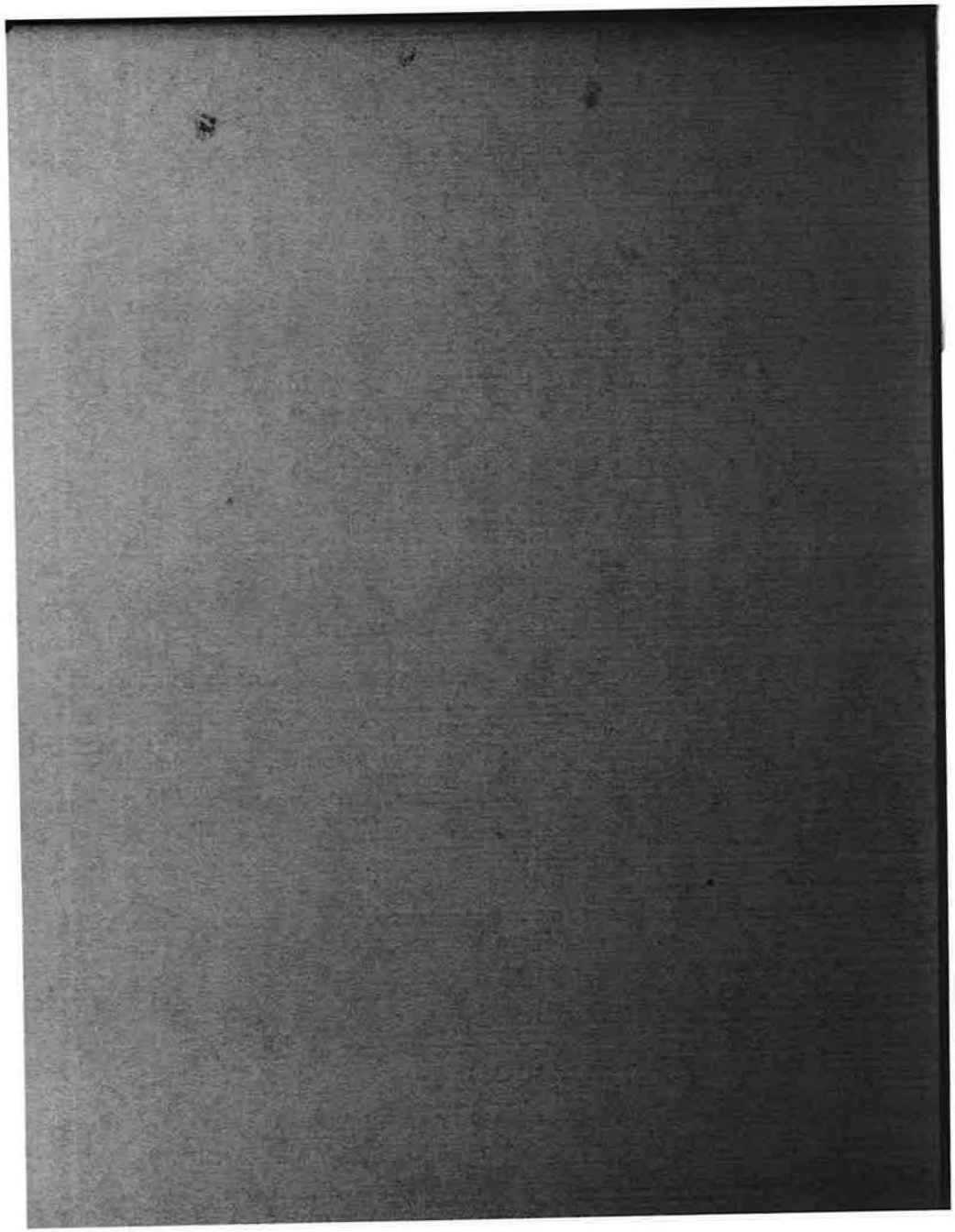

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MSC FORM 892 (SEP 67)

A B S T R A C T

The EMU (Extravehicular Mobility Unit) Garments and associated hardware were evaluated to determine if they are qualified for use in the first Lunar Landing Mission, Apollo XI (S/C 107/LM-5). It has been determined that the subject equipment is qualified for this application as summarized in this report.

TABLE OF CONTENTS

LIST OF TABLES

L I S T O F A B B R E V I A T I O N S

ASPO	Apollo Systems Program Office; NASA/MSC
CCA	Communications Carrier Assembly
CCBD	Configuration Control Board Directive
CM	Command Module
CSD	Crew Systems Division; NASA/MSC
CTR	Certification Test Requirement
DAR	Deviation Approval Request (HSD)
DLVA	Dual Life Vest Assembly
DR	Descrepancy Report
DRA	Document Revision Authorization (HSD)
ECO	Engineering Change Order
ECP	Engineering Change Proposal
EM	Engineering Memorandum
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EMU MK	Extravehicular Mobility Unit Maintenance Kit
EV	Extravehicular
EVA	Extravehicular Activity
EVC	Extravehicular Communications
EVCS	Extravehicular Communications System
EVVA	Extravehicular Visor Assembly
FCB	Feedwater Collection Bag
FCS	Fecal Containment Subsystem
HS	Helmet Shield
HPS	Helmet Protective Shield
HSB	Helmet Stowage Bag
HSD	Hamilton Standard Division of United Aircraft
ICG	Inflight Coverall Garment
ILCI	Internation Latex Company Incorporated
IR	Infrared
ITMG	Integrated Thermal Meteroid Garment
IV	Intravehicular
LCG	Liquid Cooling Garment
LEVA	Lunar Extravehicular Visor Assembly
LiOH	Lithium Hydroxide
LM	Lunar Module
MR	Malfunction Report
MRR	Material Review Record
MSC	Manned Spacecraft Center, Houston, Texas
NASA	National Aeronautics and Space Administration
OPS	Oxygen Purge System
PDA	Pre-delivery Acceptance Tests
PGA	Pressure Garment Assembly
PIA	Pre-installation Acceptance Test
PLSS	Portable Life Support System
P/N	Part Number
PRV	Pressure Relief Valve

PV	Purge Valve
RCU	Remote Control Unit
RDR	Reliability Data Report (HSD)
RF	Radio Frequency
S/C	Spacecraft (CSM)
SESL	Space Environmental Simulation Laboratory, NASA/MSC
SM	Service Module
S/N	Serial Number
SS	Qualification Test Plan (HSD)
SSC	Spacecraft Communications System
SSP	Qualification Test Procedure (HSD)
SVH SER	Qualification Test Report (HSD)
TIR	Technical Information Release (G.E.)
TLSA	Torso Limb Suit Assembly
TPS	Test Preparation Sheet
T/W	Transport Water
UCTA	Urine Collection Transfer Assembly
UV	Ultraviolet

1.0
OBJECTIVE

The objective of the activities described in this report is to assure that the Extravehicular Mobility Unit (EMU) garments and associated hardware are qualified for use in the first Apollo Lunar Landing Mission (Apollo XI, SC 107/LM-5). This effort includes a survey of previous Apollo qualification testing, mission experience, and testing accomplished since qualification for the Apollo X mission to obtain data sufficient to provide a high level of confidence in the ability of the mission hardware to perform all Apollo XI mission operations in the anticipated spacecraft, free space, and lunar surface environments. This document contains a summary of the activities, engineering judgements, and documentation used as a basis for determining that the EMU equipment is fully qualified to perform a successful Lunar Landing Mission.

2.0
INTRODUCTION

The qualification requirements for EMU garments are included in the EMU qualification test plan, CSD-A-133E, and are generally divided into the three major catagories of testing listed below:

Design Limit Cycling Tests
Design Limit Environmental Tests
Mission Interface Tests

Most of the EMU equipment used within the spacecraft has been qualified for use in previous Apollo missions and is considered qualified for the Apollo XI mission. Also, the extravehicular equipment used during the Apollo IX mission was qualified for the earth orbital application. Therefore, additional qualification required for Apollo XI includes (1) additional Lunar/EMU environmental and operational interface tests, and (2) EMU items which have had significant configuration changes. The detailed specifications for each qualification test are contained in a series of CTR's (Certification Test Requirements) which are considered a part of CSD-A-133.

Qualification test requirements for the Lunar Mission which are not applicable to previous missions are:

1. Additional Design Limit Cycling - CTR 1-1
2. Additional Design Limit Environments

   - Sand and Dust Exposure - CTR 2-3
   - Lunar Landing and Lunar Surface Shock-CTR 2-6
   - Lunar Surface Functional Demonstration - CTR 3-2

Items which have had significant configuration changes include:

1. Pressure Garment Assembly
2. Lunar Extravehicular Visor Assembly
3. Helmet Stowage Bag
4. Portable Life Support System
5. Oxygen Purge System

Compliance with each of the qualification test requirements is supported by 1) test demonstration, 2) waiver, or 3) rationale for qualifcation by similarity to a previously qualified item. This report contains summaries of tests for items which fall into category 1, reference to waivers for category 2, and rationale for category 3. Refer to document CSD-A-888 for qualification data on items which

required no additional tests for Apollo XI.

The CTR's in effect and applicable to Lunar Mission Qualification are shown below:

CTR	REV	TITLE	RELEASE DATE
1-1	I	Design Limit Cycling	5-7-69
2-1	C	Oxygen and Humidity	10-21-68
2-2	C	Salt Fog	10-25-68
2-3	C	Sand and Dust	11-11-68
2-4	C	Stowage Low Temperature	10-21-68
2-5	F	Vibration	5-8-69
2-6	E	Shock	5-8-68
2-7	D	Acceleration	10-28-68
2-9	A	Odor and Toxicity	11-4-68
3-1	E	Spacecraft Interface	1-22-69
3-2	B	EMU Lunar Surface Demonstration	1-27-69
3-3	D	EMI and Acoustic Noise	3-14-69
3-4	A	EMU Free Space Demonstration	11-15-68

Table 2-1 shows the detailed qualification requirements for the lunar mission applicable to each EMU item, except for the PLSS, OPS, and related expendables. Data pertaining to the PLSS, OPS and expendables is contained in Sections 7.0 and 8.0 of this document. This table shows all exposures for EMU qualification for Lunar Landing Mission. Some tests were also applicable to previous Apollo missions. Reports of these previous tests are contained in the applicable mission qualification reports. All documents related to the entire Apollo EMU qualification test program are referenced in matrix form in Section 9.0 of this document.

SERIES	DESIGN LIMIT																
	CYCLING					VIBRATION			SHOCK				ACCEL				
TESTS REQUIRED FOR LUNAR SURFACE MISSION	LUNAR SURFACE	O_2 AND HUMIDITY	SALT FOG	SAND AND DUST	STOWAGE LOW TEMP.	DONNED EQUIPMENT	CM STOWED	LM STOWED	INTERVEHICULAR	EARTH LANDING	LUNAR LANDING	LUNAR SURFACE	CM DONNED	LM STOWED	ODOR AND TOXICITY	LUNAR SURFACE DEMON.
CTR NUMBER	1-1	2-1	2-2	2-3	2-4	2-5			2-6				2-7		2-9	3-2
Pressure Garment Assembly	T	T	T	T	T	T	N	N	T	T	N	N	T	N	T	T
IV Gloves (PGA)	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Helmet (PGA)	T	T	T	T	T	T	N	N	T	T	N	N	T	N	T	N
Constant Wear Garment	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	T
Fecal Containment Subs.	T	T	T	T	T	N	N	N	T	T	N	N	T	N	T	N
Urine Collection Trans. Assembly	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Biomedical Instrumentation	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Bio Belt	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Communication Carrier	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Neck Dam	T	T	N	T	N	N	N	N	W	N	N	N	N	N	T	T
Inflight Helmet Stowage Bag	T	T	T	N	T	T	N	N	N	T	N	N	T	N	T	N
Dual Life Vest Assembly	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Penlight	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Inflight Coverall Garment	T	T	T	N	T	T	N	N	T	T	N	N	T	N	T	N
Liquid Cooled Garment	T	T	W	T	W	W	W	W	W	W	W	W	W	W	T	T
EV Gloves (PGA)	T	T	T	N	T	N	N	T	N	N	N	T	N	N	T	N
Lunar Boots (PGA)	T	T	T	N	T	N	N	T	N	N	N	T	N	N	T	N
Extravehicular Visor Assembly	N	T	N	N	T	N	N	T	N	N	N	T	N	N	T	N
Helmet Stowage Bag	T	T	N	N	T	N	N	T	N	N	N	T	N	N	T	N
Helmet Shield	T	T	N	N	T	N	N	T	N	N	N	T	N	N	T	N
EMU Maintenance Kit	T	T	W	T	W	W	W	W	W	W	W	W	W	W	T	T
Purge Valve	T	T	C	C	T	C	C	T	C	C	C	T	C	C	T	T
Portable Life Support System	C	T	C	C	T	C	C	T	C	C	C	T	C	C	T	T
Oxygen Purge System	C	T	C	C	T	C	C	T	C	C	C	T	C	C	T	T
Lunar Extravehicular Visor Assembly	T	T	N	T	T	N	N	T	N	N	N	T	N	N	T	T

Notes: C-Contractor Responsibility, N-Not Applicable, W-Waivered, S-Similarity, T-Test Required.

