STATEMENT OF WORK
Launch Abort System (LAS) Spring Bumper Design and Prototype Fabrication

1 PERIOD OF PERFORMANCE

Base Period: PO award through October 30, 2014
Option Period: See SOW Section 6.2

2 SCOPE

2.1 Purpose

The purpose of this Statement of Work (SOW) is to describe the tasks, services and work effort to be performed to design, fabricate, and test a spring bumper for the Orion Launch Abort System Office.

2.2 Background:

The spring bumper is a mechanism that interfaces with the Orion Multi-Purpose Crew Vehicle's Crew Module (CM) and the LAS Fairing Assembly ogive panels, providing a load path between the ogive panels and the crew module, and isolating the crew module from the acoustic loads imparted on the ogive panels during both flight and the motor firings of the LAS. The bumper is envisioned to employ a common design in six places radially about the CM – one for each of the six CM longeron interfaces.

The bumper is designed to operate in two distinct driving environments: one occurs during a nominal flight of the launch vehicle and the other more severe one occurs during an abort, when the LAS abort and attitude control motors fire and the crew module remains attached to the LAS while the LAS pulls it away from the failed launch vehicle. The current design is a bilinear spring bumper, whereupon the first stage (lower stiffness spring) maintains contact between the CM and the LAS ogive panels during assembly and nominal operation, and the second stage (higher stiffness spring) absorbs the more violent movement of the ogive panels with respect to the CM during an abort while also preventing the panels from bottoming out against the CM.

3 APPLICABLE DOCUMENTS

3.1 Codes and Standards

Design, fabrication, assembly, inspection, and testing shall conform to the latest codes, standards, and requirements of the following:

- ASME Y14.100-2004
- NASA-STD-5001A: Structural Design and Test Factors of Safety for Spaceflight Hardware
- NASA-STD-5017, Design and Development Requirements for Mechanisms
- NASA-STD-5020: Requirements for Threaded Fastening Systems in Spaceflight Hardware

3.2 ITAR Applicable Documents

The following applicable documents, which fall under ITAR regulations, may be requested but are not required to perform the task. If requested, the documents will be provided once the contractor submits required documentation of ITAR compliance to the Contracting Officer:

- MPCV 70135: Orion Multi-Purpose Crew Vehicle (MPCV) Program: Structural Design and Verification Requirements (SDVR)
- CEV-T-029: Launch Abort System (LAS) to Crew Module/Service Module (CM/SM) ICD

Required Documentation:

- A current U.S. Passport,
- A current Permanent Resident Card ("Green Card") (Form I-551)
- A currently valid driver's license/photo I.D. card issued by a State or the District of Columbia AND a birth certificate issued by a State, county, municipal authority, or territory of the U.S. bearing an official seal
- Additional forms of acceptable evidence are listed in the Dept. of Homeland Security (DHS), U.S. Citizenship and Immigration Services Form I-9, Employment Eligibility Verification Form, OMB No. 1615-0047

4 TASK REQUIREMENTS

The Contractor shall design and fabricate a prototype of a single spring bumper as described herein. Guidance and requirements for the design parameters are listed below and in Appendix 1, 2 and 3. Appendix 1 contains the same information as Appendix 2 but in an IGES files for use within the proposer's CAD system to extract the dimensional constraints for their design. Specific environment details are available in Appendix 3. An option to develop and provide a test plan and a supplier data requirements list (SDRL), and to design and fabricate test fixturing, as well as perform the prototype testing per the test plan, is also requested.

Prototype design will have the following parameters:

Parameter / Constraints	Preferred/Target	Acceptable	Unacceptable
Weight	Less than 10 lbs	Between 10-50 lbs	Greater than 50 lbs
Stroke, preload	Greater than 0.375"	Between 0.25" – 0.375"	Less than 0.25"
Stroke, Compresive		Between 0.5"- 1.125"	
Volume		Mechanism fits within the volume within IGES file	

4.1 Loading:

4.1.1 No gap from CM interface during flight: preloadable to prevent bumper gapping during extension stroke of ¼"from installed state.

4.1.2 1 kip (+/-20%) load at 0.25" compressive stroke.

4.1.3 10 kips (+/- 20%) load at 1.0" compressive stroke.

