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: Apollo A-7L Spacesuit Certification and Mission Operations Details

Date: January 28, 2015 **Time:** 11:00a.m. - noon **Location:** JSC/B5S/R3102

DAA 1676 Form #: 33683

This is a link to all lecture material and video \\js-ea-fs-01\pd01\EC\Knowledge-Capture\FY15 Knowledge Capture\20150128 McBarron_Apollo A-7L SS Cert and Mission Ops\For 1676 Review & Public Release

*A copy of the video will be provided to the NASA Technical Library and STI Program's YouTube via the Agency's Large File Transfer (LFT), or by DVD using the USPS when the DAA 1676 review is complete.

Assessment of Export Control Applicability:

This Knowledge Capture event has 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 with video through DVD request or YouTube viewing with download of any presentation material.

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

For 1676 review use_Synopsis_McBarron_Apollo A-7L_1-28-2015.docx

Presenter: Jim McBarron

Synopsis: As a result of his 50 years of experience and research, Jim McBarron shared his significant knowledge about Apollo A-7L spacesuit certification testing and Apollo 7 through 14 missions' spacesuit details.

Biography: In 1960, James (Jim) William McBarron II earned a bachelor of science in geology at the University of Dayton in Dayton, Ohio, and in 1983, he received a master of business administration from the University of Houston – Clear Lake in Houston, Texas. During his time in college, from 1958 to 1961, he worked part time on a University of Dayton contract with the Wright Patterson Air Force Base Aeromedical Laboratory that provided student test subjects to determine human endurance characteristics during and after exposure to extreme environmental conditions. His work as a student assistant also involved pressure suit design testing including suit hardware evaluation for the NASA Project Mercury. His career at NASA began in 1961 as an aerospace technologist with the Crew Equipment Branch, Life Sciences Division, Space Task Group, at Langley Field, Virginia. During his time with NASA, McBarron supported the Manned Spacecraft Center at JSC and worked with spacesuits for all NASA flight programs including Mercury, Gemini, Apollo, Apollo-Soyuz Test Project (ASTP), Skylab, Shuttle, and the ISS. Throughout his career, he was given several prestigious awards including the American Astronautical Society Victor A. Prather Award for outstanding contribution in the field of EV protection in space in 1979. He is the author and co-author of many spacesuit-related publications.

Before he retired in 1999, McBarron was the CTSD chief engineer for EVA projects. In 1999, McBarron took a position with ILC Dover, Inc. as spacesuit systems manager where he reviewed advanced spacesuit technology requirements and design concepts for future manned space flight programs. In 2002, McBarron started his own consulting service to support development of advanced spacesuit technology and inflatable products for current and future manned-space missions.

EC5 Spacesuit Knowledge Capture POCs:

Cinda Chullen, Manager
cinda.chullen-1@nasa.gov
(281) 483-8384

Vladenka Oliva, Technical Editor (Jacobs)
vladenka.r.oliva@nasa.gov
(281) 461-5681

U.S. SPACESUIT KNOWLEDGE CAPTURE SESSIONS

"Apollo A-7L Spacesuit Tests and Certification, and Apollo 7 Through 14 Missions Experience"

Completed:

- "Apollo A-7L Spacesuit Development for Apollo 7 Through 14 Missions," January 2015
- "Apollo Block I Spacesuit Development and Apollo Block II Spacesuit Competition," January 2013
- "Spacesuit Development and Qualification for Project Gemini," December 2012
- "Spacesuit Development and Qualification for Project Mercury," November 2012

James W. McBarron II
Retired NASA JSC
January 28, 2015

TODAY'S AGENDA

- **A-7L PRESSURE GARMENT ASSEMBLY (PGA) AND CEIs TEST AND CERTIFICATION**
  - **Technical Reviews**
  - **Acceptance Tests**
  - **Certification Tests**
  - **Pre-flight Reviews**

- **APOLLO MISSIONS SPACESUIT EXPERIENCE**
  - **Apollo 7**
  - **Apollo 8**
  - **Apollo 9**
  - **Apollo 10**
  - **Apollo 11**
  - **Apollo 12**
  - **Apollo 13**
  - **Apollo 14**