TABLE 2-1 EMU TEST PROGRAM

3.0
EMU GARMENTS DESIGN LIMIT CYCLING TESTS

Design Limit Cycling Tests were conducted at ILCI, Dover, Delaware, in accordance with document 881270575 which met the requirements of CTR 1-1 H, dated 7 May 1969. The purpose of the cycling tests was to exercise the EMU equipment a number of times in excess of the anticipated mission usage in order to gain confidence in the ability of the hardware to support the mission. Details of this test activity are contained in ILCI document number 8812700620.

3.1 Test Methods

The method used to conduct cycling tests was to suit an ILCI subject in the EMU garments and have the subject repeatedly exercise each flexible and manual aspect of the equipment to the limits specified in CTR 1-1 H. This includes operation of all equipment closures and controls. Mock-ups of the PLSS and OPS are used to verify proper interfaces during appropriate portions of the cycling program.

All cycling was accomplished in the manned normal operating mode of the equipment tested except for a portion of the pressure tests of the pressure relief valve. All cycles performed were accomplished at the maximum amplitude expected during mission and support usage.

The Design Limit Cycling Tests subject one set of equipment to cycling operations while being worn under laboratory ambient conditions. The cycles are representative of those to be encountered during actual usage. The number of cycles is based on a factor of 2.0 times the maximum Apollo operational usage. The operational usage was determined from an extensive study of usage during the Apollo mission, preflight, and crew training operations.

3.2 Test Item Description

The test articles used for the cycling tests were in a configuration which resulted in valid qualification for the lunar mission. The items used during conduct of the tests included test articles, support equipment which had previously been qualified, and test support equipment which is not considered a part of this qualification test program. All of this equipment is listed below:

TEST ARTICLES

ITEM	PART NUMBER	SERIAL NUMBER
Pressure Garment Assembly	A7L-100000-42	039
Helmet	A7L-102043-01	001
IV Gloves	A7L-103000-05/-06	084
EV Gloves	A7L-203025-09/-10	043

TEST ARTICLES CONT'T

ITEM	PART NUMBER	SERIAL NUMBER
Lunar Boots	A7L-106043-01/-02	029
Liquid Cooling Garment	A6L-400000-09	061
Fecal Containment Subsystem	A6L- 501000-03	094
Lunar Extravehicular Visor Assy.	A7L-205000-01	004
Purge Valve	A6L-505000-02	156
Helmet Stowage Bag	A6L-502000-05	023
Helmet Stowage Bag	A6L-502000-07	056
Helmet Protective Shield	A7L-502003-03	048
Communications Carrier	16536G-02	132
EMU Maintenance Kit	A6L-503000-05	044

PREVIOUSLY QUALIFIED EMU SUPPORT EQUIPMENT

ITEM	PART NUMBER
PLSS Mock-up with RCU	HDA02-713901-11
Mock-up and OPS Simulator	
Data Recording Pens (2)	SEB12100051-204
Penlight	ACR-FA-4
Sunglasses	CF 55081-1
Sunglasses Pouch	SEB21200034-203
Scissors	SDB-42100059-202
Check List	SKB-32100027
Crew Log	SKB-32100040
Radiation Dosimeter (Mock-up)	
Chronograph (Mock-up)	SEB-12100039
Watchband (Mock-up)	SEB-12100030
Medical Injector	EC300036-04
Force Gauge	D-500M
Glove Test Fixture	9069-1

3.3 Conclusions

All items tested are considered qualified for the Apollo XI mission to the extent of design limit cycling. During post-test examination of the PGA, leakage in excess of the maximum allowable was noted in several abraded areas of the bladder in the lower torso. A reinforcement scuff patch was placed over each of these areas to eliminate this leakage. Additional reinforcement scuff patches, similar to those used in the upper torso, will be incorporated in the flight items.

The shoulder convolute and arm assembly configuration used in the test PGA (A7L-100000-42, S/N 039) was not representative of the Apollo XI flight EV units. The flight items will include an arm bearing to improve mobility and reduce the crewman effort required

to perform certain motions. Qualification testing in the form of Design Limit cycling was successfully performed per IICI Document 8812700274-408-2 and TPS AA82-0254 on the modified (Resiweld/core yarn) Low Torque Arm Assemblies. One Arm Assembly was installed on PGA A7L-053. This Arm was cycled at 3.75 ± 0.25 psig to the requirements of CTR 1-1, Revision I, dated 7 May 1969.

The second Arm Assembly was pressure cycled 0 - 6.0 psig for 400 cycles and 0 - 8.0 psig for 100 cycles. In addition, the bearing was rotated 1600 cycles.

The Modified (Resiweld/core yarn) Low Torque Arm Assembly is considered to have satisfactorily completed Design Limit Cycling Qualification Testing, and to that extent, is qualified for pre-flight and mission usuage.

4.1 Sand and Dust Tests - CTR 2-3

The purpose of the sand and dust test was to demonstrate the capability of the EMU garment items to endure exposure to the most severe sand and dust environmental exposure anticipated during the Apollo Mission. The sand and dust test was conducted at White Sands, New Mexico, in accordance with procedure CSD-A-476, which met the requirements of CTR 2-3C dated 11 Nov. 1968.

The test items were suspended in a chamber with the purge valve installed and the Extravehicular Visor Assembly attached. The PGA was pressurized to 3.7 ± 0.2 psig.

The sand and dust characteristics and concentration were controlled and monitored to ensure that the requirements of MIL-STD-810, method 510, were maintained.

The following items were tested for the sand and dust exposure:

ITEM	PART NUMBER	SERIAL NUMBER
Pressure Garment Assembly	A7L-100000-22	001
Helmet	A7L-102003-08	024
EV Gloves	A7L-203000-03/-04	001
Lunar Boots	A7L-106015-01/-02	001
Pressure Relief Valve	A7L-104005-06	2045
Extravehicular Visor Assy.	A6L-201000-07	015
Purge Valve	A6L-505000-02	129

EMU items (except the PGA) successfully met the requirements for the sand and dust exposure and are considered qualified for use on the Lunar Surface to that extent. Details of this test are contained in document CSD-A-900.

After removal of the PGA from the environmental exposure, the test items were visually inspected. The left outlet and right inlet gas connector lock-locks would not disengage. The gas connectors cover was not installed during the exposure. Two Discrepency Report/ Material Review Records (DR/MRR) were initiated against these discrepancies. The disposition of these DR's indicated that no corrective action was required since the gas connector cover was not attached. After closure of the subject DR's the subject MR's were reopened as a result of a proposed change in the PGA configuration (i.e. removal of the gas connectors cover for Apollo XI Lunar Surface Operations). The subject MR's were then closed after evaluation of the mission impact should such a malfunction occur on the Lunar surface. A procedure was developed, as documented in the EMU Operational Data Handbook, which permits use of the Water Dispenser/Fire Extinguisher to clean the disconnects upon reentering the LM cabin after a Lunar surface excursion.

4.2 Shock Tests - CTR 2-6

The purpose of the Impact Shock Test was to demonstrate the capability of the EMU garment items to endure exposure to Design Limit Impact Shocks for Intravehicular, Earth Landing, Lunar Landing and Lunar Surface shock levels. Intravehicular and Earth Landing shock tests were accomplished on all applicable equipment as a part of the qualification for the Apollo IX mission. Therefore, the impact shock tests remaining for qualification to the Lunar Landing Mission were 1) LM stowed equipment and 2) Lunar Surface Impact Tests, Details of these tests are contained in document CSD-A-900 and summarized below.

4.2.1 LM Stowed Equipment - Lunar Landing Shock

The LM stowed equipment was subjected to the Lunar Landing shock environmental tests at MSC on March 19, 1969. The test was accomplished in accordance with procedure CSD-A-482 which met the requirements of CTR 2-6C. The test articles were subjected to a simulated impact load of 8.0 g in the -X direction combined with the effect of 14.0 rad/sec^2 angular acceleration normal to the 8.0 g shock. The LEVA, EV gloves (part of PGA) and EMU Maintenance Kit were stowed in the HSB with the bag attached to the impact plate in the same manner as in the spacecraft.

The following test articles were used in the LM Stowed Equipment Lunar Landing Shock Test:

ITEM	PART NUMBER	SERIAL NUMBER
Helmet Stowage Bag	A6L-502000-05	024
EMU Maintenance Kit	A6L-503000-04	022
Lunar Extravehicular Visor	A7L-205000-01	001
EV Gloves (part of PGA)	A7L-203025-01/-02	057

The above items successfully completed the test and are considered qualified for use in Apollo XI and subsequent missions to the extent of Lunar Landing Impact Shock.

4.2.2 Lunar Surface Impact Shock

The purpose of the Lunar Surface Impact Shock Test was to determine if the helmet and Extravehicular Visor Assembly could withstand specific impact loads and remain pressurized. This test was accomplished at MSC on February 20, 1969, in accordance with procedure CSD-A-840 which met the requirements of CTR 2-6C. The helmet (P/N A7L-102003-08, S/N 024) and EVVA (P/N A6L-201000-07, S/N 015) were impact tested with 100 ft/lbs. impact energy and 115 $\pm$ ^{o}F and 250 $\pm$ 5 ^{o}F temperature exposure to the helmet and EVVA, respectively. Details of this test are contained in document CSD-A-938. There was no loss of pressure integrity or destruction of the EVVA on

completion of the front and side impacts. These items successfully completed this test, and are therefore considered qualified for lunar surface impact shock. The Lunar Extravehicular Visor Assembly is considered qualified for this exposure by similarity as stated in 6.2.7 of this document.

4.3 Additional Environmental Tests Due to Configuration Changes

4.3.1 Pressure Garment Assembly Tests

The PGA items which required additional environmental exposures due to configuration changes include the helmet, pressure gage, and redesigned arm.

Helmet - Oxygen and Humidity Test

The helmet was changed from P/N A7L-102003-07 to P/N 102043-01. The current helmet is qualified by similarity to the previous version in all respects except for the feedport gasket torque values. An oxygen and humidity test was conducted on the new helmet to verify that the changed torque values effectively minimize leakage of the helmet while subjected to this environment. This test was conducted in accordance with procedure CSD-A-604 as modified by TPS 11921815, which met the requirements of CTR 2-1C. Before and after conduct of the test the leakage was less than 4.0 scc/min (spec. is 10.0 scc/min). The helmet P/N A7L-102043-01 is therefore qualified to the extent of this environment. See document CSD-A-900.

Pressure Gage Tests

The pressure gage was changed from P/N A7L-104025-03 to P/N A7L-104025-04. This change consists of changing the range of operation from 2.5-5.0 psi to 2.5-6.0 psi and replacing the dial. In order to qualify this change, IV impact shock and IV vibration tests were performed. See document CSD-A-900.

Pressure Gage - IV Impact Shock Test

Pressure gage P/N A7L-104025-04, S/N 256, was shock tested at MSC on 4-16-68 in accordance with procedure CSD-A-483 as modified by TPS 11922011, which met the requirements of CTR 2-6C. Details of this test are contained in document CSD-A-900. The pressure gage successfully passed this test and is therefore considered qualified to the extent of this exposure.

Pressure Gage - IV Vibration Test

Pressure gage P/N A7L-104025-04, S/N 256 was then vibration tested in accordance with procedure CSD-A-477 on a suited anthropomorphic dummy at MSC on 4-27-69. The details of the test are also contained

in document CSD-A-900. The pressure gage successfully completed the vibration and is therefore considered qualified to this extent. All other environmental exposures are considered to be qualified by similarity of configuration to the earlier version (P/N A7L-104025-03).

PGA Redesigned Arm - Thermal Vacuum Test

The mobility of the PGA has been improved by the incorporation of a redesigned arm configuration. This new configuration was tested at ILCI, Dover, Delaware, to the extent of design limit cycling and was also tested at MSC in a manned thermal-vacuum test. The PGA arm bearing thermal-vacuum test was conducted in SESL Chamber B on May 16, 1969 with Mr. J. Mays as the test subject. The PGA (A7L-100000-61, S/N 053) was modified to include the following right arm configuration:

TLSA Assembly	
Upper Arm	A7L-104059-02
Shoulder Convolute	A6L-104006-02
Arm Bearing	A7L-104050-01
Shoulder turn around ring	A7L-104074-01
Lower Arm	A7L-104058-02
Cable Elbow Convolute	A7L-104068-01
ITMG Arm Assembly	
Upper Arm	A7L-201100-07
Lower Arm	A7L-201139-02

The test subject entered the manlock and spacesuit pressure decay checks were made at ambient pressures of 14.7, 5.0, and 0 psia (macimum altitude). During dynamic pressure decay checks, the crewman moved his right arm through several specific motions. He stood motionless for static checks. No discernable pressure decay was noted during any of the six checks made.

