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EML4551-2

Team 519: Composite Airframe Life Extension

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Appendix B: Targets Catalog

Appendix B includes every target, including secondary targets and three that are not functions. All targets can be found in table B1, with a description following.

Table B1

Comprehensive Targets and Metrics

Functions	Metrics	Targets
	Tensile Strength	x MPa
Withstand Loading	Shear Strength	x MPa
	Vibration Frequency/Intensity	Varies
Withstand Temperature	Maximum Temperature	85˚C
	Minimum Temperature	–60˚C
Resist Corrosion	Qualitative Visual Inspection	< Al
	Density	< 2.698 g/cm^3
Other	Cost per Pound	< 0.15$/lb
	Size	< x < y < z

Target 1: Tensile Strength.

The behavior under tension for the part will be evaluated by conducting a three-point bend test using an MTS 858 Mechanical Test System. Three-point bend tests are preferred for carbon fiber due to the difficulty of manufacturing traditional tensile specimens, and its nature as a brittle material. Understanding the part's tensile characteristics are crucial for validating that it has sufficient strength the withstand the forces on the airframe. The MTS 858 performs a multi-stress test; acquiring data for tension, compression, and shear all at once. The system has a 25 kN applied loading capability, allowing for destructive testing as well as non-destructive testing.

Target 2: Shear Strength.

The behavior under shear for the part will be evaluated by conducting a three-point bend test using an MTS 858 Mechanical Test System. Understanding the part's shear characteristics are crucial for validating that it has sufficient strength the withstand the forces on the airframe. The MTS 858 performs a multi-stress test; acquiring data for tension, compression, and shear all at once. The system has a 25 kN applied loading capability, allowing for destructive testing as well as non-destructive testing.

Target 5: Vibration.

The fatigue limit will be tested using a Landmark Hydraulic Mechanical Test System, which allows cyclic loading with a 150 kN capacity. The part will be subjected to continuous vibration during flight operations, with the intensity and frequency dependent upon the location in the aircraft. There are three location groups with vibration profiles respective to each. These vibration profiles are shown below in the following order: Forward FS 100, Between FS 100 –

240, Aft of FS 240. (Fuselage Station (FS) indicates where along the aircraft the part is, along an axis running from nose to tail.)