4.1.4 25 kips maximum allowable compressive load.

4.2 Operational Parameters:

4.2.1 Total compressive stroke of 1.0" from installed state.

4.2.2 Total extensive stroke of 0.25" from installed state.

4.3 Environment – See Appendix 3.

5 TASK DESCRIPTION:

The Task is divided into two segments: Base, which includes items to be delivered under this Section 5.1, and Options in Section 5.2. The task descriptions in Section 5.2 correspond to the deliverables in Section 6.2.

5.1 Base:

5.1.1 The Contractor shall design a spring bumper prototype that meets the requirements of this statement of work.

5.1.2 The Contractor shall provide a detailed design package to include engineering drawings that meets the requirements noted in the "Codes and Standards" section of this statement of work.

5.1.3 The Contractor shall fabricate and deliver a prototype spring bumper per design in Base Task Item 5.1.1.

5.2 Options 1-4:

5.2.1 The Contractor shall develop and provide a test plan for verifying performance of the spring bumper.

5.2.2 The Contractor shall develop and provide a SDRL.

5.2.3 The Contractor shall Design and fabricate test fixturing required to support the test as defined in the test plan of Option 1.

5.2.4 The Contractor shall perform testing on the prototype hardware using the approved test plan from 5.2.1 above and the test fixturing from option 5.2.3 above, and provide a test report detailing the successful completion of the testing. NASA representatives shall be allowed to support the testing and provide final acceptance of the test report.

6 DELIVERABLES

6.1 Base

6.1.1 Contractor shall provide no later than August 15, 2014 preliminary engineering design drawings in Creo Parametric 2.0. However, dxf and stp will be acceptable.

6.1.2 Contractor shall deliver to NASA Langley NLT September 18, 2014 detailed drawing design package, to include engineering drawings, in Creo Parametric 2.0.

6.1.3 Prototype a single hardware device compliant to design specifications in Appendix 1 and 2 shall be delivered to NASA Langley NLT September 18, 2014.

6.1.4 Government review and any revisions shall be completed NLT October 30, 2014

6.2 Options 1-4

6.2.1 A draft test plan shall be delivered 15 days after exercise of option for review and approval by NASA.

6.2.2 The final test plan shall be delivered within 30 days after exercise of option.

6.2.3 SRDL shall be provided 45 days after exercise of option.

6.2.4 Testing shall be performed by the Contractor utilizing the prototype hardware and test fixturing, and the test plan as delivered in 6.2.2., as approved by NASA. NASA will ship the prototype hardware to vendor for testing.

6.2.5 Testing shall be complete NLT November 14, 2014.

6.2.6 Draft Test Report shall be provided in MS-Word format and delivered NLT November 30, 2014.

6.2.7 The Government will have 30 days to review the Draft Test Report and provide comments. Final report shall be delivered January 30, 2015.

6.2.8 Government review and any revisions shall be completed NLT February 28, 2015.

7 INTELLECTUAL PROPERTY

All deliverables including, but not limited to, design, data, test results, and physical hardware, may be transmitted by the Government to other Government Agencies or Contractors and their subcontractors. The agencies or contractors, including subcontractors, may use, modify, or re-design the deliverables if needed.

It is also noted that any data first produced in the performance of this effort is in accordance with 52.227-14 (as modified by 1852.227-14). See 52.212-4 for more information.

8 TRAVEL

Travel is not anticipated.

9 Appendix 1: SPRING BUMPER SYSTEM PARAMETERS FOR ORION LAUNCH ABORT SYSTEM

The following parameters are provided to support development of the Bumper design for the Launch Abort System (LAS) Office at Langley Research Center. This guidance is provided in two parts. The first contains the overarching requirements as flowed from the Orion Program to the LAS Project Office (see Table 1). The second contains design parameters currently in use for the Bilinear Spring Bumper design baselined in the current spacecraft design (see Table 2). Please note that the stiffness parameters employed in the current design are not a hard requirement for your design.

