ANNEX 1
BETWEEN
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
AND
RAYTHEON COMPANY
UNDER
THE SPACE ACT UMBRELLA AGREEMENT NO. 36114

ARTICLE 1. PURPOSE

The purpose of this Annex is for Raytheon and NASA to enter into a mutually beneficial partnership to further basic research advancements in the area of hypersonic boundary-layer transition, and to support key design decisions for the Boundary Layer Transition (BOLT) and Boundary Layer Turbulence Flight II (BOLT2) flight assessment experiment. The goal is to compare computational models and wind tunnel data from the NASA-developed BOLT Step Test (BST) model with partner-developed Flat-BOLT models.

The first test entry will be the *Parametric Step Effects Test* which will be used to investigate the effects of forward or rearward facing steps on boundary-layer transition (BLT) on the BOLT2 Flight Geometry. The first test entry will be the *Parametric Step Effects Test* which will be used to investigate the effects of forward or rearward facing steps on boundary-layer transition (BLT) on the BOLT2 Flight Geometry. The focus of this study in the 20”M6 Tunnel will be to characterize the impact of steps on BLT, as well as any impact of the steps on surface streamlines, in order to provide insight into the optimum locations for sensors for flight. The model will be designed to have a polyether-ether-ketone (PEEK) surface suitable for testing with infrared (IR) thermography. It is anticipated that the model to be built for this test will be half-scale. Once built, NASA LaRC will install the model into the 20”M6 tunnel and obtain measurements at a variety of Reynolds numbers and model orientations. NASA LaRC will provide staff to oversee the test and process the data. NASA LaRC will provide a summary of the test data and also provide the processed images to TEES so they can be used to support the design of the BOLT II Flight Geometry. Immediately following that test, Raytheon will provide a BOLT-derivative model with a similar step mechanism to obtain a comparative data set. Subsequent tests will include more targeted BST entries with the NASA model, and additional geometries with a run matrix tailored based on the initial results. Approximately 10 weeks of tunnel time is estimated for the completion of the Initial and Subsequent tunnel entries. This is to be shared among the NASA BST model and the Raytheon models.

A material study will be conducted to determine a viable candidate material for entry into 31-inch Mach 10 test facility. New hardware may be fabricated to allow testing of similar geometries within the 31-inch Mach 10 tunnel.

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. Participate in Conceptual, Preliminary and Critical Design Reviews;
2. Provide existing NASA-owned BOLT model technical documentation;
3. Provide one (1) polyether-ether-ketone (PEEK)-based subscale model of BOLT or BOLT II sufficient for infrared (IR) measurements for the Parametric-Step Effects test entry;
4. Provide Principal Investigator, model installation and access to the NASA LaRC 20”M6 Wind Tunnel to conduct ten (10) days of testing consisting of three (3) separate test entries;
5. Attend in-person and virtual meetings to facilitate collaboration;
6. Advise on the technical development of models, materials, and test parameters;
7. Facilitate test hardware readiness activities for LAL facilities;
8. Facilitate the writing of technical papers and publishing of resulting data from initial testing and follow-on tests;
9. Participate in wind tunnel testing at other facilities capable of hypersonic flow.

B. Partner will use reasonable efforts to:

1. Participate in BOLT and BOLT-derivative wind tunnel testing;
2. Develop appropriate BOLT and BOLT-derivative hardware for ground testing;
3. Conduct computational solutions for their own model designs;
4. Conduct model material trade studies and test articles, where appropriate;
5. Facilitate wind-tunnel testing at hypersonic facilities outside of LAL;
6. Facilitate virtual and in-person meetings as necessary for model development;
7. Contribute to the writing of technical papers and publishing of data, where appropriate;
8. Participate in wind tunnel testing at other facilities capable of hypersonic flow.

ARTICLE 3. SCHEDULE AND MILESTONES

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

1. NASA LaRC and Raytheon will participate in the Conceptual Design Review.	By no later than one (1) month upon execution of Agreement.
2. Raytheon shall provide test plan for each test	No less than two (2) weeks prior to

entry to NASA LaRC.	each test entry.
3. NASA LaRC and Raytheon will participate in the Preliminary Design Review.	By no later than August 31, 2022.
4. NASA LaRC will provide one (1) PEEK-based subscale model.	No less than one (1) week prior to each test entry.
5. NASA LaRC will provide a principal investigator, model installation and access to the 20”M6 tunnel for testing.	No less than one (1) week prior to each test series.
6. NASA LaRC and Raytheon will complete first Test Entry.	By no later than June 30, 2022.
7. NASA LaRC and Raytheon will complete second Test Entry.	By no later than June 30, 2023.
8. NASA LaRC and Raytheon will complete third Test Entry.	By no later than June 30, 2024.
9. NASA LaRC and Raytheon will complete the BOLT Critical Design Review (CDR).	By no later than October 31, 2023.
10. NASA LaRC will provide validation and computational data analysis to Raytheon.	No more than four (4) weeks upon completion of each test series.
11. NASA LaRC will provide a summary of test data and reduced images from each test entry to Raytheon to support BOLT and BOLT II Flight Geometry.	By no later than September 30, 2024.

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 1 year.

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 September 30, 2024, 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
Scott Berry
Aerothermodynamics Branch
Langley Research Center
Hampton, VA 23681
Phone: 7578645231
scott.a.berry@nasa.gov

RAYTHEON COMPANY
Rodney L. Nielsen
Senior Manager, Contracts
1151 E Hermans Rd
Tucson, AZ 85756-9367
Phone: 520.513.4114
rlnielsen@rtx.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	RAYTHEON COMPANY
BY: MARY DIJOSEPH Digitally signed by MARY DIJOSEPH Date: 2022.05.06 11:30:50 -04'00'	BY: Rodney L Nielsen Digitally signed by Rodney L Nielsen Date: 2022.05.05 20:50:19 -07'00'
Mary DiJoseph, Director Aeronautics Research Directorate	Rodney L. Nielson Senior Manager, Contracts
DATE: 06 May 2022	DATE: 05 May 2022