- **SPACESUIT RECORDS USE DATA**

- **LESSONS LEARNED**

A-7L PGA AND CEI's TEST AND CERTIFICATION

TECHNICAL REVIEWS

- **Preliminary Design Review (PDR) held at International Latex Corp. (ILC) plant**
  - Contractor prepared and submitted CEI Specifications based on NASA CSD-prepared Extravehicular Mobility Unit (EMU) Master End Item Specification.
  - Proposed CEI specifications review by NASA Reliability, Quality Assurance, Safety, and technical personnel.
  - NASA review of comments with contractor personnel at ILC plant.
  - Preliminary CEI's design configuration submitted for NASA review.
  - Review Item Discrepancy (RID) form documented NASA findings.
  - ILC Program Manager and NASA technical manager dispositioned RIDs defining actions and completion due dates.
  - ILC prepared and distributed minutes after NASA approval.
  - Proposed CEI's prototype configuration approved for design verification testing (DVT).

jmcbarron

A-7L PGA AND CEI's TEST AND CERTIFICATION

TECHNICAL REVIEWS

- **Critical Design Review (CDR) held at ILC plant.**
  - Contractor submitted CEI design configuration reviewed by NASA personnel.
  - NASA personnel reviewed results of CEI's prototype DVT.
  - NASA approved CEI specifications and design configuration for ILC manufacture of production CEIs.
  - Failure Modes and Effects (FMEA) and Critical Items List (CIL) submitted for NASA approval.
  - RID form documented NASA findings.
  - RID's dispositioned by ILC program manager and NASA technical manager defining actions and completion due dates.
  - ILC prepared review minutes and NASA approved them.
  - Production initiated using formal configuration and quality assurance control of certification CEIs.

A-7L PGA AND CEI's TEST AND CERTIFICATION

TECHNICAL REVIEWS

- **First Article Configuration Inspection (FACI) held at ILC plant.**
  - NASA review of first production CEIs to verify compliance with requirements:
    - CEI specifications current and approved by NASA.
    - As-designed vs. as-built drawing configuration verified.
    - Parts and material lists reviewed and approved.
    - Materials Use Authorizations (MUA) approved.
    - DVT identified problems resolved with changes incorporated.
    - Predelivery acceptance testing satisfactorily completed.
    - RIDS dispositioned by ILC program manager and NASA technical manager with any corrective actions identified.
    - Review minutes prepared by contractor and approved by NASA.

A-7L PGA AND CEI's TEST AND CERTIFICATION

CONTROLLED PRODUCTION

- **Initial three production CEIs allocated for certification testing.**
  - First spacesuit assembly allocated for ILC plant endurance life cycle certification testing.
  - Second and third units allocated for NASA MSC and Hamilton Standard (HS) plant certification testing.

- **Subsequent production CEIs allocated for crew training and flight.**

A-7L PGA AND CEI's TEST AND CERTIFICATION

GROUND TEST SUPPORT EQUIPMENT

- **Common ground support equipment (GSE) test stands**
  - Designed, manufactured, and delivered to NASA under HS contract.
  - PGA and CEI test stands located at all test site locations:
    - HS and ILC plants.
    - NASA CSD and Kennedy Space Center (KSC) spacesuit test facilities.

- **Allowed standardized test procedure document implementation**
  - Provided for comparable test results from all sites.

- **Minimized test personnel training**
  - Provided capability for assignment of experienced field support personnel at multiple test sites.

A-7L PGA AND CEI's TEST AND CERTIFICATION

CEI ACCEPTANCE TESTS

- **PRE-DELIVERY ACCEPTANCE (PDA) TEST**
  - Verification of CEI design and performance after contractor manufacture.
  - Conducted on each deliverable end item to obtain NASA DD250 approval.
  - Included applicable visual inspection, leakage, proof pressure, pressure drop, weight, and astronaut fit check.

- **PRE-INSTALLATION ACCEPTANCE (PIA) Test**
  - Verify PGA and CEI readiness to perform ground test or flight use.
  - Conducted on each PGA or CEI after ground test and post-flight use.
  - Included applicable visual inspection, leakage, structural pressure, pressure drop, weight, and subject fit check.
  - Ground tests included certification, crew training, and preflight checkout.