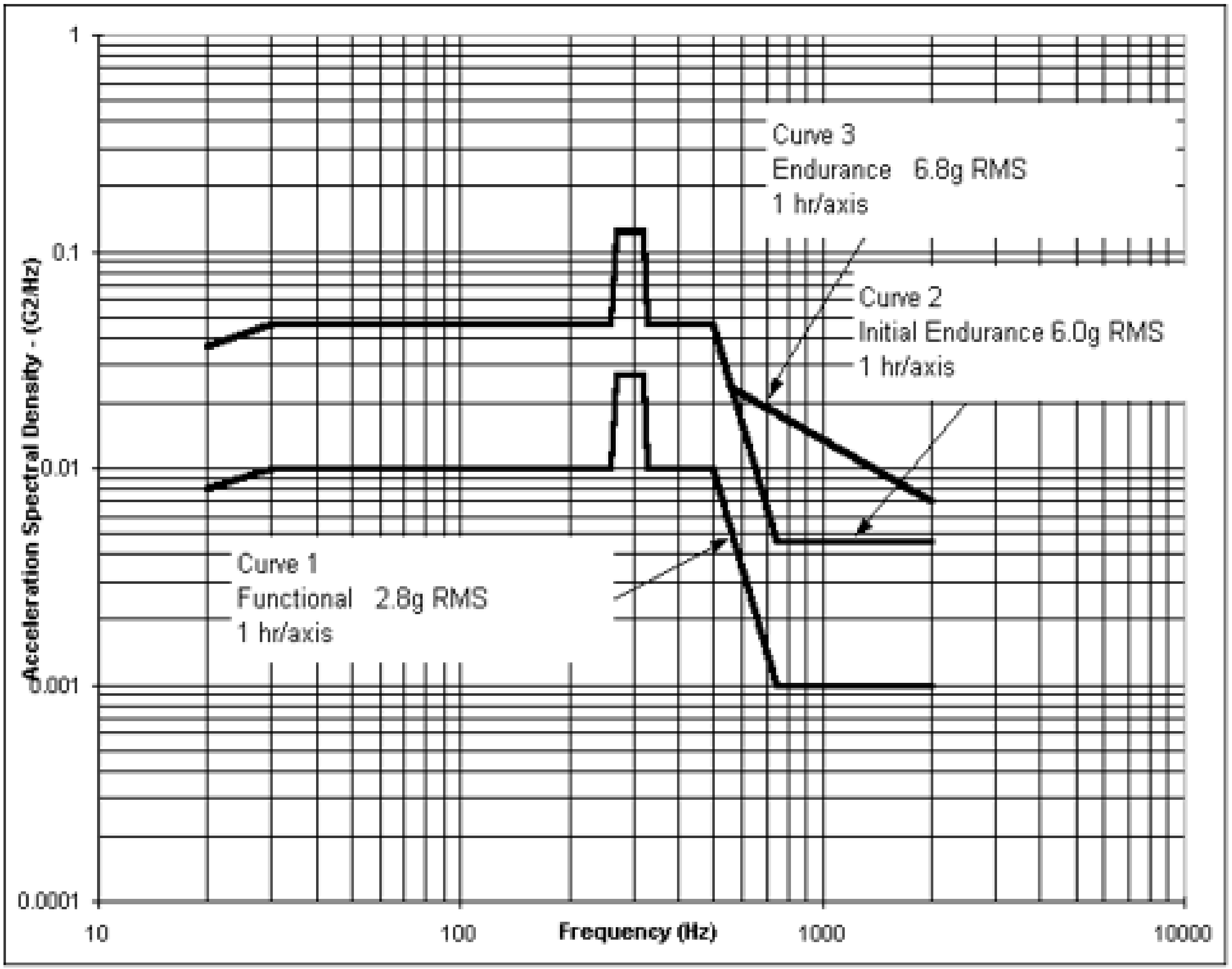

Figure B2: Vibration profile Forward of FS 100.