The crewman entered the main chamber (under cold wall conditions) and subjected the EMU to a 30-minute cold soak period in which the right arm of the PGA was exercised. Static and dynamic pressure decay checks were again performed with no increase in leakage observed.

Chamber heat sources were activated and the EMU was subjected to a 30-minute hot soak period. The crewman again exercised the right arm. Static and dynamic checks were once more performed with the same results as the previous tests.

The above test showed that the redesigned arm configuration had no significant leakage during the test either while in motion or motionless. The mobility of the right arm was demonstrated to be significantly superior to that of the left arm (old configuration).

At one point the crewman demonstrated that with equivalent effort his right hand could be raised about a foot higher than his left hand. The crewman reported that he could not feel the arm bearing or any hot or cold spots during the test. The crewman also reported that all EMU controls were accessible and operable with the new arm configuration.

4.3.2 Lunar Extravehicular Visor Assembly - Odor and Toxicity Test

The lunar extravehicular visor assembly (P/N A7L-205000-01) is an upgraded version of the previously used extravehicular visor assembly (EVVA P/N A6L-201000). The major differences between the two items is the addition of "blinders", change of visor material to polysulfone, and stowage of visors under this insulated shell rather than outside. This item is considered qualified by similarity to the EVVA for all individual environmental exposures except for Odor and Toxicity. LEVA part number A7L-205000-01, S/N 004, was exposed to the odor and toxicity test at White Sands on May 10, 1969. The procedure was defined in TPS 11931541, which met the requirements of CTR 2-9A.

As a result of the test, DR No. 11931747 was initiated against the LEVA, because of an odor panel score of 2.8 (2.5 or less is acceptable). However, the ratio of test item weight to test chamber volume was out of specification. When this factor is taken into account, the corrected score is 1.8 which is acceptable. Thus the LEVA is considered qualified to the extent of this exposure.

5.0
LUNAR SURFACE FUNCTIONAL DEMONSTRATION - CTR 3-2

5.1 Introduction

A Lunar Surface Functional Demonstration was conducted at the Space Environment Simulation Laboratories (SESL) in the period from February 20, 1969 through March 7, 1969, as reported in document CSD-A-910. This demonstration consisted of six manned EMU thermal-vacuum tests and was accomplished in accordance with the requirements of CTR 3-2B dated January 27, 1969. The purpose of this series of tests was to demonstrate the functional capability of the EMU to accomplish the lunar surface excursions of the Apollo mission at the most severe nominal environments. The following is a summary of the tests accomplished and the purpose of each.

TEST NO.	DATE	TYPE	PURPOSE
1	2/20/69	Lunar Plain-Night	Demonstrate the ability of the EMU to support the crewman during a lunar night or while working in a shadow.
2	2/22/69	Lunar Plain-Day	Demonstrate the capability of the EMU to properly support the crewman during a lunar plain day with a 33 degree sun angle.
3	2/24/69	Lunar Crater-Day	Demonstrate the capability of the EMU to properly support the crewman during a lunar day in a 10:1 aspect ratio spherical crater with a 33 degree sun angle.
4	2/26/69	Lunar Crater-Day	Demonstrate the capability of the EMU to properly support the crewman during a lunar day in a 10:1 aspect ratio spherical crater with a 48 degree sun angle.

ITEM	TEST CONFIGURATION		MISSION "G" CONFIGURATION PART NO.
	PART NO.	S/N	
Pressure Garment Assembly	A7L-100000-42	050	A7L-100000-71/-74
ITMG	A7L-20110-01	057	
Helmet	A7L-102043-01	003	A7L-102043-01
Lunar Extravehicular Visor Assembly	A7L-205000-01	001	A7L-205000-01
EV Gloves	A7L-203025-01/02	057	A7L-203025-09/10
Lunar Boots	A7L-106043-03/04	030	A7L-106043-05/06
Oxygen Purge System	SV730101-2-2P1	010	SV730101-2-12
PLSS	SV706100-6-4P1	017	SV706100-6-14
Liquid Cooling Garment	A6L-400000-09	072	A6L-400000-11
Communication Carrier	16536G-04	133	16536G-04
Fecal Containment System	A6L-501000-02	039	A6L-501000-05
Glove Inserts	A7L-102056-05/06	050	
Purge Valve	A6L-505000-02	141	A6L-505000-04
Roll-on Cuff	14-283-5	N/A	
Urine Collection and Transfer Assembly	14-0108-02-42	3348	14-0108-02
Safety Instrumentation Package	8-4A100	2	N/A
ITMG Gas Connector Cover	A7L-201109-01	057	N/A
ITMG Gas Connector Cover Extension	11920810-02	001	N/A

Table 5 - 1 Equipment used for Lunar Surface Functional Demonstration

TEST NO.	DATE	TYPE	PURPOSE
Delta Test	3/7/69	Cold Soak Test	Evaluate the ability of the EMU to maintain body temperatures under worst case cold conditions.
Off-Design	2/28/69	Hot Case Test	Define the performance envelope during the lunar day in craters with aspect ratios of 10:1, 8:1, 6:1, and 5:1.

5.2 Description of Test Hardware

The EMU hardware listed in Table 5-1 was used for all tests in this series. This equipment is representative of the configuration used in the Apollo XI mission.

5.3 Test Methods

Each of the tests of this series was conducted in Chamber "B" at SESL. The basic procedures used for all tests were similar, in that the chamber pressure is reduced and maintained at 1×10^{-6} torr and the chamber walls and floor are maintained at -300°F. The crewman was escorted to the manlock where the PLSS/OPS was donned. Communications checks were accomplished and the crewman transferred from the portable suit ventilators to the facility environmental control system. The PLSS/OPS was suspended from a trolley system which supported approximately 40 percent of the PLSS/OPS weight and restrained the crewman in an upright position. The manlock was then evacuated to 250 torr, the PLSS was activated and a pressure decay test of the PGA was performed. The manlock pressure was then reduced to 160 torr. PLSS operation and PGA pressure relief valve function were verified. The PLSS sublimator was started at a manlock pressure of 0.5 torr. Manlock pressure was reduced to minimum, final EMU checks were accomplished, manlock to main chamber pressure was equalized, and the chamber door was opened.

The crewman entered the main chamber and moved to the exercise stand. The PLSS/OPS trolley system moved along a monorail to support the EMU. After the crewman was positioned in the exercise stand, he exercised by stepping up and down on a five-inch step. The step rates were varied to produce the desired metabolic rates.

After completion of the test profile, the crewman moved to the manlock and closed the main chamber door. The PLSS sublimator was turned off and the manlock pressurized to 250 torr. When a pressure of 250 torr was reached the PLSS was turned off and the facility ECS system was activated. The manlock was then returned to ambient pressure and the crewman exited the test facility.

5.3.1 Ambient Runs

Crewman [redacted] performed a full dress ambient run in accordance with the procedure on February 12. Both crewmen performed the ambient runs using the same hardware which was used for the thermal vacuum runs. The ambient tests provided crewman with ingress and egress training and familiarization for using the EMU with SESL support equipment. A verification of the test procedures was accomplished and the final procedure was prepared for the thermo-vacuum tests. The tests also gave [redacted] a chance to make final adjustments to the EMU and supporting hardware.

5.3.3 Lunar Plain Night Conditions - Test No. 1

February 20, Crewman - [redacted]
Crewman suit-up was complete at 1030 hours and he entered the chamber at 1158 hours. A cold soak test was the first test phase. As the EMU cooled, the crewman commented that the silicone finger tips of his gloves became "sticky". The backs of the gloves were 40°F when the "sticking" was noticed and -43°F when the "sticking" ceased. The crewman grasped a -185°F rod with no discomfort. During the test, slight fogging of the outer protective visor occurred in the form of milky rings about 4 inches in diameter. These rings were later attributed to water vapor from the PLSS sublimator exhaust, which had also frosted the facility mirror used by the crewman to check areas of the EMU that are out of his range of vision. The crewman performed a 550 BTU/hr cold soak for 60 minutes, a 1200 BTU/hr exercise for 30 minutes, a 2000 BTU/hr exercise for 15 minutes with feedwater valve closed, a 10 minute rest, a 1200 BTU/hr exercise for 20 minutes with PLSS off, and OPS on and a 1200 BTU/hr exercise for 20 minutes under transient conditions with the solar simulator on and chamber floor heated. The transient test was not effective because the chamber temperatures did not rise fast enough. The crewman egressed at 1542 hours. During post-test briefing, the crewman commented that the EMU had maintained him at a comfortable level in all phases of the test.

5.3.4 Lunar Plain Day Conditions - Test No. 2

February 22, Crewman - [redacted]

On Saturday, February 22, the lunar plain day condition test with a 33° sun angle was performed. The lunar crater simulator was turned on to simulate the IR energy radiated from a lunar plain. The Crewman entered the chamber at 1631. A teflon sheet was attached to the EMU between the PLSS and PGA to prevent the PLSS from rubbing holes in the ITMG, since several holes were noticed in the back of the ITMG after the previous test. This was the result of abnormal loads caused by the restraint system attached to the PLSS and the "one G" environment. During this test the crewman performed a 1600 BTU/hr exercise for 20 minutes, a 2000 BTU/hr exercise for 15 minutes, a 1000 BTU/hr exercise for 15 minutes, a 40 minute rest, a 1600 BTU/hr exercise for 20 minutes, a 2000 Btu/hr exercise for 15 minutes, a 1000 BTu/hr exercise for 15 minutes and a 15 minute rest. A cold transient test was deleted when the PLSS water supply was exhausted at 1920 hours. It was evident from Test No. 1 that the transient test would not be beneficial because of the slow temperature response of the chamber. During the test the crewman experienced no hot spots in the PGA. There was no fogging of the helmet or visor, and the blinders for the helmet were very useful when the solar simulators were on. The crew commented that his feet got warm when he stepped across a rail used to position the work stand, but it was not uncomfortable. He commented during the post-test briefing that the EMU kept him comfortable during all phases of the test.

5.3.5 Lunar Crater Day Condition - Test No. 3

February 24 Crewman - [redacted]

On Monday, February 24, the lunar crater day condition test with a 33° angle sun and a 10:1 aspect ratio spherical crater was performed. The crewman entered the chamber at 1148 hours. During this test, the crewman performed a 1600 BTU/hr. exercise for 30 minutes, a 2000 BTU/hr. exercise for 15 minutes, a 1000 BTU/hr. exercise for 15 minutes, a 30 minute rest, a 2000 BTU/hr. exercise for 15 minutes, a 1000 BTU/hr. exercise for 15 minutes, and a 2000 BTU/hr. exercise for 15 minutes with sun and crater simulators off. While performing the 1600 BTU/hr. exercise facing the solar simulator, the crewman reported the back of his right hand was getting hot. The outer cover layers of the glove were 163°F and 182°F. The thermocouple on the back of his hand indicated 99°F. There was no fogging or hot spots in the PGA. During post-test briefing, the crewman commented that the EMU had maintained him comfortably during all phases of the test.

[redacted]

5.3.6 Lunar Crater Day Condition - Test No. 4

February 26 Crewman - [redacted]

On Wednesday, February 26, the lunar crater day condition test with a 48° sun and a 10:1 aspect ratio spherical crater was performed. The crewman entered the chamber at 1122. He performed a 1600 BTU/hr. exercise for 30 minutes, a 2000 BTU/hr. exercise for 15 minutes, a 1000 BTU/hr. exercise for 30 minutes, rest for 20 minutes, a 1600 BTU/hr. exercise for 30 minutes, a 2000 BTU/ hr. exercise for 15 minutes, a 1000 BTU/hr. exercise for 20 minutes, a 9 minute rest, and a 1200 BTU/hr. exercise for 20 minutes with PLSS off and OPS on. During the first exercise period with solar simulator on, and the crewman facing the sun, he commented that the inside of the helmet was about the same temperature as his body, and that the feedport was cool to the touch of his lips. The sun visor temperature was 109° F at this time. During a "hot rod" EV Glove test, the crewman commented that the back of his hands were hot. This was caused by the nearness of his hand to an element of the lunar crater simulator. The crewman reversed hands such that the lunar crater simulator element would not be a factor in the evaluation. The rod temperature was 198°F and the crewman grasped the rod with no discomfort. During the OPS evaluation, the crewman commented that the OPS was not cooling as well as the PLSS, but it kept him comfortable. During post-test briefing, the crewman commented that the EMU kept him comfortable during all phases of the test.

5.3.7 Cold-Soak Test

March 7 Crewman - [redacted]

The crewman entered the chamber at 1154 hours. After the inner door of the chamber was opened, the crewman remained in the manlock until a stable set of data was obtained from the PLSS.