A-7L PGA AND CEI's SPACESUIT CERTIFICATION

TESTS CONDUCTED

- **Manned design limit endurance cycle testing conducted at ILC**
  - Quantity of joint cycles required established by team review of video showing mission preflight, flight, and flight contingency tasks.
  - Required cycles equation: Preflight + (2 times mission) + flight contingency
  - Manned testing conducted at both vent pressure and 3.75 psig using air.
  - Provided quick problem solution and timely incorporation of design changes.

- **EMU performance and CEI's environmental tests conducted at MSC**
  - Manned test facilities included Bldg. 7, 8-foot vacuum chamber, and 20-foot vacuum chamber with attached auxiliary glove and boot T/V chambers. Tests performed in Bldg. 30 Chamber B vacuum and Chamber A thermal/vacuum chamber facilities.
  - Unmanned CEI's test facilities included Bldg. 32 environmental test chambers.

- **Additional manned preflight tests supported**
  - Crewman EMU vacuum training conducted at MSC in the 8-foot chamber.
  - Suited Command Module (CM) and Lunar Module (LM) preflight crew compartment fit and functional (CCFF) interfaces verification, and vacuum chamber tests conducted at KSC.

ENDURANCE CYCLE LIFE* CERTIFICATION REQUIREMENTS

CONVOLUTE COMPONENT	MISSION* Apollo 7 C	Apollo 11 G	Apollo 12-14 H
SHOULDER	13, 500	14, 400	20, 564
ELBOW	4, 500	5, 360	17, 020
STEPS	0	22, 780	23, 056
GLOVE - EV	0	2, 480	10, 219
WRIST - EV	0	9, 600	9, 112
NECK	0	0	0

*Cycle Life = preflight + 2(Mission) + Contingency

jmcbarron

CEI's CERTIFICATION LIFE CYCLE ENDURANCE TESTS PERFORMED ILC DOVER

Fluorel Boot Soles - A7L
  Start 8/1/68
  Finish 9/19/68

Mission "C" - IV Earth Orbital - A7L
  Start 1/25/68
  Finish 8/29/68

Mission "C" Prime - IV Earth Orbital - A7L
  Start 10/15/68
  Finish 10/22/68

Mission "D" - ITMG Qual - A7L
  Start 11/12/68
  Finish 12/12/68

Mission "G" - A7L Lunar Surface
  Start 2/4/69
  Finish 6/12/69

A-7L PGA AND CEI's TEST AND CERTIFICATION

DESIGN TECHNICAL REVIEW

- **Design Certification Review (DCR)**
  - Final design review conducted before CEI acceptance for first flight use.
  - Review conducted by contractor and NASA with findings presented to the Apollo Program Office.

- **DCR Content**
  - Design configuration.
  - Completion status of flight certification requirements.
  - Identification of certification failures with corrective actions implemented.
  - Status of training and flight CEI's failure closures with closure plan and date.
  - Open work identified for flight hardware with planned completion date.
  - Any and all issues affecting flight readiness.

A-7L PGA AND CEI's TEST AND CERTIFICATION

PREFLIGHT READINESS REVIEWS

- **Apollo Program Flight Readiness Review (FRR)**
  - Conducted contractors and NASA before each flight mission.
  - Establish flight hardware and launch site readiness.
  - Identify configuration changes since prior mission.
  - Identify certification open items and closure status.
  - Open failure reports and closure status.
- **ILC and NASA Technical Manager Flight CEI's Readiness Review**
  - Conducted for Apollo 11 and all subsequent lunar surface missions.
  - Perform technical review of discrepancy reports disposition adequacy.
  - Verify flight CEI's configuration incorporate all required modifications.
  - Review incorporation of field operations instructions.
  - Review PGA and Liquid Cooling Garment (LCG) leakage test trends from PDA to flight PIA tests.

Apollo 7 MISSION

October 11-17, 1969

Mission Objective

- CSM manned flight demonstration

Crew

Walter Schirra Jr. - Commander
Donn F. Eisele - Command module pilot
R. Walter Cunningham - Lunar module pilot

Significant Design Changes From A-7L Baseline

- A-7L CMP PGA Torso Limb suit assembly (TLSA) established:
  - Exterior materials cross-section modified for IV use only.
    - Outer layer Beta Cloth - Inner layer Nomex Cloth.
  - Deleted one set of vent system inlet and outlet gas connectors, LCG water connector, and Portable Life Support System (PLSS) brackets.
    - Reduced weight, bulk, and increased comfort.
  - A-7L Extravehicular Activity (EVA) Crewmen PGA TLSA modification.
    - Arm bearings and convolutes deleted from arms and replaced with link-net type arm mobility joints.
    - Improved crewmen shoulders/arms interference condition when laying side by side in CM couches.