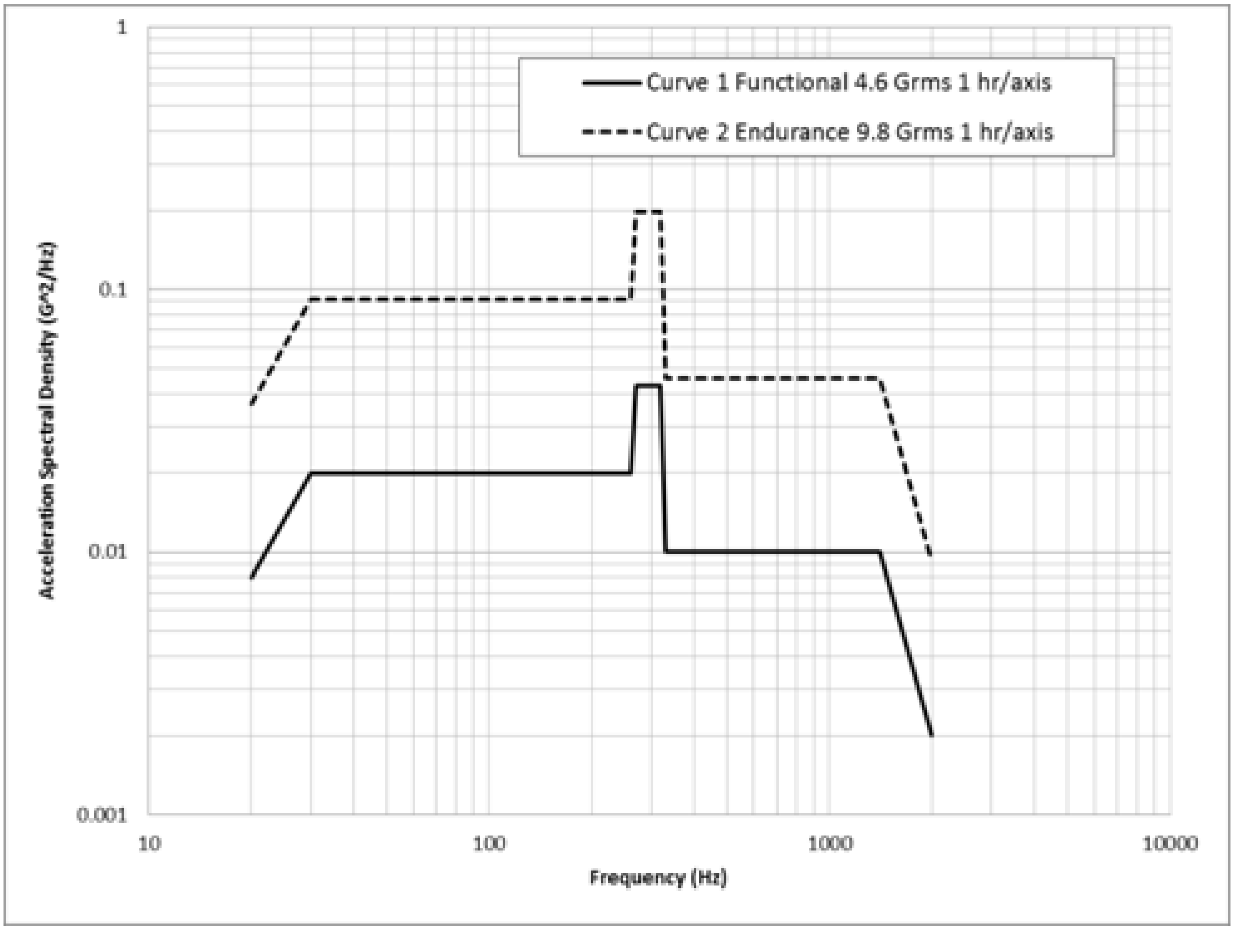

Figure B3: Vibration profile between FS 100 and FS 240

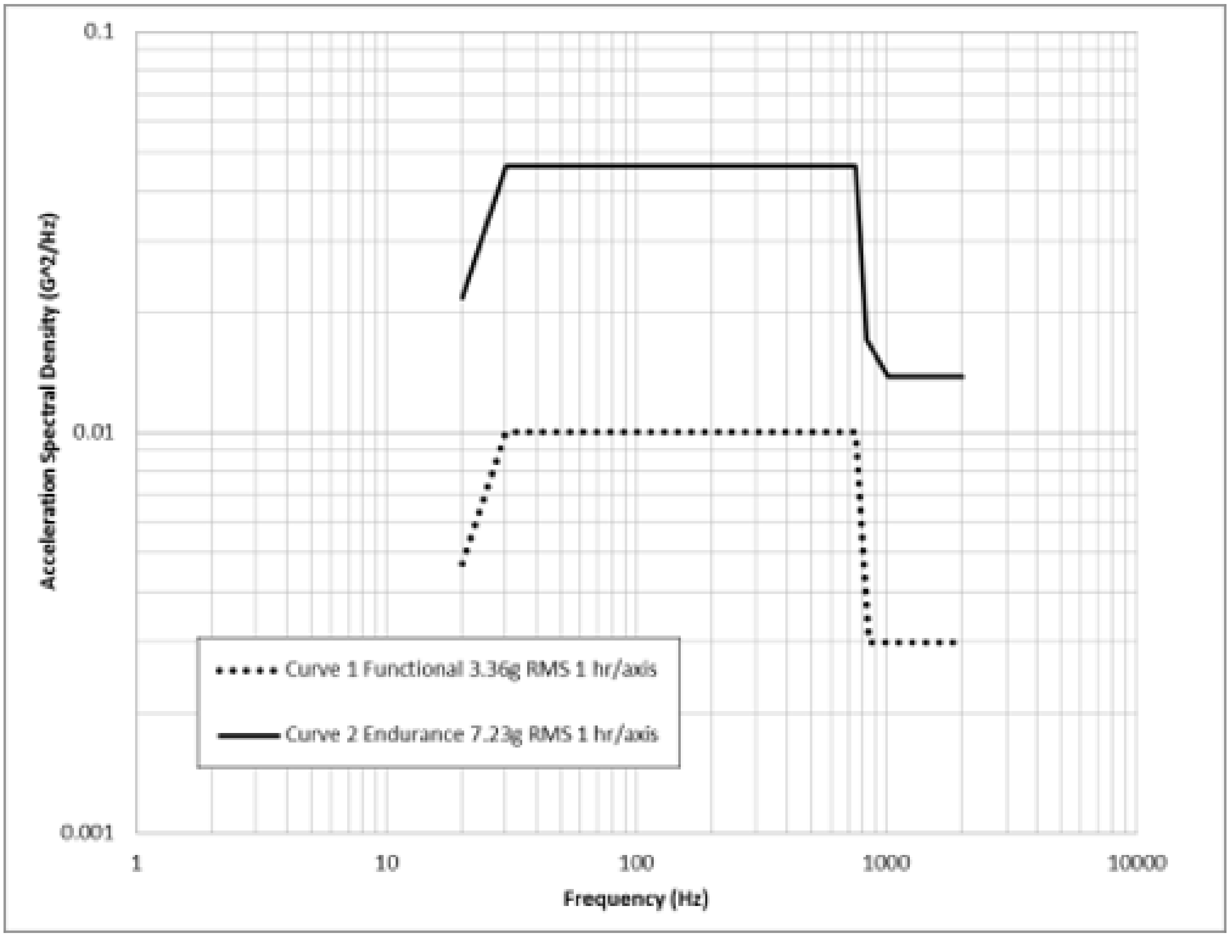

Figure B4: Vibration profile aft of FS 240.

Target 6: Maximum Temperature.

The maximum temperature the part must withstand is 85˚C, which is in non-operating conditions. The part must maintain appropriate strength at this temperature. The test to validate this target is the Hot/Wet test, during which a specimen is immersed in hot water, then taken out and analyzed by the TA Instruments q800 Dynamic Mechanic Analyzer which tests the mechanical properties with respect to time, temperature, and frequency. This test will determine the thermal degradation of the composite system under high temperature.

Target 7: Minimum Temperature.

The minimum temperature the part must withstand is -60˚C, which is the absolute minimum temperature any external part will be exposed to under any conditions or altitude. The part must maintain appropriate strength at this temperature. The test to validate this target is the Cold/Wet test, during which a specimen is immersed in cold water, then taken out and analyzed by the TA Instruments q800 Dynamic Mechanic Analyzer which tests the mechanical properties with respect to time, temperature, and frequency. This test will determine the thermal degradation of the composite system under low temperature. While this test cannot accommodate a temperature below 0˚C, it is likely the best method available to the team. Accurate predictions can be made by extrapolating the change in mechanical properties at various known temperatures within the limited temperature range the team can test at (0˚C to 100˚C).

Target 8: Corrosion Qualitative Visual Inspection.