Table 1: General bumper requirements

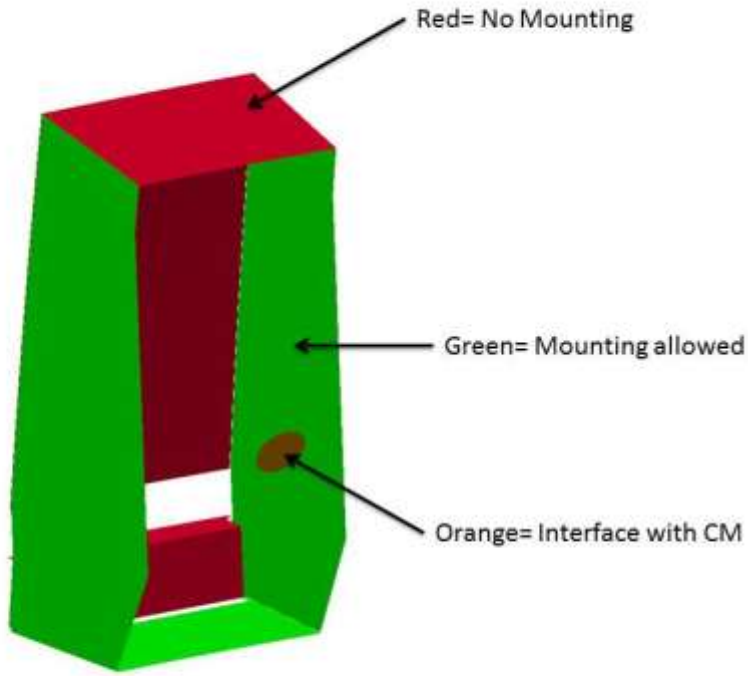
1	Preload at installed position	The device will be preloaded during integration with the vehicle
2	Stroke	1.0-in (does not include initial compression at installation)
3	Maximum allowable load	25 kip compressive

Table 2: Parameters of current Bilinear Spring Bumper design (for reference only)

1a	Preload at installed position	The device will be preloaded to 370 lbf during integration with the vehicle
1b	Preload at assembly	Coil spring is compressed approximately 0.050-in to assemble the Bumper, thus when Bumper is unloaded, the coil spring has approximately 75 lbf preload
2	Stroke	1.125-in (not including 0.25 installation preload compression)
3	Maximum allowable load	25 kip compressive
4	Spring rate – low rate	1500 lbf/in
5	Spring rate – high rate	10,500 lbf/in
6	Point where rate shifts	At 0.25-in of travel (from initial preload position of 0.25-in), higher spring rate is engaged

10 Appendix 2: PICTURE OF MOUNTING LOCATIONS AND VOLUME

Appendix 2a is an IGES files for use within the proposer's CAD system to extract the dimensional constraints for their design. *Appendix 2a can be provided upon request.



11 Appendix 3: CM/LAS INTERFACE LOADS TO BE USED FOR BILINEAR SPRING BUMPER DESIGN

The complete vehicle loads environments are documented in the Project Orion Environments Definition Document (EDD) Rev 6. This document is available for review. In addition, information to aid in defining coordinate frames and descriptions of how to best use the load factors will be made available if requested.

The following Tables and Figures from the EDD provide the CM/LAS Interface Loads that the bumper will be required to operate in:

3.3.1.96 CM/LAS Bumper

Table 6.2-1 CM/LAS Bumper I/F Abort Transient Load Factors by Event

Direction	Pad Abort (G)	MaxQ Abort (G)
R	0.8	1.7
Theta	0.8	4.0
Z	2.5	4.6

Table 6.2-2 CM/LAS Bumper I/F Vibroacoustic Load Factors by Event

Direction	Liftoff (G)	Transonic (G)	MaxQ (G)	Pad Abort (G)	MaxQ Abort (G)
R	5.6	-	-	49.4	-
Theta	6.8	-	-	77.3	-
Z	4.4	-	-	39.6	-

Table 6.2-3 CM/LAS Bumper I/F Combined Load Factors by Event

Case	Direction	Liftoff (G)	Transonic (G)	MaxQ (G)	All Launch Phases (G)	Pad Abort (G)	MaxQ Abort (G)	All Abort Phases (G)
Load Set 1	R	5.8	-	-	5.8	49.4	-	49.4
	Theta	2.6	-	-	2.6	25.9	-	25.9
	Z	4.5	-	-	4.5	29.2	-	29.2
Load Set 2	R	2.2	-	-	2.2	16.5	-	16.5
	Theta	6.9	-	-	6.9	77.3	-	77.3
	Z	4.5	-	-	4.5	29.2	-	29.2
Load Set 3	R	2.2	-	-	2.2	16.5	-	16.5
	Theta	2.6	-	-	2.6	25.9	-	25.9
	Z	6.7	-	-	6.7	55.1	-	55.1

Random Vibe Environments: There are two flight regimes: nominal flight and abort flight. These environments are separate load cases to be applied independently, and to all three axes.