APOLLO 8 MISSION

December 21-27, 1968

(Post Review Corrected Chart)

Mission Objectives

- CSM flight demonstration
- Lunar orbit and return to earth

Crew

Frank Borman, Commander
James A. Lovell, Command module pilot
William A. Anders, Lunar module pilot

Significant Design Changes from A-7L Baseline

- *CDR and LMP provided A-7L-EVA type PGA's.*
- *CMP provided A-7L-CMP type PGA*
- Valsalva device added to helmets.
  - Recommended by Apollo 7 crew. Attachment provided on interior of disconnect.
- Commanders PGA helmet
  - Polycarbonate shell size enlarged to accommodate crewman head size for helmet donning and doffing.
  - Implemented for all subsequent new production helmets.

Apollo 9 MISSION

March 3-13, 1969

Mission Objectives

- LM manned flight demonstration.
- Conduct CM standup EVA, LM EVA transfer to CM, LM PLSS recharge demonstration.

Crew

James A. McDivitt, Commander
David R. Scott, Command module pilot
Russell L. Schweickart, Lunar module pilot

Significant Design Change from A-7L PGA Baseline

- Kapton-bonded Beta Marquisette inner layer added to CMP TLSA outer cover layer materials cross-section.
- Change made to reduce cover layer flammability.

jmcbarron

Apollo 10 MISSION

June 18-26, 1968

Mission Objectives

- LM manned flight demonstration
- Lunar Orbit and return

Crew

Thomas P. Stafford, Commander
John W. Young, Command module pilot
Eugene A. Cernan, Lunar module pilot

Significant Design Change from A-7L PGA Baseline

- Revised A-7L PGA TLSA ITMG materials cross-section for CM and LMP.
  - Outer to inner layers:
    - Teflon fabric
    - Beta cloth
    - 2 layers Kapton-bonded Beta Marquisette
    - 5 layers perforated aluminized Mylar film separated by non-woven Dacron
    - Neoprene coated Nylon rip stop inner most layer
  - Made to improve abrasion resistance, durability, and to reduce flammability.

Apollo 11 MISSION

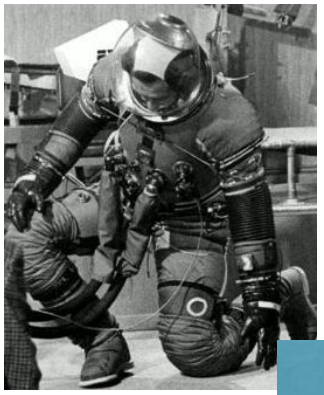
July 16-24, 1969

Mission Objectives

- Manned lunar landing demonstration
- EMU's lunar surface demonstration

Crew

Neil Armstrong, Commander
Edwin E. Aldrin Jr., Lunar Module Pilot
Michael Collins, Command Module Pilot



Significant Design Changes to A-7L Baseline

- Lower profile shoulders, lower torque and profile arm bearings, and improved elbow convolute design incorporated to increase arms mobility.
- Helmet vent pad changed to aluminum, vent connection to TLSA neck ring modified, red color for to helmet/TLSA neck ring disconnect.
- Apollo 9 Extravehicular Visor Assembly (EVVA) shell covered with multi-layer thermal insulation; side retractable sun shades added; sun visor material changed from Polycarbonate to Polysulfone.
  - Polycarbonate shell deformed during unmanned T/V testing. Renamed Lunar Extravehicular Visor Assembly (LEVA).