The crewman ingressed the chamber and performed a 2000 BTU/hr. exercise for 20 minutes with the PLSS diverter valve at maximum cooling. The PGA was adjusted in size before the test and the crewman felt it to be more comfortable, and offered less resistance to body movement than during the previous test series.

A one-hour cold soak and rest period with chamber solar and crater simulators off, was started at 2126. The crewman commented that all illuminated PLSS dials were clearly readable in the dark. The PLSS diverter valve was positioned to minimum and the LCG lost cooling slowly. At 1233 the LCG had stabilized and the crewman could feel no cooling. At 1319 hours, the crewman commented that his fingers were getting cold. The PLSS water transport loop differential temperature read 0.9°F with no sign of freezing.

At 1326 hours, the crewman performed a 2000 BTU/hr. exercise for 15 minutes. At 1341, another rest and cold soak for 45 minutes was begun. While the crewman knelt to rest, a warning tone sounded with no flag. After experimenting to reproduce the tone, it was found that when the volume of the suit was changed by kneeling, small spikes of high O_2 flow triggered the tone, but the spikes did not last long enough to trigger the warning flags.

5.3.8 Off Design, Hot-Case Test

An off-design limit test of the EMU was performed in Chamber "B" at SESL/MSC on February 28, 1969, with [redacted] as the crewman. The EMU equipment and procedures used the previous Lunar Surface Qualification Test performed February 18 through 26 were used in this test. The crewman carried the complete weight of the PLSS with a safety line attached to the trolley system.

The crewman performed varying metabolic rates while the simulated lunar crater was set at a 10:1, 8:1, and 5:1 aspect ratio. The position of the EMU was varied in relation to the chamber solar simulator in order to evaluate the EMU in all positions. The Lunar Extravehicular Visor was the only item of EMU equipment to reach its design limit temperature. The EMU supported the crewman comfortably in all phases of the test.

The lunar crater was set for a 10:1 aspect ratio spherical crater for the following test phases: 1500 BTU/hr. exercise for 5 minutes, 2000 BTU/hr. exercise for 5 minutes, a rest for 5 minutes. The lunar crater was then set for a 8:1 aspect ratio spherical crater for the following test phases: 3000 BTU/hr. for 5 minutes, rest for 5 minutes, maximum work rate (3600 BTU/hr.) for 5 minutes, rest for 5 minutes, 2500 BTU/hr. for 5 minutes, 1500 BTU/hr. for 5 minutes, and the rest for 5 minutes. The lunar crater was then adjusted to a 6:1 aspect ratio; but, since the EMU temperature was still under specification limits, it was decided to increase the crater to a 5:1 aspect ratio.

During a 5 minute exercise period with the crater set at an aspect ratio of 5:1, the crewman's hands became hot. The visor temperature read 287°F with the helmet temperature at 109°F. As the gloves became hot, the lunar crater simulator was reduced to a 10:1 aspect ratio. The LEVA was the only component of the EMU that approached the design limit temperature.

After a 5 minute rest, the PLSS was turned off and the OPS activated. The crewman then performed a 2000 BTU/hr. exercise for 15 minutes, and a 2500 BTU/hr. exercise for 10 minutes. The crewman then egressed the chamber at 1800 hours.

For this test, liquid crystals were attached to the helmet and visor which were to change colors as the helmet and visor changed temperatures. During the test, the crewman could not distinguish any color changes of the liquid crystals. The crewman commented that when he placed all his weight on one foot, he could feel an increase in the temperature of his feet. Several warning tones sounded without the PLSS RCU flags. This was later determined to be short spikes of high oxygen flow that were not long enough to trigger the flags. The crewman commented in post-test briefing that the EMU performed well, and he had no serious problems that would prevent the EMU from performing as well on the lunar surface.

5.4 Conclusions

During all phases of the Lunar Surface Demonstration test series, the EMU adequately supported the metabolic work rates under all environmental conditions experienced. All specified test objectives were demonstrated and the EMU is considered qualified for the Apollo XI mission to the extent of lunar surface operations.

6.0
CONFIGURATION OF APOLLO XI HARDWARE

Qualification of the Apollo XI hardware is based on 1) the conduct of formal tests and 2) previous mission usage of like items. Figure 6-1 presents a summary of the configuration of EMU items tested versus the configuration of Apollo XI equipment. Figure 6-2 presents the configurations of equipment used for previous Apollo missions.

Since the configuration of the EMU items has changed as mission applications have evolved, much of the previous testing was accomplished using earlier configurations than is scheduled for Apollo XI. Where the changes in configuration were minor, previous test experience was justification for qualification by similarity, and the item was used for a mission. If changes were significant enough to invalidate qualification by similarity, additional testing was accomplished to verify that the current configuration is qualified for the intended mission application. The decision as to whether or not an item is similar enough to proven items to qualify for mission usage was made on the basis of engineering judgement, as documented herein.

Once an item is qualified for mission usage, either by test or similarity, it is considered qualified for subsequent similar mission usage. Therefore, items qualified and used for previous missions in the configuration applicable to Apollo XI are not reported in this document, but are reported in the qualification report for the first mission in which the item was used. These previous reports are referenced in section 9.0 of this document.

6.1 Configuration of Hardware Tested

Figure 6-1 shows all test requirements applicable to the Apollo XI mission, along with the configuration of Apollo XI hardware, configuration of items actually tested, and comments as to how each item is qualified. In using figure 6-1, the following rules apply for the qualification comments:

a) Qualified - The item was subjected to all required tests in the Apollo XI configuration and successfully met qualification criteria, as reported in previous qualification test reports.

b) Similarity - The item tested was not the Apollo XI configuration, but was qualified by similarity for use in previous missions as documented in previous qualification reports, and the item has been successfully used in space (qualification

ITEM	APOLLO XI PART NUMBER	1-1 CYCLING	2-1 O_2 AND HUMIDITY	2-2 SALT FOG	2-3 SAND DUST	2-4 STOWAGE TEMPERATURE	2-5 VIBRATION	2-6 SHOCK	2-7 ACCEL.	2-9 ODOR TOXICITY	3-2 LUNAR SURFACE	QUALIFICATION COMMENTS
Pressure Garment Assy (IV)	A7L-100000-72											
Pressure Garment Assy (EV)	A7L-100000-74/-71	-42	-22	-22	-22	-22	-22	-22	-22	-01	-42	See 6.2.1
IV Gloves	A7L-103000-19/18	-05/06	-05/06	-05/06		-05/06	A6L-103000 -09/10	A6L-103000 -09/10	A6L-103000 -09/10	A6L-10300 -09/10		See 6.2.1
Helmet	A7L-102043-01	-01	-01	A7L-102003 -08	A7L-102003 -08	A7L-102003 -08	A7L-102003 -08	A7L-102003 -08	A7L-102003 -08	A7L-102003 -08	-01	See 6.2.1
Constant Wear Garment	SEB13100061-208	-208	-207	-207		-207	-207	-207	-207	-207		Similarity
Fecal Containment System	A6L-501000-05	-03	-02	-02		-02				-02	-02	See 6.2.2
Urine Collection Trans.	14-0108-02	-02	-02	-02		-02	-02	-02	-02	-02	-02	Qualified
Biomedical Instrumentation	SEB42100083-306		-301	-301		-301	-301	-301	-301	-301		Similarity
Bio Belt	SEB13100084-202	-202	-201	-201		-201	-201	-201	-201	-201		Similarity
Communications Carrier	16536G-04	-02	-02	10625G-08		10625G-08	10625G-08	10625G-08	10625G-08	10625G-08	-04	Similarity
Inflight Helmet Stowage Bag	SEB13100077-206	-202	-202	-202		-202				-202		Similarity
Dual Life Vest Assembly	SEB40100165-203	-202	-202	-202		-202	-202	-202	-202	-202		Similarity
Penlight	ACR-FA-5	-4	-4	-4		-4	-4	-4	-4	-4		Similarity
Inflight Coverall Garment	BW-1060-001/002	SEB13100062 -205	SEB13100062 -204							SEB13100062 -203		See 6.2.3
Liquid Cooling Garment	A6L-400000-11	-09	-08	-08		-08	-08		-08	-08	-09	See 6.2.4
EV Gloves	A7L-203025-09/10	-09/10	A7L-203000 -03/04	A7L-203000 -03/04	A7L-203000 -03/04	A7L-203000 -03/04	A7L-203000 -03/04	-01/02	A7L-203000 -03/04	A7L-203000 -03/04	A7L-203025 -01/02	See 6.2.5
Lunar Boots	A7L-106043-05/06	-01/02	A7L-106015 -01/02	A7L-106015 -01/02	A7L-106015 -01/02	A7L-106015 -01/02	A7L-106015 -01/02		A7L-106015 -01/02	A7L-106015 -01/02	-03/04	See 6.2.6
Lunar Extravehicular Visor	A7L-205000-01	-01						-01 L.L.		-01	-01	See 6.2.7
Helmet Stowage Bag	A6L-502000-07	-05	-03			-03	-03	-05	-03	-03		See 6.2.8
Helmet Shield	A7L-502003-03	-03	-01			-01				-01		See 6.2.9
EMU Maintenance Kit	A6L-503000-07	-05	-05			-05	-05	-04/05	-05	-05		See 6.2.12
Purge Valve	A6L-505000-04	-02	-02	-02	-02	-02	-02		-02	-02	-02	See 6.2.13
CWG Electrical Harness	A6L-507000-02											Similarity
Portable Life Support System	SV706100-6-14										-6-4PI	Section 7
Oxygen Purge System	SV730101-2-12										-2-2PI	Section 8
EVVA	A6L-201000-06		-07		-07	-07	-07	IS-07	-07	-07		Not Required

FIGURE 6-1 QUALIFICATION CONFIGURATION SUMMARY

ITEM	PART NUMBER	APOLLO VII MISSION C HARDWARE	APOLLO VIII MISSION C' HARDWARE	APOLLO IX MISSION D HARDWARE	APOLLO X MISSION F HARDWARE	APOLLO XI MISSION G HARDWARE	QUALIFICATION STATUS
Pressure Garment Assembly (IV)	A7L-100000	-18	-33	-56	-67	-72	See 6.2.1
Pressure Garment Assembly (EV)	A7L-100000	-16	-37/-40	-54	-63/-68	-74/-71	See 6.2.1
IV Gloves	A7L-103000	-01/-02	-01/-02	-05/-06	-05/-06	-19/-18	See 6.2.1
Helmet	A7L-102003	-07	-07	-11	-11	N/A	See 6.2.1
	A7L-102043	N/A	-01	N/A	N/A	-01	
Constant Wear Garment	SEB13100061	-205	-208	-208	-208	-208	Qualified in C'
Fecal Containment Subs.	A6L-501000	N/A	-02/-03	-02/-03	-02/-03	-05	See 6.2.2
Urine Collection Trans. Assy.	14-0108	-02	-02	-02	-02	-02	Qualified in C
Biomedical Instrumentation	SEB42100083	-301	-305	-305	-306	-306	Qualified in F
Bio Belt	SEB13100084	-201	-202	-204	-202	-202	Qualified in C'
Communications Carrier	16536G	-03	-02/-03	-02	-04	-04	Qualified in F
Inflight Helmet Stowage Bag	SEB13100077	-206	-206	-206	-206	-206	Qualified in C
Dual Life Vest Assembly	SEB40100165	-202	-203	-203	-203	-203	Qualified in C'
Penlight	ACR-FA	-5	-5	-5	-5	-5	Qualified in D
Inflight Coverall Garment	SEB13100062	-206	-204	-003/-004	-003/-004	BW1060-001 -002	See 6.2.3
	BW1043	N/A	-003/-004				
Liquid Cooling Garment	A6L-400000	N/A	N/A	-09	-09	-11	See 6.2.4
EV Gloves	A6L-203000	N/A	N/A	-03/-04	N/A	-09/-10	See 6.2.5
	A7L-203025			N/A	-01/-02		
Lunar Boots	A7L-106043	N/A	N/A	N/A	N/A	-05/-06	See 6.2.6
Extravehicular Visor Assembly	A7L-201000	N/A	N/A	-07	-09	N/A	Not Required
Lunar Extravehicular Visor	A7L-205000	N/A	N/A	N/A	N/A	-01	See 6.2.7
Helmet Stowage Bag	A6L-502000	N/A	N/A	-05	-05	-07	See 6.2.8
Helmet Shield	A7L-502003	N/A	N/A	-01	-02	-03	See 6.2.9
EMU Maintenance Kit	A6L-503000	-04	-04	-05	-05	-07	See 6.2.12
CWG Electrical Harness	A6L-507000	N/A	N/A	N/A	-02	-02	Qualified in F
Portable Life Support System	SV706100	N/A	N/A	-5-5	-5-5	-6-14	Section 7
Remote Control Unit	SV721783	N/A	N/A	-4	-4	-5	Section 7
LiOH Cartridge	SV710854	N/A	N/A	-4/-5	-4/-5	-9	Section 7
Battery	SV701900	N/A	N/A	N/A	N/A	-9/-10	Section 7
Oxygen Purge System	SV730101	N/A	N/A	-1-1	-1-5	-2-12	Section 8
Purge Valve	A6L-505000	N/A	N/A	-02	-03	-04	See 6.2.13
PLSS/EVCS Assembly	SEB111100066	N/A	N/A	N/A	N/A	-319	See 6.2.10
PLSS/EVCS Assembly	SEB111100066	N/A	N/A	N/A	N/A	-320	See 6.2.10
Feedwater Collection Bag	BW1080	N/A	N/A	N/A	N/A	-001	See 6.2.11

FIGURE 6.2 MISSION CONFIGURATION SUMMARY

6.1 b (Cont.) in itself).

c) See 6.2___ - The Apollo XI configuration differs from items qualified by usage in previous missions and from the item tested. Rationale for the qualification of these items is contained herein as a part of section 6.2 "Qualification of Apollo XI Configuration Hardware".

