JSC/EC5 Spacesuit Knowledge Capture (KC) Series Synopsis

All KC events will be approved for public using NASA Form 1676.

This synopsis provides information about the Knowledge Capture event below.

Topic: Intra-Extra Vehicular Activity Russian & Gemini

Date: August 3, 2016 **Time:** 12:00 p.m. – 1:15 p.m. **Location:** JSC/B5S/R3102

DAA 1676 Form #: 37263

This is a link to all lecture material \\js-ea-fs-03\pd01\EC\Knowledge-Capture\FY16 Knowledge Capture\20160803 Thomas_IEVA Russian & Gemini Suits\1676 - Videos

Assessment of Export Control Applicability:

This video recorded presentation, along with additional questions and answers, have been reviewed by the EC5 Spacesuit Knowledge Capture Manager in collaboration with the author and is assessed to not contain any technical content that is export controlled. It is requested to be publicly released to the JSC Engineering Academy, as well as to STI for distribution through NTRS or NA&SD (public or non-public) and YouTube viewing.

* This file is also attached to this 1676 and will be used for distribution.

For 1676 review use_Synopsis_Thomas_IEVA Russian & Gemini_Video.docx

Presenter: Kenneth S. Thomas

Synopsis: Kenneth Thomas will discuss the Intra-Extra Vehicular Activity Russian & Gemini spacesuits. While the United States and Russia adapted to existing launch- and reentry-type suits to allow the first human ventures into the vacuum of space, there were differences in execution and capabilities. Mr. Thomas will discuss the advantages and disadvantages of this approach compared to exclusively intra-vehicular or extra-vehicular suit systems.

Biography: Kenneth S. Thomas is a second-generation space engineer who was graduated cum laude with a bachelor's degree from Central Connecticut State University, and worked over four decades in industry. In 1989, he became a contractor project engineer (task manager and team leader) on the Shuttle Extravehicular Mobility Unit Program. To develop his expertise in this area, he conducted hundreds of hours of unpaid research interviewing scores of early spacesuit designers and engineers from many organizations who were directly involved from the beginning of U.S. developments to what was then current. Mr. Thomas also reviewed documents from the early NASA period to provide further insight and validate interview results. In 1993, he became a consultant to the National Air and Space Museum's Space History Division where he gained access to even greater documentation, interview information, and insights. He was a suit-system project engineer for over 20 years and served as principal investigator or key technical support engineer on Lunar-Mars suit efforts for over 15 years, being an inventor or the sole inventor on four international spacesuit patents. He is currently teaching engineering part-time at Central Connecticut State University.

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Questions and Answers for Ken Thomas' "Intra-Extra Vehicular Activity Russian & Gemini Spacesuits" Presentation

August 3, 2016

Question: Which parts of the spacesuit should be 100% instantly self-healed? Such a design strategy, could be a mandatory design parameter for designing spacesuits?

Answer: All the self-healing concepts that I am familiar with (other than the Orlan double bladders) have baggage associated with them that detract from pressure suit performance. If you have orbital debris or ejecta impingement, you almost certainly have immediate loss of life. Sealing the pressure suit is not of much use.

Question: What are the most important challenges concerning the testing cycles for spacesuits?

Answer: First, getting the right requirements. Second, not having the customer invent and implement new requirements that have not been certified.

Question: Can you elaborate the term you mention: Neutral buoyancy?

Answer: Neutral buoyancy is where you place a pressure-suited person in a pool and then add a ballast to their torso, arms, and legs until the person in the suit can be rotated in any position, and they remain there without further movement, i.e., "rolling." Except for water resistance in moving, it allows an amazingly good replication of zero gravity on Earth.

Question: To what extend could current spacesuit requirements constrain the testing procedures for new materials/spacesuits systems?

Answer: None that I know of. The very, very big constraints are money and fear of known problems.

Question: Should common interfaces for spacesuits to be developed?

Answer: I answered this, but I would like to do so again. Yes. The very big challenge is getting nations to work together for compatible systems with common interfaces.

Question: You said in your presentation that Russian testing identified that 5.9 psi was a minimum zero pre-breathe suit (ZPS) pressure. U.S. programs have considered the minimum ZPS pressure to be 8 psi. Why the difference?

Answer: Due to a last-minute change in format, I lost my opportunity to discuss minimum zero pre-breathe suit (ZPS) pressure. ZPS pressure is important in that it allows a person to decompress from a sea-level nitrogen/oxygen atmosphere such as the International Space Station or modern spacecraft and immediately go out in a spacesuit with a lower pressure pure oxygen atmosphere to perform an extra-vehicular activity (EVA) without suffering injury or loss of life due to decompression sickness.

I had planned to share my awareness of errors in the data collection that formulated the U.S. 8 psi ZPS value that would tend to make the U.S. value overly conservative. The Soviet space program conducted a similar program and arrived at a 40 kPa (5.9 psi) ZPS value. The format of their testing program could have easily biased their data in favor of a lower value. The Russians implemented their ZPS value into their EVA suits over four decades ago. The European Space Agency through Dornier conducted a European ZPS study and arrived at 500 hPa (7.25 psi). I suspect the 7.25 psi is still a conservative value and that is the most accurate of the three ZPS values.

We now live in an era when the only way for Americans to reach orbit is aboard Russian spacecraft. The only way an American could immediately go EVA to respond to an emergency is in a Russian spacesuit. I would hope that the next American EVA spacesuit would be a smarter and safer system. Commercial jet fuel controls have used digitally controlled valves to control pressures and flows for decades. A next American suit system could be one that starts with a pre-breathe input. If the pre-breathe is zero, then the spacesuit would start at an initial operating pressure of hopefully 7.25 psi, and slowly reduce pressure over the course of the EVA, based on current U.S. pre-breathe protocol to decrease the human effort required to work and reduce the resulting wear on the pressure garments for maximum operating life. I hope to see this in my life-time.