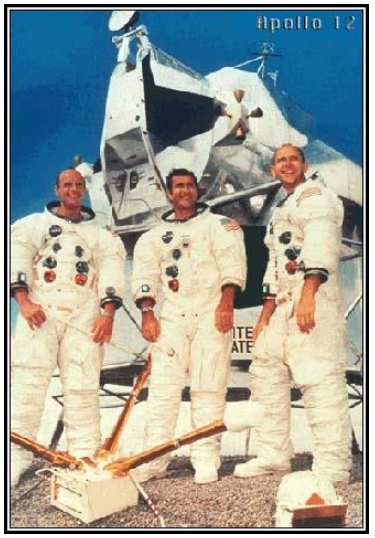
jmcbarron

Apollo 12 MISSION

November 14-24, 1969

Mission Objectives

- Demonstrate precision manned lunar surface landing.
- Develop techniques for a point landing capability.
- Obtain photographs of candidate exploration sites.
- Conduct systematic lunar surface exploration.
- Perform inspection, survey and sampling in lunar mare.
- Deploy Apollo Lunar Surface Experiment Package.
- Develop capability to work in the lunar environment.



Crew

Charles Conrad, Jr, Commander
Richard F. Gordon, Command module pilot
Alan Bean, Lunar module pilot

Significant Design Change from Design Baseline

- Incorporate LEVA center retractable eye shade with adjustable sun blocking center “bill.”
  - Apollo 11 crew recommendation to improve lunar surface visibility.

Apollo 13 MISSION

April 11-17, 1970

Mission Objectives

- Planned precision manned lunar surface landing demonstration and systematic lunar surface exploration.
  - Aborted because of SM oxygen tank 2 explosion.
  - Safe return of crew successfully accomplished.

Crew

James A. Lovell, Commander
John L. Swigert, Jr., Command module pilot
Fred W. Haise, Jr., Lunar module pilot

Real-time Mission Support Necessary

- Suit personnel identified materials, and supported design and chamber life testing for in-flight CM carbon dioxide (CO2) canister modification necessary for LM CO2 level control.

Apollo 14 MISSION

January 31 - February 9, 1971

Mission Objectives

- Demonstrate precision manned lunar surface landing.
- Conduct systematic lunar surface exploration.

Crew

Alan B. Shepard Jr., Commander
Edgar D. Mitchell, Lunar Module Pilot,
Stuart A. Roosa, Command Module Pilot

Significant preflight failure and flight PGA's rework

- PGA depressurization occurred during crew training. Failure traced to boot bladder rubber rupture. Investigation revealed common condition in most dipped PGA convolutes and bladders older than 14 months. Condition caused by premature natural rubber reversion to a natural state.
- Decision implemented to replace all dipped boot bladders with newly dipped bladders plus conduct detailed inspection of dipped components in all flight suits.
- Accomplished successfully at ILC within weeks of flight.
- Failure investigation continued to determine root-cause and implement final corrective action.

FLIGHT PGA'S EXPERIENCE

Apollo Mission	Crew	A-7L PGA s/n	Pre Flight Leakage scc/min	Post Flight Leakage scc/min	Pre-Flight Hours at vent	Pre-Flight Hours at 3.75psi	Flight Hours at vent	Flight Hours at 3.75psi
7	**CDR**	**004**	**60**	**90**	**11.1**	**3.5**	**11**	**0.1**
	CMP	**005**	**90**	**100**	**11.1**	**3.5**	**11**	**0.1**
	LMP	**006**	**125**	**265**	**10.0**	**3.3**	**11**	**0.1**
8	**CDR**	**030**	**60**	**50**	**2.4**	**0.3**	**5.0**	**0**
	CMP	**037**	**87**	**35**	**5.5**	**4.0**	**5.2**	**0**
	LMP	**031**	**55**	**65**	**5.4**	**0.5**	**3.3**	**0**
9	**CDR**	**020**	**90**	**54**	**20.5**	**9.7**	**50.3**	**1.4**
	CMP	**019**	**200***	**225**	**19.9**	**3.3**	**50.3**	**1.4**
	LMP	**015**	**55**	**53**	**24.9**	**25.8**	**50.3**	**1.4**
10	**CDR**	**047**	**60**	**75**	**11.2**	**2.3**	**27.1**	**0.1**
	CMP	**043**	**108**	**75**	**9.2**	**5.9**	**22.0**	**0.1**
	LMP	**044**	**60**	**75**	**29.9**	**8.1**	**25.1**	**0.1**