6.2 Qualification of Apollo XI Configuration Hardware

Figure 6-2 shows the dash number configuration of the EMU garments and associated equipment for previous Apollo missions. The qualification status column indicates the rationale for Apollo XI qualification of each item. In all cases where the dash number of the Apollo XI item differs from that of any previous mission, a reference to a part of this section is included.

Although other sections of this document contain reports of testing activities required to qualify EMU items for Apollo XI, this section relates all applicable testing and rationale to each end item which has had any configuration change or required additional testing exposures for the Lunar Mission.

6.2.1 Qualification of the Pressure Garment Assembly, P/N A7L-100000-71, -72 and -74

The Pressure Garment Assembly (PGA) P/N A7L-100000-71/-72/-74 are qualified for use in the Apollo XI mission for the following reasons.

NOTE: Although the EV Gloves and Lunar Boots are technically a part of the PGA they are reported separately in 6.2.5 and 6.2.6 respectively.

1. Cycling - PGA P/N, A7L-100000-42, S/N 039, successfully completed Lunar Mission Cycling tests as reported in section 3.0 of this document.

2. Environments - The following items successfully completed the environmental tests shown as reported in CSD-A-888 and herein.

ITEM	ENVIRONMENT	CTR
PGA A7L-100000-22	O_2 and Humidity	2-1
IV Gloves A7L-103000-05/06	O_2 and Humidity	2-1
Helmet A7L-102043-01	O_2 and Humidity	2-1
PGA A7L-100000-22	Salt Fog	2-2
IV Gloves A7L-103000-05/06	Salt Fog	2-2
Helmet A7L-102003-08	Salt Fog	2-2
PGA A7L-100000-22	Sand and Dust	2-3
Helmet A7L-102003-08	Sand and Dust	2-3
PGA A7L-100000-22	Stowage Low Temperature	2-4

ITEM	ENVIRONMENT	CTR
IV Gloves A7L-103000-05/-06	Stowage Low Temperature	2-4
Helmet A7L-102003-08	Stowage Low Temperature	2-4
PGA A7L-100000-22	Vibration	2-5
IV Gloves A6L-103000-09/-10	Vibration	2-5
Helmet A7L-102003-08	Vibration	2-5
Pressure Gage A7L-104025-04	Vibration	2-5
PGA A7L-100000-22	Shock	2-6
IV Gloves A6L-103000-09/-10	Shock	2-6
Helmet A7L-102003-08	Shock	2-6
Pressure Gage A7L-104025-04	Shock	2-6
PGA A7L-100000-22	Acceleration	2-7
IV Gloves A6L-103000-09/-10	Acceleration	2-7
Helmet A7L-102003-08	Acceleration	2-7
PGA A7L-100000-01	Odor and Toxicity	2-9
IV Gloves A6L-103000-09/-10	Odor and Toxicity	2-9
Helmet A7L-102003-03	Odor and Toxicity	2-9

PGA P/N A7L-100000-71/-72/-74 is qualified by test and similarity to the test items shown above since the configuration differences (discussed in 4, and 5 below) are not significant enough to invalidate test exposures on previous configurations.

3. Spacecraft and Mission Interface

PGA P/N A7L-100000-71/-72/-74 is qualified for spacecraft interface by similarity to configurations used for previous Apollo missions as shown below.

Mission	PGA(IV)	PGA(EV)	Helmet	IV Gloves
Apollo VIII (C')	A7L-100000-33	A7L-100000-37 A7L-100000-40	A7L-102003-07 A7L-102043-01	A7L-103000-01/-02
Apollo IX (D)	A7L-100000-56	A7L-100000-54	A7L-102003-11	A7L-103000-05/-06
Apollo X (F)	A7L-100000-67	A7L-100000-63 A7L-100000-68	A7L-102003-11	A7L-103000-05/-06

PGA (EV) A7L-100000-74 is qualified for Lunar Mission Interface by similarity to PGA A7L-100000-42 (S/N 050) which successfully completed the Lunar Surface Functional Demonstration in accordance with CTR 3-2 and documented in Section 5.0 of this report. The arm section of PGA (EV) A7L-100000-74 is qualified for mission use by test of the redesigned arm in a thermal-vacuum environment as reported in Section 4.0.

4. Configuration Differences - PGA (EV)

PGA Item	Qualification A7L-100000-42	Apollo XI Flight (EV) A7L-100000-71/74	Qualification Method
Torso Limb Suit Assembly	A7L-100002-22	A7L-100002-34	Test & Similar.
Pressure Gage Cover	A7L-201136-02	A7L-201136-03	Similarity (a)
Pressure Gage	A7L-104025-03	A6L-104025-04	Test (b)
Electrical Conn. Flange	A6L-101016-02	A6L-101016-03	Similarity (c)
Torso Limb Suit	A7L-100001-36	A7L-100001-48	Test & Similar. (d)
Torso Assembly	A7L-101091-03	A7L-101091-04	Similarity (e)
Leg Assembly	A7L-105000-09/10	A7L-105000-09/14	Similarity (f)
Arm Assembly	A7L-104025-19/20	A7L-104025TBD (-71 only)	Test (g)
UCTA Disconnect	A7L-105003-01	A7L-105003-03	Similarity (h)
Lunar ITMG	A7L-201100-01	A7L-201100-16	Test & Similar. (i)
Contingency Sample Pocket	TBD	TBD	Similarity (j)

Torso Limb Suit Assembly P/N A7L-100002-34 is qualified by test and similarity to the qualified A7L-100002-22 configuration and differs as outlined in (a) through (j) below.

(a) Pressure Gage Cover P/N A7L-201136-03 is qualified by similarity to P/N A7L-201136-02, which was previously qualified. The -03 unit is enlarged to accommodate the extended range pressure gage. The materials of both configurations are identical.

(b) Pressure Gage P/N A6L-104025-04 is qualified by test and similarity to P/N A6L-104025-03. The -04 differs from the -03 in that the dial range is extended from 5 psi to 6 psi. Cycling, IV impact shock, and IV vibration tests were performed on the -04 unit as reported herein. All other requirements are qualified by similarity to the -03.

(c) Electrical Connector Flange P/N A6L-101016-03 is qualified by similarity to P/N A6L-101016-02, which was used in the qualification PGA. The -03 differs from the -02 in that the tap drill depth is changed to correct buckling problems.

(d) Torso Limb Suit P/N A7L-100001-48 is qualified by test and similarity to P/N A7L-100001-36 configuration, which differs as outlined in notes (c) and (d) above.

(e) Torso Assembly P/N A7L-101091-04 is qualified by similarity to the qualified P/N A7L-101091-03 configuration and differs by the relocation of the RCU/PGA interface and improved purge valve access modifications.

(f) Leg Assembly P/N A7L-105000-09/14 is qualified by similarity to P/N A7L-105000-09/10 which differs in that the UCTA lanyard attachment material is changed and requires material certification only.

(g) Arm Assembly P/N A7L-104025-TBD (-71 PGA only) is qualified by similarity to P/N A7L-104025-18/-20 except for cycling and thermal-vacuum tests which were successfully accomplished as reported herein. The changed arm assembly differs in that an arm bearing and mirror image shoulder convolutes have been added to improve mobility.

The new arm part numbers are A7L-104058-01/-02 (lower) and A7L-104059-08/-09 (upper) with the A7L-104050-01 bearing assembly. The following items were changed due to the bearing installation in the P/N A7L-100000-71 EV PGA.

Pressure Garment Assembly	A7L-100000-71	A7L-100000-74
Integrated TLSA	A7L-201100-17	A7L-201100-16
TLSA	A7L-100001-52	A7L-100001-48
Shoulder ring and cable guide	A7L-104074-01	A7L-104035-03
Liner Assembly	A7L-107000-15	A7L-107000-12
Arm Bias Assembly	not present	present
Ring retaining convolute	present	not present
Arm bearing locking tab	present	not present
Shoulder ring and cable assy.	not present	present

(h) UCTA Disconnect. P/N A7L-105003-03, is qualified by similarity to P/N A7L-105003-01, which is qualified by test and mission use. The -03 differs from the -01 in that the cap retaining lanyard material is changed from Beta to Nomex. Qualification is by similarity to other spacecraft uses of Nomex material.

(i) Lunar ITMG, P/N A7L-201100-16, is qualified by similarity to P/N A7L-201100-01 which is qualified by test as a part of PGA A7L-100000-42 as reported herein. The -16 differs from the -01 as shown below:

(1) RCU/PGA interface is relocated.
(2) Purge Valve access improved.
(3) LM tether flap replaced with an insert.
(4) Zipper flap abrasion strip of Nomex webbing is added to prevent fraying of Beta flap by the pressure zipper teeth. This change was included in PGA A7L-100000-42 S/N 050, which was used for lunar thermal-vacuum qualification testing.
(5) Nomex abrasion patch added under torso tie-down buckles to decrease wear on the ITMG.
(6) Thermal gas connectors cover is deleted.

(j) The Contingency Sample Pocket (Crew preference item is qualified by similarity to other ITMG strap-on pockets.)

6.2.1.4 (Cont.) Helmet P/N A7L-102043-01/-02 is qualified by test and similarity to P/N A7L-102043-01, which was used on Apollo VIII (C'). Changes from that configuration include:

a. Addition of a chin strap
b. Revised feedport mounting procedure.

P/N A7L-102043-01 is qualified for Lunar Surface impact shock by similarity to P/N A7L-102003-08, which successfully completed a test as reported herein. The revised feedport mounting procedure is qualified by successfully completing an oxygen and humidity test as reported in section 4.0 of this document. The -02 helmet differs from the -01 by the addition of alignment mark on the neck ring and is qualified by similarity.

IV Gloves P/N A7L-103000-18/-19 are qualified by similarity to P/N A7L-103000-05/-06, which were used in Apollo missions IX and X (D and F). The only configuration difference is the addition of a crewman identification label in P/N A7L-103000-18/-19. There is no change in form, fit, or function. The label is of an approved type.

Comfort Gloves P/N A7L-103056-07/-08 and -09/-10 are qualified by similarity to P/N A7L-103056-01/-02 and -05/-06, which are qualified by previous mission usage. The -07/-08 and -09/-10 differ from the -01/-02 and -05/-06 in that crewman identification labels are added. There is no change in form, fit, or function. The materials of the label are approved for spacecraft use.

5. Configuration Differences IV versus EV PGA

The IV PGA P/N A7L-100000-72 is qualified by similarity to the Apollo X PGA P/N A7L-100000-67 and the EV qualification PGA A7L-100000-42. The IV PGA P/N A7L-100000-72 differs from EV PGA P/N A7L-100000-42 as shown below:

a. Two, rather than four, gas connectors are provided as in PGA P/N A7L-100000-67 (used for Apollo X).
b. No PLSS attachment "D" rings are provided.
c. The ITMG is replaced with an IV Cover Layer.
d. No RCU/PGA interface is provided.
e. The redesigned arm configuration is not included.

6.2.2 Qualification of the Fecal Containment Subsystem, P/N A6L-501000-05

The Fecal Containment Subsystem (FCS) P/N A6L-501000-05 is qualified for use in the Apollo XI mission for the following reasons:

1. FCS P/N A6L-501000-02 passed the following invironmental tests and was used for missions C', D, and F.

Test	CTR
O_2 and Humidity	2-1
Salt Fog	2-2
Stowage Low Temp	2-4
Odor and Toxicity	2-9
Lunar Surface Demonstration	3-2

The following tests were not performed since the FCS is composed entirely of soft goods and is similiar to the EMU Maintenance Kit, which had these tests waived via memo EC921NA0411.

Test	CTR
Vibration	2-5
Shock	2-6
Vibration	2-7

FCS P/N A6L-501000-02 was also used for design limit cycling tests at ILCI as reported in Section 3.0 of this document.