11.1.1.1 CM/LAS Bumper

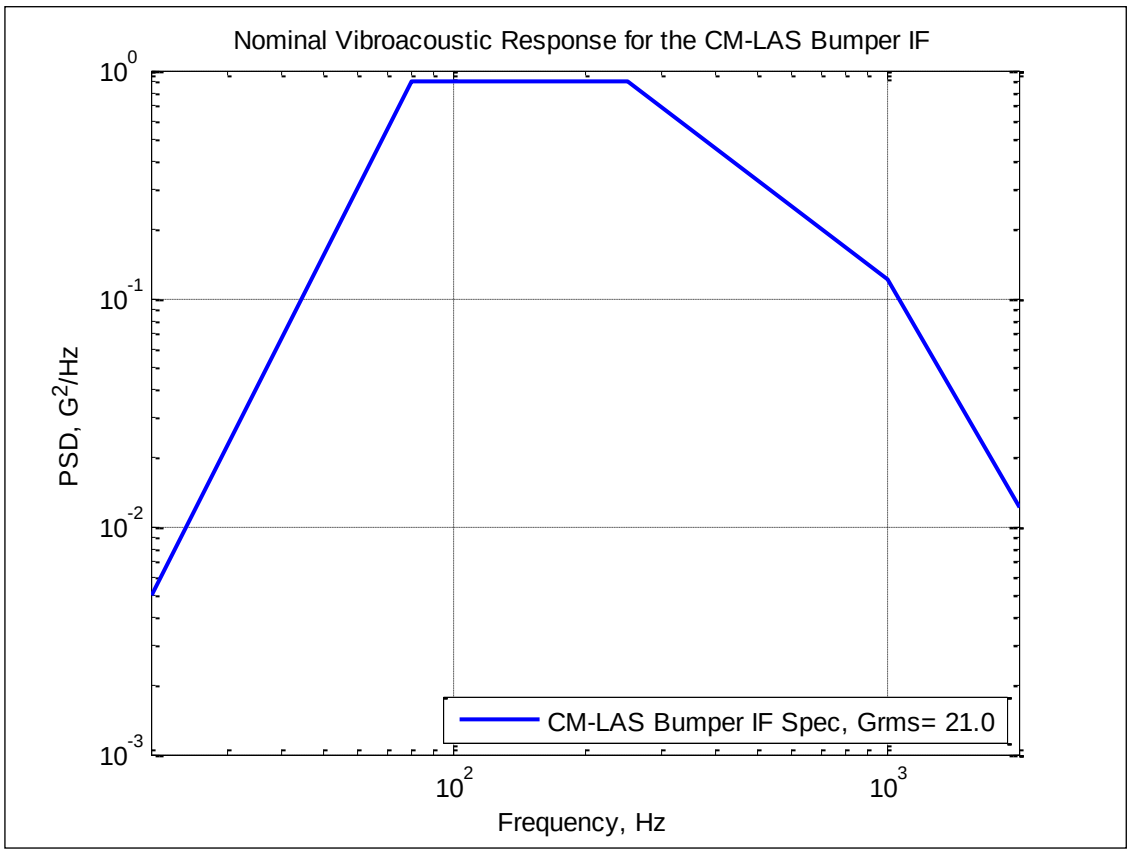


Figure 6.2-1. Nominal Random Vibration MPE for the CM-LAS Bumper IF

Table 6.2-4. Nominal Random Vibration MPE for the CM-LAS Bumper IF

CM-LAS Bumper IF Spec	
Grms=21	
Freq (Hz)	PSD (g^2/Hz)
20	0.005
80	0.9
250	0.9
1000	0.12
2000	0.012