***Waiver #FLC 8812-4W-0250

jmcbarron

FLIGHT PGA'S EXPERIENCE

Apollo Mission	Crew	A-7L PGA s/n	Pre flight Leakage scc/min	Post Flight Leakage scc/min	Pre-Flight Hours vent	Pre-Flight Hours 3.75psi	Flight Hours vent	Flight Hours 3.75 psi
11	**CDR**	**056**	**33**	**117**	**29.9**	**13.2**	**41.5**	**3.2**
	CMP	**033**	**60**	**85**	**7.3**	**2.0**	**45.1**	**0.3**
	LMP	**077**	**95**	**115**	**2.2**	**6.9**	**40.5**	**3.3**
12	**CDR**	**065**	**105**	**400****	**11.3**	**7.1**	**41.5**	**8.0**
	CMP	**066**	**55**	**18**	**5.1**	**1.0**	**11.0**	**0.0**
	LMP	**067**	**51**	**45**	**5.4**	**6.7**	**41.5**	**8.0**
13	**CDR**	**078**	**80**	**90**	**21.6**	**19.8**	**8.8**	**0.3**
	CMP	**088**	**130**	**145**	**10.6**	**4.7**	**8.8**	**0.3**
	LMP	**061**	**58**	**60**	**14.5**	**29.7**	**8.8**	**0.3**
14	**CDR**	**090**	**93**	**130**	**25.3**	**19.5**	**46.0**	**9.5**
	CMP	**085**	**125**	**135**	**23.7**	**13.9**	**16.5**	**-**
	LMP	**073**	**90**	**100**	**44.4**	**41.5**	**46.0**	**9.5**

**Failure Report – MR 03952

jmcbarron

FLIGHT PGA'S EXPERIENCE

Apollo Mission	Crew	A-7L PGA s/n	Sealing Closures Replaced s/n	Sealing Closures Replaced qty	Sealing Closure Cycles at Launch	Sealing Closure Cycles at Landing
7	CDR	004	-	0	74	75
	CMP	005	084	1	77	80
	LMP	006	-	0	76	79
8	CDR	030	50	1	40	41
	CMP	037	-	0	61	62
	LMP	031	-	0	61	62
9	CDR	020	80	1	45	51
	CMP	019	-	0	87	90
	LMP	015	104/44	2	38	45
10	CDR	047	-	-	36	44
	CMP	043	-	0	62	68
	LMP	044	82	1	60	66

FLIGHT PGA'S EXPERIENCE

Apollo Mission	Crew	A-7L PGA s/n	Sealing Closures Replaced s/n	qty	Sealing Closure Cycles at Launch	Landing
11	CDR	056	82	1	48	50
	CMP	033	-	0	73	75
	LMP	077	-	0	71	75
12	CDR	065	-	0	91	96
	CMP	066	-	0	55	59
	LMP	067	-	0	86	93
13	CDR	078	102	1	58	59
	CMP	088	-	0	58	60
	LMP	061	-	0	50	51
14	CDR	090	034/260	2	56	62
	CMP	085	039/251	2	66	71
	LMP	073	076	1	66	70

LESSONS LEARNED

- **Significance of crewman-induced loads identified during both A-6L DVT and A-7L PGA manned endurance cycle life testing.**
  - Numerous structural restraint cable failures occurred.
  - Induced man-loads requirement incorporated in A-7L PGA design and verified during endurance cycle life certification testing.
  - Recommend load cells instrumentation and measurement of structural load paths for all future advanced spacesuit designs to establish crewman-induced load requirements.

- **PGA bladder and molded rubber components self-abrasion and leakage during flexure.**
  - Excessive leakage failures occurred.
  - Added reinforcement nylon scuff layer on convolutes at wear areas.

LESSONS LEARNED

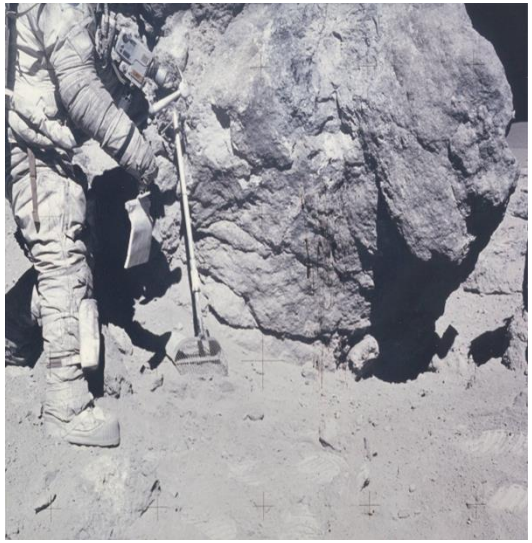
- **Limited TLSA pressure sealing closure don/doff life cycle.**
  - Frequent factory pressure sealing closure replacement in training and flight PGAs necessary because of excessive leakage.
  - Develop new don/doff entry design for future IV and EVA spacesuits having low leakage requirement.