2. FCS P/N A6L-501000-03 is qualified by similarity to A6L-501000-02 since the only difference between the two is that the manufacturer was changed. This interchangeability is certified by the contractor in ECO A 12648 which is attached to ECP 347-4, CCBD 8E510. The documents and drawings were changed from sub contractor- controlled to prime contractor-controlled and are interchangeable.

3. FCS P/N A6L-510000-05 is qualified by similarity to the A6L-501000-02/-03, since the only difference is the addition of a crewman identification label.

6.2.3 Qualification of the Inflight Coverall Garment, P/N BW 1060-001/-002

The Inflight Coverall Garment, (ICG) P/N BW 1060-001/-002 is qualified for use in the Apollo XI mission for the following reasons:

1. The qualification test configuration of the ICG is that shown below. The indicated items successfully completed the tests indicated.

Item	Test	CTR
SEB 13100062-205	Cycling	1-1
SEB 13100062-204	O_2 and Humidity	2-1
SEB 13100062-203	Odor and Toxicity	2-9

The -204 differed from -203 in that material was changed from uncoated Beta to Teflon coated Beta per CCBD 8E105. The -204 was used for mission C prime.

The -205 differed from -204 in that a Nomex liner was added per CCBD 8E206.

The -206 differed from -205 in that reinforcements were added to pants and seams per CCBD 8E298. The -206 was used for mission C.

2. ICG P/N BW-1043-001 is qualified by similarity to SEB 13100062-206 since the design is the same.

The only difference is that the material of the BW-1043-001 is 100% Teflon woven yarn rather than Teflon coated Beta per CCBD 8E404, which reduces skin irritation.

3. ICG P/N BW-1043-002 is qualified by similarity to BW-1043-001 since the only difference is the deletion of the liner per CCBD 8E404A.

4. ICG P/N BW-1043-003/-004 is qualified by similarity to BW-1043-002 since the only difference is the addition of a pass through for the LWHS and T-connector per CCBD 8E462. The BW-1043-003/-004 was used for missions C prime, D, and F.

5. ICG P/N BW-1060-001/-002 is qualified by similarity to BW-1043-003/-004 since the difference is a documentation change only per CCBD 8E514 which requires separate identification of each end item in the ICG assembly. The end items of the ICG assembly are shown below:

Item	Part Number
Jacket (LW)	BW-1060-001
Jacket (HW)	BW-1060-002
Pants	BW-1061-001
Boots (LH)	BW-1062-001
Boots (RH)	BW-1062-002

6.2.4 Qualification of the Liquid Cooling Garment, P/N A6L-400000-11

The Liquid Cooling Garment (LCG) P/N A6L-400000-11 is qualified for use in the Apollo XI for the following reasons:

1. LCG P/N A6L-400000-08 was successfully tested for the following qualification tests:

Test	CTR
O_2 and Humidity	2-1
Salt Fog	2-2
Stowage Low Temperature	2-4
Vibration	2-5
Acceleration	2-7
Odor and Toxicity	2-9

2. LCG P/N A6L-400000-09 is similiar to P/N A6L-400000-08 since the only difference is a change in the Bio belt snap location. The -09 was used for the following qualification testing and used in missions D and F.

Test	CTR
Cycling	1-1
Mission D Free Space Demonstration	3-4
Lunar Surface Demonstration	3-2

3. LCG P/N A6L-400000-10 is qualified by similarity to A6L-400000-09 since the only difference is the addition of a crewman identification label.

4. LCG P/N A6L-400000-11 is qualified by similarity to A6L-400000-10 and by the following tests: MSC 11 foot chamber vacuum tests and MSC SESL thermal vacuum tests by the Apollo XI crew. The -11 differs from the -10 by the replacement of the tygon manifold with an aluminum manifold and replacement of tygon risers with reinforced silicone risers, which prevents the tygon from collapsing. The -11 LCG also includes a crew preference padding modification to give added comfort without affecting functional performance.

6.2.5 Qualification of the EV Gloves, P/N A7L-203025-09/-10

The extravehicular (EV) gloves (Part of the PGA) P/N A7L-203025-09/-10 are qualified for use in the Apollo XI mission for the following reasons:

1. The qualification test configuration of the EV gloves is shown below. The indicated items successfully completed specified tests:

Item		CTR
A7L-203025-09/-10	Cycling	1-1
A7L-203000-03/-04	O_2 and Humidity	2-1
A7L-203000-03/-04	Salt Fog	2-2
A7L-203000-03/-04	Sand and Dust	2-3
A7L-203000-03/-04	Stowage Low Temp	2-4
A7L-203000-03/-04	Vibration	2-5
A7L-203025-01/-02	Shock	2-6
A7L-203000-03/-04	Acceleration	2-7
A7L-203000-03/-04	Odor and Toxicity	2-9
A7L-203025-01/-02	Lunar Surface Demonstration	3-2
A7L-203025-01/-02	Spacecraft Interface	Apollo IX

Refer to Section 9.0 of this document for reports of environmental tests, section 3.0 for cycling report, and Section 5.0 for lunar surface functional demonstration report.

2. EV gloves P/N A7L-203025-09/-10 are qualified by test and similarity to the configurations shown above since the following minor changes in configuration are not significant enough to invalidate any previous testing. As shown below, "yes" indicates that the referenced change was incorporated in the subject configuration item.

Change	Cycling A7L-203025-09/-10	Environments A7L-203000-03/-04	Interface A7L-203025-01/-02
Curved Fingers	yes	no	yes
Short Gauntlet	yes	no	yes
Thumb Easement	yes	no	no
Reinforcement Seams	yes	no	no
Silicone Coating	yes	no	no

Change	Apollo XI A7L-203025-09/-10
Curved Fingers	yes
Short Gauntlet	yes
Thumb Easement	yes
Reinforcement Seams	yes
Silicone Coating	yes

6.2.6 Qualification of the Lunar Boots, P/N A7L-106043-05/-06

The Lunar Boots P/N A7L-106043-05/-06 are qualified for the Apollo XI mission for the following reasons.

1. Cycling - Lunar Boots P/N A7L-106043-01/-02 successfully completed Lunar Mission cycling tests as reported herein. These boots were modified in accordance with TPS AA 82-0621 which yielded the same configuration as the -03/-04.

2. Environments - Lunar Boots P/N A7L-106015-01/-02 successfully completed all environmental tests shown below:

Test	CTR
O_2 and Humidity	2-1
Salt Fog	2-2
Sand and Dust	2-3
Stowage Low Temperature	2-4
Vibration	2-5
Acceleration	2-7
Odor and Toxicity	2-9

The Lunar Boots, P/N A7L-106043-05/-06, are qualified by similarity since the configuration differences are minor as shown in 4 below.

3. Lunar Surface Demonstration - Lunar Boots, P/N A7L-106043-03/-04, successfully completed the Lunar Surface Demonstration as reported in section 5.0 of this document.

4. Configuration Similarity - Lunar Boots, P/N A7L-106043-05/-06, are qualified by test and similarity to the configurations shown above since the following minor changes in configuration are not significant enough to invalidate any previous testing.

Changes	Cycling A7L-106043-01/-02	Environments A7L-106015-01/-02	Interface A7L-106043-03/-04
ITMG Lay up	yes	no	yes
Non-slip buckle	yes	no	yes
Additional strap	yes	no	yes
Name tag on liner	no	no	no

Changes	Apollo XI A7L-106043-05/-06
ITMG Lay up	yes
Non-slip buckle	yes
Additional strap	yes
Name tag on liner	yes

6.2.7 Qualification of the Lunar Extravehicular Visor Assembly, P/N A7L-205000-01

The Lunar Extravehicular Visor Assembly (LEVA) P/N A7L-205000-01 is qualified for use in the Apollo XI mission for the following reasons.

1. Cycling - The LEVA P/N A7L-205000-01 successfully completed lunar mission cycling tests as reported in Section 3.0 of this document.

2. Environments - The Extravehicular Visor Assembly (EVVA) P/N A6L-201000-07 successfully completed the following environmental tests as reported in CSD-A-888 and herein.

Test	CTR
O_2 and Humidity	2-1
Sand and Dust	2-3
Stowage Low Temperature	2-4
Vibration	2-5
Shock	2-6
Acceleration	2-7

This testing is applicable to the LEVA since the configuration is similar as shown in 4 below.

3. Interface - The LEVA P/N A7L-205000-01 is qualified for mission interface since it successfully completed the Lunar Surface Functional Demonstration in accordance with CTR 3-2 as reported herein.

4. Configuration Similarity - The LEVA P/N A7L-205000-01 is qualified by test and similarity to the EVVA P/N A6L-201000-05 and P/N A6L-201000-07 which were used for the Apollo IX mission. The differences between the qualified EVVA and the LEVA are as follows:

   a. The LEVA sun visor material is polysulfone instead of polycarbonate.
   b. The thermal insulation is on the outside of the LEVA shell, instead of inside.
   c. The LEVA has fluorel foam standoff pads to protect the pressure helmet since there is no insulation on the outside of the shell.

d. Two opaque sun shields have been added which block approximately fifty percent of the LEVA visor area. These two shields slide over the sun visor on each side of the face.

6.2.8 Qualification of the Helmet Stowage Bag, P/N A6L-502000-07

The Helmet Stowage Bag (HSB) P/N A6L-502000-07 is qualified for the Apollo XI mission for the following reasons:

1. Cycling - HSB P/N A6L-502000-07, S/N 056, successfully completed Lunar Mission Cycling tests as reported in Section 3.0 of this document.

2. Environments - HSB successfully completed the environmental tests shown below in the configuration indicated.

Item	Test	CTR
A6L-502000-03	O_2 and Humidity	2-1
A6L-502000-03	Stowage Low Temperature	2-4
A6L-502000-03	Vibration	2-5
A6L-502000-05	Shock	2-6
A6L-502000-03	Acceleration	2-7
A6L-502000-03	Odor and Toxicity	2-9

HSB P/N A6L-502000-07/-08 is qualified by similarity since the configuration differences are minor as shown in 4 below.

3. Mission Interface - HSB P/N A6L-502000-05 was qualified for the Apollo IX and X missions and was used for these missions. HSB P/N A6L-502000-07/-08 is qualified by similarity to P/N A6L-502000-05 since the configuration differences are minor as shown in 4 below.

4. Configuration Similarity - HSB P/N A6L-502000-07/-08 is qualified by test and similarity to the configurations shown above since the following changes are significant improvements which do not invalidate previous testing except for cycling which is qualified by test. The new HSB closure method and LM/HSB interface are superior to the previous design and are acceptable for flight without formal demonstration of vibration and shock based upon the following engineering evaluation.

   a. The -05 and earlier model HSB utilized a horizontally actuated zipper to close the bag. The -07 HSB utilizes two snaps and velcro with a vertical zipper closed gusset to close the bag. The -07 bag closes into the base. The -05

and earlier bags closed midway between the base and the top. The -07 closure method is sufficiently strong to contain the HSB contents alone. Assistance is given by the new LM interface method.

b. The -05 HSB LM interfacing snaps were mounted with the lexan base. This method of mounting was subject to premature separation. The -07 bag has the interface snaps mounted on extensions from the upper shell. This method eliminates snap failure and positively retains the upper shell to the spacecraft. The -07 bag is also enlarged to accommodate the Lunar Extravehicular Visor Assembly.

c. The -08 HSB is qualified by similarity to the -07 HSB since the only difference is that the glove retainers are made for large wrist disconnect gloves.

6.2.9 Qualification of the Helmet Shield (HS) P/N A7L-502003-03 is qualified for the Apollo XI mission for the following reasons:

1. HS P/N A7L-502003-01 was qualified by successfully passing the following tests and was used in Mission D.

Test	CTR
Cycling	1-1
Stowage Low Temperature	2-4
Odor and Toxicity	2-9

2. HS P/N A7L-502003-02 was qualified by similarity to A7L-502000-06 and was used for Mission F. The following differences exist between the two configurations.

   a. The -02 is manufactured from General Electric UV stabilized lexan 9030-112, while the -01 was manufactured using General Electric lexan 9410-112 (no UV stabilizer). The UV stabilized lexan provides 11 minutes of UV eye protection.

   b. The -02 encompasses more of the helmet; however, this has no effect on mission usage.

3. HS P/N A7L-502003-03 is qualified by similarity to A7L-502003-02 since the only difference is that the -03 is wider in order to accommodate a larger size helmet.

6.2.10 Qualification of the PLSS/EVCS Assembly, P/N SEB 11100066-319/-320

The PLSS/EVCS Assembly P/N SEB 11100066-319/320 is qualified for the Apollo XI Mission since the PLSS/EVCS Assembly consists of the following items which have been qualified separately.

ITEM	COMMENT
P/N SEB 11100066-319	
PLSS P/N SV706100-6-14	refer to section 7.0 for details of qualification
EVC-1, P/N 8358750-503	refer to Space Electronic Systems Division, NASA/MSC for details of qualification
P/N SEB 11100061-320	
PLSS, P/N SV706100-6-14	same as above
EVC-2, P/N 8358751-503	same as above

6.2.11 Qualification of the Feedwater Collection Bag, P/N BW1080-001

The feedwater collection bag (FCB), P/N BW1080-09 is qualified for the Apollo XI mission for the following reasons.