Naval aircraft are continually exposed to corrosive environments. The corrosion target is simply to have less corrosion than Al, which is extremely likely. The way to test this is to expose an Al and composite specimen to salt water for a period of time, then to examine both under an optical microscope for visible corrosion. If the composite has less visual evidence of corrosion, then it can be considered better than Al.

Target 9: Electrical Resistance.

The team does not have the ability to test the radar cross section (RCS) of the part, and the team may not be able to afford an electromagnetic interference (EMI) test either. The third best option to get an estimate of how much the part will reflect radar waves is an electrical resistance test. A Four-Point probe is used to measure the resistivity of the specimen over an area. This can serve as a very rough estimate for how well the part will reflect radar waves. If the part is more resistive than Al, then it will probably contribute to a smaller RCS.

Target 10: Density.

The density of the material can be found by measuring the dimensions of the part using calipers and determining mass using a scale. Once the dimensions are known, volume can be determined. The average density can then be found by dividing the mass by the volume. The target density is to be less than aluminum, which has a density of 2.698 g/cm^3.

Target 11: Cost.

Cost is a primary disadvantage of composites; however, the team is hoping to mitigate this by using recycled materials. The team is very interested in the cost of the part; the target is to be cheaper than Al6061, which costs 0.15$/lb. (The exact price of the aluminum part is not known at the time of writing because the size of the aluminum part has not been disclosed to the team yet).

Target 12: Size.

The specimens and any prototypes will need to be manufactured in specific sizes. These sizes will be measured using electronic calipers. The specimen sizes depend on the tests being run, and the strength NGC wants the part to have, which has not yet been disclosed to the team as of the time of writing.