MANUFACTURING CHALLENGES AND BENEFITS WHEN SCALING THE HIAD STACKED-TORUS AEROSHELL TO A 15 METER CLASS SYSTEM.

G. T. Swanson[1], F. M. Cheatwood[2], R. K. Johnson[2], S. J. Hughes[2], A. M. Calomino[2], [1]AMA Incorporated, NASA Ames Research Center, Moffett Field, CA 94035 USA, [2]NASA Langley Research Center, Hampton, VA, 23681, USA

Abstract: Over a decade of work has been conducted in the development of NASA's Hypersonic Inflatable Aerodynamic Decelerator (HIAD) deployable aeroshell technology. This effort has included multiple ground test campaigns and flight tests culminating in the HIAD project's second generation (Gen-2) aeroshell system. The HIAD project team has developed, fabricated, and tested stacked-torus inflatable structures (IS) with flexible thermal protection systems (F-TPS) ranging in diameters from 3-6m, with cone angles of 60 and 70 deg. To meet NASA and commercial near term objectives, the HIAD team must scale the current technology up to 12-15m in diameter. Therefore, the HIAD project's experience in scaling the technology has reached a critical juncture. Growing from a 6m to a 15m-class system will introduce many new structural and logistical challenges to an already complicated manufacturing process.

Although the general architecture and key aspects of the HIAD design scale well to larger vehicles, details of the technology will need to be reevaluated and possibly redesigned for use in a 15m-class HIAD system. These include: layout and size of the structural webbing that transfers load throughout the IS, inflatable gas barrier design, torus diameter and braid construction, internal pressure and inflation line routing, adhesives used for coating and bonding, and F-TPS gore design and seam fabrication. The logistics of fabricating and testing the IS and the F-TPS also become more challenging with increased scale. Compared to the 6m aeroshell (the largest HIAD built to date), a 12m aeroshell has four times the cross-sectional area, and a 15m one has over six times the area. This means that fabrication and test procedures will need to be reexamined to account for the sheer size and weight of the aeroshell components. This will affect a variety of steps in the manufacturing process, such as: stacking the tori during assembly, stitching the structural webbing, initial inflation of tori, and stitching of F-TPS gores. Additionally, new approaches and hardware will be required for handling and ground testing of both individual tori and the fully assembled HIADs.

There are also noteworthy benefits of scaling up the HIAD aeroshell to a 15m-class system. Two complications in working with handmade textile structures are the non-linearity of the material components and the role of human accuracy during fabrication. Larger, more capable, HIAD structures should see much larger operational loads, potentially bringing the structural response of the material components out of the non-linear regime and into the preferred linear response range. Also, making the reasonable assumption that the magnitude of fabrication accuracy remains constant as the structures grow, the relative effect of fabrication errors should decrease as a percentage of the textile component size. Combined, these two effects improve the predictive capability and the uniformity of the structural response for a 12-15m HIAD.

In this presnetation, a handful of the challenges and associated mitigation plans will be discussed, as well as an update on current manufacturing and testing that addressing these challenges.