- **Limited flex cycle life of PGA restraint cables at attachment swage fittings.**
  - Numerous swage redesigns because of failures during cycle certification test.
  - Apollo 14 LMP in-flight glove cable failure with wrist joint extension.
  - Eliminate use of cables and swage fittings for future spacesuits design.

LESSONS LEARNED

- **Lock-Locks necessary at all pressure integrity connections.**
  - Found necessary during training use to prevent accidental connector disconnection and potential loss of suit pressure.
  - Incorporate lock-locks for all pressure integrity connections in future spacesuits design.

- **Lunar Dust Particles Contamination.**
  - Suit disconnects and connectors found difficult to actuate upon LM entry and next EVA preparation.
  - RCU readout lens visually obscured.
  - Mostly on lower suit surfaces, lunar module cabin surfaces and atmosphere.
  - Design future spacesuits to provide dust contamination protection.



jmcbarron

LESSONS LEARNED

- **Materials age life limited reuse of both PGA pressure bladder (Neoprene) and molded/dipped rubber components (Proprietary Compound) to four years.**
  - Specify age life requirements based upon then-current materials technology for future spacesuits.
  - Preclude use of proprietary materials in future spacesuit designs.

U.S. SPACESUIT KNOWLEDGE CAPTURE SESSIONS

Future Spacesuit Sessions:

- "Apollo A-7LB Spacesuit Development for Apollo 15 -17 Missions"
- "Apollo Spacesuit Modifications and Development for the Skylab Program"
- "Apollo Spacesuit Modifications and Development for the Apollo Soyuz Test Project"
- "Space Shuttle EMU Spacesuit Development for Initial Space Shuttle Program Flights"
- "Space Shuttle EMU Spacesuit Development for the International Space Station Program"

REFERENCES

- **"NASA Developmental Study of Apollo Helmet Assembly," CSD-65-13, July 16, 1965.**
- **A Collection of Papers on Spacesuits and Human Performance, Chrysler Corporation Space Division, REL-HFG-65-1, August 16, 1968.**
- **NASA letter, Robert R. Gilruth, MSC to Dr. George E. Mueller, Code M, NASA Hdqrs. Procurement Plan for the EMU and ground support equipment development and fabrication, September 20, 1965.**
- **Letter to GAEC, Attn: R. S. Mullaney, Contract NAS 9-1100, Deletion of Multiple Gas Connector (substitute separate Airlock, Inc., connectors).**
- **Statement of Work for Apollo EMU CEI Program, Rev. A, Nov. 17, 1965, submitted by ILC Dover Inc. in response to NASA Request for Proposal No. BG721-21-6130P, September 23, 1965.**
- **NASA and ILC Dover Inc. conference held at NASA MSC, Nov. 3-4, 1965.**
- **TWX, Richard S. Johnston, MSC, to International Latex Corporation. January 3, 1966.**
- **MSC, ASPO Weekly Management Report, January 6-13, 1966.**
- **Extravehicular Mobility Unit Master End Item Specification for Apollo Block II Missions, CSD-A-096, January 31,1966.**
- **"Study of the Apollo Spacesuit Electrical Fire Hazard," CSD-A-518, January 8, 1968.**
- **"Carbon Dioxide Build-up Characteristics in Spacesuits," Aerospace Medicine, Vol. 40, No. 8, August, 1968.**
- **Apollo Design Certification Review Report, "GFE EMU for Mission 504 (CSM 104, LM-3) and Subsequent Missions," CSD-A-826, October 28, 1968.**
- **Test Report, "Apollo Suit Cover-layer Candidates," CSD-A-928, May 5, 1969.**
- **NASA Technical Note D-8093, "Apollo Experience Report – Development of the Extravehicular Mobility Unit," November, 1975.**
- **Author's personal records, 1965 through January, 2015.**