1. Mission Use - The feedwater collection bag will be used on the Apollo XI mission only and will be used to determine the amount of feedwater remaining in the PLSS after the lunar extravehicular activity. This item consists of a water-tight bag including a water connector and a scale. To more accurately determine water weight and to verify scale calibration, the scale will be calibrated with known weights prior to flight and prior to usage on the lunar surface.

2. Bag Functional Tests - The following tests were successfully completed at MSC in accordance with TPS 13923130 and reported in General Electric Company Technical Information Release (TIR) 721-E1.3.3-9072.

Volume	Fluid Temperature
Leakage	Operating Pressure
Proof Pressure	Flow Rate
Burst Pressure	

3. Bag Environmental Tests - Requirement for the following environmental exposures were waived via memorandum EC 951NA1453 dated June 13, 1969.

Test	CTR
Oxygen and Humidity	2-1
Stowage Low Temperature	2-4
Vibration	2-5
Shock	2-6

4. Scale Calibration - Scale calibration was accomplished in accordance with TPS 18923082. The accuracy was within +/- 0.5 oz throughout the entire 0-2 lb range. These tolerance limits are expressed in more normal engineering terms than that stated in the design requirements. The +/- 0.5 oz falls within the five percent tolerance above a 10 oz scale reading.

5. Configuration - The prototype FCB used for qualification testing differs from the flight FCB assembly in the material used for constructing the inner bag. The test unit inner bag was made of heat sealed PVC and the flight unit inner bag uses MIL-CE-19002 neoprene coated nylon. The water connectors were previously qualified for other spacecraft uses as reported in Hamilton Standard documents SVHER 4238, 5322, and 4624.

   Anomalies on like hardware were leaks of the inner PVC bag of the first units received. The change in material from PVC to neoprene coated nylon and a change of adhesives have corrected these anomalies. The unit tested in accordance with TPS 13923130 was of the latter configuration.

6.2.12 Qualification of the EMU Maintenance Kit, P/N A6L-503000-07

The EMU Maintenance Kit (EMU MK) P/N A6L-503000-07 is qualified for use in the Apollo XI mission for the following reasons:

1. Cycling - EMU MK, P/N A6L-503000-05, S/N 044, successfully completed Lunar Mission Cycling tests as reported in Section 3.0 of this document.

2. Environments - EMU MK, P/N A6L-503000-05 successfully completed the following environmental exposures; as reported for previous mission qualification.

CTR	ENVIRONMENT
2-1	Oxygen and Humidity
2-4	Stowage Low Temperature
2-5	Vibration
2-6	Shock
2-7	Acceleration
2-9	Odor and Toxicity

3. Interface - EMU MK, P/N A6L-503000-05, was successfully used for Apollo Missions IX and X.

4. Configuration - EMU MK, P/N A6L-503000-07, is qualified by similarity to the fully qualified EMU MK, P/N A6L-503000-05 since the only difference is the addition of beta cloth and tape for repair of a worn ITMG on a PGA.

6.2.13 Qualification of the Purge Valve, P/N A6L-505000-04

The Purge Valve (PV), P/N A6L-505000-04 is qualified for use in the Apollo XI mission for the following reasons:

1. Cycling - PV, P/N A6L-505000-02, successfully completed Lunar Mission Cycling tests as reported in Section 3.0 of this document.

2. Environments - PV, P/N A6L-505000-02, successfully completed the following environmental exposures as documented in previous mission qualification reports and herein.

CTR	ENVIRONMENT
2-1	Oxygen and Humidity
2-2	Salt Fog
2-3	Sand and Dust
2-4	Stowage Low Temperature
2-5	Vibration
2-7	Acceleration
2-9	Odor and Toxicity

3. Interface - PV, P/N A6L-505000-02 was successfully used in the Apollo IX mission and PV, P/N A6L-505000-03, was flown on Apollo X. In addition PV, P/N A6L-505000-02 was successfully used during the Lunar Surface Function Demonstration in accordance with CTR 3-2 as reported here in.

4. Configuration - PV, P/N A6L-505000-04, is qualified by similarity to PV, P/N A6L-505000-02/03 since the differences in configuration are not significant enough to invalidate any qualification tests. Configuration differences are shown below:

   a. PV -03 differs from PV -02 in the size of the orifice.

   b. PV -04 differs from PV -03 in that a washer is added to the lanyard to open the connector cover of the ITMG. This capability has been demonstrated in crew training. The washer may be used when no connector cover is present with no detrimental effects.

7.0 PLSS AND EXPENDABLES (LiOH AND BATTERY) QUALIFICATION SUMMARY

7.1 Qualification Program Rationale

Systems testing performed on dash 3, dash 5, and dash 6 PLSS's provides the basis for qualification of the dash 6 PLSS for Apollo XI, Design Limit and Double Nominal Mission Requirements. The chronological sequence is shown in paragraph 7.2.1. This test experience is utilized to the extent shown as applicable and supplemented by the component testing listed in paragraph 7.2.2.

PLSS Batteries SV701900, dash 9 and dash 10, are qualified for the Apollo XI Mission by similarity to the dash 5 testing outlined in paragraph 7.2.3.

The PLSS LiOH Cartridge SV710854, dash 6 and dash 7, are qualified for the Apollo XI Mission by similarity to the dash 4 and dash 5 testing outlined in paragraph 7.2.4.

7.2 Test Outline

7.2.1 Systems Testing

Qual Test Plan/ Procedure SS/SSP	Qual Test Report SVHSER	Test Article Configuration SV706100-()	Applicable Qual Data For -6 PLSS/Apollo XI
3030	4930	(3)	Sand & Dust (less RCU) Salt Atmosphere (less RCU) Humidity (less RCU) (Note: RCU performance for these requirements demonstrated by SS/SSP 3049)
3048	5149 and 5361	(5)	System Design Limit Cyclic Endurance (less RCU) Operational Life Cycles (Thermal Vacuum Performance) Thermal Soak
2128	5176	(5)	Odor and Toxicity
5120	5366	(6)	EMI

Qual Test Plan/ Procedure SS/SSP	Qual Test Report SVHSER	Test Article Configuration SV706100-( )	Applicable Qual Data For -6 PLSS/Apollo XI
3049	5366	(6)	System Design Limit & Double Nominal Mission Structural Endurance System Performance (Thermal Vacuum) RCU Sand and Dust, RCU Salt Fog, RCU Humidity, RCU Design Limit Double Nominal Mission Structural Endurance, RCU Design Limit Cyclic Endurance
SS 3080	Ref HSEM No. NA-SS-3758	(6)	Subsytem Interface and System Structural Verification of T/W Line Relocation, and Addition of Gas Separator

7.2.2 PLSS Component Delta Tests

Test Plan/ Procedure SS/SSP	Test Report SVHSER	Test Article Part No.	Component Name
3048	5149	SV713812-3	PLSS/PGA Electrical Umbilical
3049	5366	SV721783-3	RCU
4048	Ref. HSEM No. NA-SS 3804 & 3763	SV742108 (SV713083-2)	Transport Water Gas Separator
5105	5242	(SV731719-2	Wiring Harness
5110	5269	SV714170-5	Vent Loop PSID Pressure Switch
5111	5327	SV714171-4	Vent Loop PSID Pressure Transducer
4023	4248	SV713010	Oxygen Bottle

Test Plan/ Procedure SS/SSP	Test Report SVHSER	Test Article Part No.	Component Name
5116	5149	(SV713810-2) (SV715458-3)	Wiring Harnesses
5117	5152	SV723713-2	Terminal Boxes
5119	5343	SV721722-1	Alarm Control Module

7.2.3 PLSS Battery

Qual Test Plan/ Procedure SS/SSP	Qual Test Report SVHSER	Test Article Configuration SV701900-( )	Applicable Data For -6 PLSS/Apollo XI
5083	5117	(5)	Functional Endurance
3048	5149	(5)	PLSS Design Limit Requirements

7.2.4 PLSS LiOH Cartridge

Qual Test Plan/ Procedure	Qual Test Report	Test Article Configuration SV710854-( )	Applicable Data For -6 PLSS/Apollo XI
SS4027		(4)	LM ECS Design Limit Requirements
SS3049 SSP3049	SVHSER 5366	(5)	PLSS Design Limit Requirements

7.2.5 RCU Delta Tests

Qual Test Plan/ Procedure	Qual Test Report	Test Article Configuration SV721783-( )	Applicable Data For -6 PLSS/Apollo XI
SS/SSP3082	Ref. HSEM No. NA-SS-3794	(7)	Structural Endurance and Functional (Addition of Camera mount and PGA positive locking device)

7.3 PLSS/RCU Test Description and Results

7.3.1 Sand and Dust

Sand and Dust test requirements were established in accordance with MIL-STD-810A, Method 510.1, modified to limit the RH to 20%, the ambient temperature to 100°F, sand and dust density to 0.1 grams per cubic foot, and exposure time to four hours minimum.

Initial testing was accomplished on dash 3 configuration PLSS S/N 003 per SS/SSP 3030. The PLSS was fully charged and nonoperating for this sequence of testing. No failures of the PLSS were attributed to this testing. Subsequent PLSS redesign requiring delta qualification for Sand and Dust was tested at the component level.

The SV721783-5 RCU for the dash 6 PLSS is qualified for this requirement by similarity to the SV721783-3 RCU subjected to this environment per SS/SSP 3049. There were no hardware failures associated with this testing.

The SV714171-4 Transducer and the SV714170-5 switch were tested for PLSS application in this environment per SS/SSP 5111 and SS/SSP 5110 respectively. There were no hardware failures associated with this testing.

The Transport Water Gas Separator which is incorporated into the PLSS for Apollo XI was subjected to this environment for component qualification per SS/SSP 4048. There were no hardware failures associated with this testing.

7.3.2 Salt Atmosphere

Salt atmosphere test requirements were established in accordance with MIL-STD-810A, Method 509.1, modified for a minimum salt solution of 1.0% by weight, a temperature range of 95-100°F, and a test time of 48 hours minimum.

Initial testing was accomplished on dash 3 configuration PLSS S/N 003 per SS/SSP 3030. The PLSS was fully charged and nonoperating for this sequence of testing. No failures of the PLSS were attributed to this testing. Subsequent PLSS design changes affecting exterior finishes or seals were qualified at the component level.

The RCU, P/N SV721783-5, is qualified for this requirement by similiarity to the SV721783-3 RCU subjected to this environment within the SS 3049 delta qualification program. There were no hardware failures associated with this test.

The PLSS/PGA Electrical Umbilical, P/N SV713812-4, is qualified for this requirement by similarity to the SV713812-3 umbilical subjected to this environment within the SS 3048 delta qualification program. There were no hardware failures associated with this test.

The terminal boxes, P/N's SV726873-7 and SV715500-4 of the dash 6 PLSS, are qualified for this requirement by similarity to the SV723713-2 terminal box subjected to this environment per SS/SSP 5117A, as part of the OPS Qualification Program. There were no hardware failures associated with this test.

The dash 6 PLSS wiring harness, SV715458-2 and SV731810-3, are qualified for this requirement by similarity to the SV715458-3 and SV713810-2 harnesses subjected to this environment per SS/SSP 5116A. The SV731719-2 and SV713083-2 wiring harnesses were subjected to this environment per SS/SSP 5105. There were no hardware failures associated with this testing.

The Alarm Control Module, P/N SV721722-3, is qualified for this requirement by similarity to the SV721722-1 Alarm Control Module subjected to this environment per SS 5119 for component qualification. There were no no hardware failures associated with this testing.

The Transport Water Gas Separator, P/N SV742100, was subjected to this environment for component qualification per SS/SSP 4048. There were no hardware failures associated with this testing.

7.3.3 Humidity

Humidity test requirements were established in accordance with MIL-STD-810A, Method 507.1, modified to limit the maximum ambient temperature to 100°F.

Initial humidity testing was accomplished on dash 3 configuration PLSS S/N 003 per SS/SSP 3030. The PLSS was full charged and nonoperating for this sequence of testing. No failures of the PLSS were attributed to this testing. Subsequent PLSS design changes affecting exterior finishes or seals were qualified at the component level.

The RCU, P/N SV721783-5, is qualified for this requirement by similarity to the SV721783-3 RCU subjected to this environment within the SS 3049 delta qualification program. One failure report was generated for this testing. RDR 289-9, Low Insulation Resistance, was issued during this sequence. This incident was verified acceptable under these test conditions, and would not result in degradation of PLSS function; the RDR is closed.

The PLSS/PGA Electrical Umbilical, P/N SV713812-4, is qualified for this requirement by similarity to the SV713812-3 umbilical subjected to this environment within the SS 3048 delta qualification program. There were no hardware failures associated with this test.

