Party will fund its own participation. All activities under or pursuant to this Agreement are subject to the availability of funds, and no provision of this Agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, (31 U.S.C. § 1341).

ARTICLE 5. INTELLECTUAL PROPERTY RIGHTS - DATA RIGHTS

A. Data produced under this Annex which is subject to paragraph C. of the Intellectual Property Rights - Data Rights Article of the Umbrella Agreement will be protected for the period of five years.

B. Under paragraph H. of the Intellectual Property Rights - Data Rights Article of the Umbrella Agreement, Disclosing Party provides the following Data to Receiving Party. The lists below may not be comprehensive, are subject to change, and do not supersede any restrictive notice on the Data provided.

1. Background Data: *The Disclosing Party's Background Data, if any, will be identified in a separate technical document.*
2. Third Party Proprietary Data: *The Disclosing Party's Third Party Proprietary Data, if any, will be identified in a separate technical document.*
3. Controlled Government Data: *The Disclosing Party's Controlled Government Data, if any, will be identified in a separate technical document.*
4. The following software and related Data will be provided to Partner under a separate Software Usage Agreement: None

ARTICLE 6. TERM OF ANNEX

This Annex becomes effective upon the date of the last signature below ("Effective Date") and shall remain in effect until the completion of all obligations of both Parties hereto, or one (1) year, six (6) months from the Effective Date, whichever comes first, unless such term exceeds the duration of the Umbrella Agreement. The term of this Annex shall not exceed the term of the Umbrella Agreement. The Annex automatically expires upon the expiration of the Umbrella Agreement.

ARTICLE 7. RIGHT TO TERMINATE

Either Party may unilaterally terminate this Annex by providing thirty (30) calendar days written notice to the other Party.

ARTICLE 8. POINTS OF CONTACT

The following personnel are designated as the Points of Contact between the Parties in the performance of this Annex.

Management Points of Contact

NASA Langley Research Center  
Randolph H. Cabell  
Supv Ast, Flight Vehicle Acoustics  
Mail Stop: 463  
Langley Research Center  
Hampton, VA 23681  
Phone: 757-864-5266  
randolph.h.cabell@nasa.gov

Sierra Space Corporation  
Stein Cass PhD, PMP  
Director of Programs, EarthSpace Systems  
390 Interlocken Crescent, Suite 500  
Broomfield, CO 80021-8041  
Phone: 720-544-9827  
Stein.Cass@sierraspace.com

Technical Points of Contact

NASA Langley Research Center  
Michael Jones  
Ast, Flight Vehicle Acoustics  
Mail Suite: 463  
Langley Research Center  
Hampton, VA 23681  
Phone: 757-864-5272  
michael.g.jones@nasa.gov

Sierra Space Corporation  
Michael Martinez  
Senior Mechanical Engineer  
390 Interlocken Crescent, Suite 500  
Broomfield, CO 80021-8041  
Phone: 513-706-3523  
michael.martinez@sierraspace.com

ARTICLE 9. MODIFICATIONS

Any modification to this Annex shall be executed, in writing, and signed by an authorized representative of NASA and the Partner. Modification of an Annex does not modify the terms of the Umbrella Agreement.

ARTICLE 10. SIGNATORY AUTHORITY

The signatories to this Annex covenant and warrant that they have authority to execute this Annex. By signing below, the undersigned agrees to the above terms and conditions.

NATIONAL AERONAUTICS AND  
SPACE ADMINISTRATION  
LANGLEY RESEARCH CENTER

SIERRA SPACE CORPORATION

BY: \_\_\_\_\_  
John H. Koelling  
Director, Aeronautics Research  
Directorate

BY: Logan Smith  
Logan Smith  
Contracts Manager

DATE: \_\_\_\_\_

DATE: 4/2/2024