The Terminal Boxes, P/N's SV726873-7 and SV715500-4 of the dash 6 PLSS, are qualified for this requirement by similarity to the SV723713-2 terminal box subjected to this environment per SS/SSP 5117A as part of the OPS Qualification Program. There were no hardware failures associated with this test.

The dash 6 PLSS wiring harnesses SV715458-2 and SV731810-3 are qualified for this requirement by similarity to the SV715458-3 and SV713810-2 harnesses subjected to this environment per SS/SSP 5116A. The SV731719-2 and SV713083-2 wiring harnesses were subjected to this environment per SS/SSP 5105. There were no hardware failures associated with this testing.

The Alarm Control Module, P/N SV721722-3, is qualified for this requirement by similarity to the SV721722-1 Alarm Control Module subjected to this environment per SS 5119 for component qualification. There were no hardware failures associated with this testing.

The Transport Water Gas Separator, P/N SV742100, was subjected to this environment for component qualification per SS/SSP 4048. There were no hardware failures associated with this testing.

The SV714171-4 Transducer and the SV714170-5 switch were tested for PLSS application in this environment per SS/SSP 5111 and SS/SSP 5110, respectively. There were no hardware failures associated with this testing.

7.3.4 Design Limit Cyclic Endurance

The cyclic endurance requirement was established to provide for double cycling of all controls, connectors, access covers, and interfaces in excess of those cycles normally accumulated in the course of double nominal mission testing. In addition, this requirement was extended to apply to those PLSS subsystems normally requiring charging and/or deactivation.

The dash 6 PLSS (less RCU) is qualified for this requirement by similarity to the dash 5 configuration PLSS, S/N 009, subjected to Cyclic Endurance and Deactivation/Charging Cyclic Testing per SS/SSP 3048, and by the dash 6 configuration Charging/Discharging Testing conducted on PLSS S/N 016 per SS/SSP 3080. There were four (4) failure reports (RDR's) associated with the cyclic testing per SS/SSP 3048; these are listed and explained below:

RDR 228-3: PGA Electrical Umbilical Electrical Handle Loose.

Repair and successful retest accomplished; Engineering Change EC 32691 implemented structural verification at component level acceptance test to preclude reoccurrence. Qualification status of this component was accepted, and this RDR is closed.

RDR 289-1: RCU Umbilical to PLSS/RCU Electrical Connector Required High Force to Connect.

Failure cause was soft finish on PLSS Electrical Connector, SV731810, which was changed to SV731810-2 for flight hardware. Delta testing of the RCU Harness accepted the qualification status of this connector. This RDR is closed.

RDR 281-2: OPS to PLSS Installation and Removal Force Exceed Maximum Specification Limit.

The cause of this failure was the combination of tight tolerances between the PLSS/OPS interface and the presence of a burr or foreign material on the interface. Engineering Change EC 33225 opened the tolerances on this interface. Requal was run and accepted. This RDR is closed.

RDR 281-5: Snap Torn Out of Beta Cloth Strap Used for Hose Storage On Lower Conformal Pad.

Engineering Change EC 33218 changes conformal pad configuration to add a double layer of strap material, and also reduce snap force so that lower stresses are placed on beta cloth strap. Cycling tests were successfully completed, and this RDR is closed.

There were no failures associated with the Charging/Discharging Testing per SS/SSP 3080.

The SV721783-5 RCU for the dash 6 PLSS is qualified for this requirement by similarity to the SV721783-3 RCU subjected to cyclic endurance testing per SS/SSP 3049 and the SV721783-2 RCU cyclic testing per SS/SSP 3048. There were no RCU hardware failures associated with this testing.

7.3.5 Operational Life Cycles

The Operational Life Cycle Test Requirement is to demonstrate the operational life capability to provide life support for the minimum of one life cycle plus one mission cycle of hardware. The dash 6 PLSS (including RCU) is qualified for mission requirements by similarity to the dash 5 PLSS, S/N 009, subjected to a total of ten (10) unmanned operational simulations per SS/SSP 3048. The dash 6 PLSS, S/N 016, was subjected to three operational performance tests per SS/SSP 3049, and one operational performance test per SS/SSP 3080 for systems compatibility verification.

The ten (10) operational simulations per SS/SSP 3048 were as follows:

NUMBER OF TESTS	DURATION -HOURS-	TYPE OF TEST
3	3	Room Ambient Temperature
1	4	Room Ambient Temperature
1	3	Lunar Night Simulation
2	4	Lunar Night Simulation
2	3	Lunar Day Simulation
1	4	Lunar Day Simulation
10 Total*	34 Total*	

*ADDITIONAL OPERATIONAL TIME FOR ATTEMPTED AND ABORTED RUNS DUE TO PROCEDURAL/FACILITIES PROBLEMS ARE NOT INCLUDED.

The four (4) operational simulations per SS/SSP 3049 and SS/SSP 3080 were as follows:

NUMBER OF TESTS	DURATION -HOURS-	TYPE OF TEST
2	3	Room Ambient Temperature
1	3	Lunar Night Simulation
1	4	Lunar Day Simulation

The failure reports (RDR's) associated with this testing, along with a description of the incident, a summary of the closure action, and the rationale for Apollo XI Qualification Status, are provided below.

The following twenty-four RDR's were generated in testing for two operational simulations per SS/SSP 3048.

RDR 200-61: Erratic Feedwater Warning Tone.

Erratic Feedwater Warning Tone traced to inadequate test equipment. Equipment and procedural changes incorporated and verified adequate function of feedwater alarms.

RDR 200-64: Low Ventilation Flow Rate.

Ventilation Flow Rate below 5.5 acfm minimum specification limit. Primary cause of decreased performance tracked to higher than anticipated pressure drop of "wet" system due to condensation on internal passages. Final corrective action to insure minimum "wet" system performance of 5.5 acfm flow at 1.5 in. H_2O pressure rise was to increase dash 6 PLSS PDA "dry" system requirements to provide a minimum 2.85 in. H_2O pressure rise of 5.5 acfm. Subsequent production hardware meeting the upgraded PDA requirements have demonstrated acceptable flow capabilities for "wet" system performance. The endurance capability of the PLSS fan/motor assembly was verified by completion of the PLSS Qualification Program without shift of performance output.

RDR 200-71: Sublimator Breakthrough.

Sublimator breakthrough at startup due to test procedure error causing startup in wrong diverter valve position. Successful retest accomplished with corrected procedures.

RDR 200-72: Oxygen Temperature Above Specification.

Ventilation Oxygen Temperature above specification during Design Limit Hot Temperature Soak and Startup, Lunar Day simulated profile. Subsequent redefined maximum startup conditions and PLSS contingency operational requirements per ECP 217-74-E33851 were established for dash 6 qualification per SS/SSP 3049.

RDR 200-73: Feedwater Supply Depletion.

Early depletion of Feedwater Supply. Improper charging procedure allowed trapped gas to remain in bladder. The procedures being utilized were specialized for this test facility only, and would not be encountered in manned use of the PLSS. Adequacy of corrected procedures verified in subsequent PLSS testing.

RDR 200-74: Current Limiters and SSC Damage.

Four (4) Current Limiters and the SSC blown by application of reverse polarity to PLSS main power connector. Test facility defect. Destroyed components replaced. Current Limiters qualified by similarity to non-affected limiters. SSC replaced with qualified EVC for dash 6 PLSS.

RDR 200-75: Early Feedwater Supply Depletion.

Feedwater supply depleted 22 minutes prior to end of four (4) hour lunar day profile. Data analysis showed 6000 BTU total heat rejection accomplished vs 4800 BTU requirement. The overload was incurred by transients between condition changes due to the test facility and account for the faster rate of feedwater consumption. Based on the overload penalty and the ability of the PLSS to respond to heat rejection requirements, the test objectives were considered satisfied, and thus, RDR closed.

RDR 200-82: Oxygen Temperature Above Specification.

Same as 200-72.

RDR 200-83: Oxygen Quantity Indicator Out-of-Specification.

Oxygen Quantity Indicator accuracy out-of-specification tolerance. Analysis disclosed chipped pivot assembly causing indicator hang-up at temperature extremes. Component acceptance test revised to incorporate calibration at zero and 200°F.

RDR 200-84: Feedwater Pressure Switch Actuation.

Feedwater pressure switch actuation at above specification pressure. Test equipment error gave false indication. Switch and transducer subsequently verified to be functioning within specification.

RDR's 202-2, 8, 16: Vent Flow Sensor Set Point:

Ventilation Flow Sensor set point degraded by moisture trapped out of ventilation loop. Reevaluation of specification limits allowed establishment of wider tolerance limits to accept data. The Apollo XI Mission requires only one possible utilization subsequent to final PIA calibration check, thus insuring moisture-free element at time of use.

RDR 204-8: PGA Pressure Transducer Accuracy.

PGA pressure transducer accuracy out-of-specification limits. Tolerance band reevaluated and subsequently approved for wider limits which accepted system data.

RDR 207-2: Oxygen Quantity Indicator Accuracy.

Oxygen Quantity Indicator accuracy out-of-specification limits. Specification limits revised to accept data.

RDR's 211-56, 58, 65, 66: SSC Performance.

SSC performance anomalies. The SSC has been replaced by the EVC for dash 6 PLSS's.

RDR 235-22: Oxygen Flow Sensor.

High oxygen flow sensor deactuation of warning tone below minimum specification limits. Reevaluation of tolerance band allowed expansion of limits to accept data.

RDR 235-29: Oxygen Flow Sensor.

Test procedure error produced false indication of High Oxygen Flow Sensor error.

RDR 239-7: Feedwater Pressure Transducer.

Feedwater pressure transducer set point shift. Permanent deformation of sensing element caused by test error overpressurization of sensor. This item qualified by similarity to Oxygen Ventilation Circuit pressure transducer of same design, mechanism, and range.

RDR 207-4: Oxygen Quantity Indicator.

Reading error on Oxygen Quantity Indicator produced false indication of one out-of-specification reading. Extensive component testing, including thermal/vacuum operations, verified indicator accuracy to be within specification requirements.

7.3.6 Thermal Soak (Shipping and Ground Storage)

Test requirements were defined to cover the thermal extremes of preflight transportation and storage as follows:

A. High temperature soak: thermal soak at 140 to 145°F for 8 hours after the exterior surface of the shipping container reaches 140°F at room ambient pressure.

B. Low temperature soak: thermal soak at 45 to 55°F for 8 hours after the exterior surface of the shipping container reached 45°F at room ambient pressure.

The dash 5 PLSS with RCU SV721783-2 was subjected to sixteen (16) hour test per SS/SSP 3048 while uncharged, nonoperating, and installed into the PLSS shipping container. The PLSS/RCU successfully passed the test. There were no hardware failures as a result of this testing. The dash 6 PLSS and RCU SV721783-5 is qualified by similarity.

7.3.7 Odor and Toxicity

The Odor and Toxicity requirements were a series of eight (8) gas samples, four (4) pretest samples, and four (4) outgassing samples, representing test samples of the outgassing experiment to be submitted for analysis of gaseous reaction products to verify absence of crew safety hazards.

An analysis per SS 2128 included the determination of the total organic content, the carbon monixide content, the odor level, and the identification of the individual gaseous constituents if above 10 gm/gms. The analytical test data established that the outgassing and odor levels were below the maximum acceptable levels. The test article was SVSK71738. The dash 6 PLSS is qualified by similarity as component redesign has not altered material composition.

7.3.8 Electromagnetic Interference (EMI)

EMI test requirements to insure compatibility with the LM electrical systems as follows:

A. Baseline Performance - All electrical functions of the PLSS/EVC interface were performance tested, and a baseline performance calibration of the system was obtained.

B. Radiated Interference -

1. Steady-state Mode - The EVC primary receiver transmitter was keyed for all tests. Interference measuring instruments were slowly turned through each continuous tuning range, and the frequencies at which maximum interference was detected became the test frequency.

2. Alarm On Mode - Narrow band radiated interference measurements made during an alarm condition as obtained with fan and pump motors off. (Deleted)

3. Transient Switching Mode - Switching operations were performed for the purpose of measuring broadband interference emanating from the PLSS.

C. Radiated susceptibility an rf signal turned through a frequency range as applied to the antenna input connectors while PLSS operating parameters were observed for indications of malfunctions.

D. Power Line Ripple - Ripple in the eight power lines interfacing with the EVC was measured.

E. Performance Record

The dash 6 PLSS was tested per SSP 5120 while its systems were charged and operating in a steady-state mode, except during the "alarm on" power line ripple test which was repeated with the fan and pump switches off, and vent flow loop pressure reduced to 1.3 psid. The following anomalies were associated with this testing.

A. During the radiated interference testing, the Mode Selector Switch, fan, and pump switches generated broadband interference which exceeded specification limits. These out-of- specification conditions were waivered with the incorporation of DAR's W-5120 (-22 and 26). There were failures of the pump motor and current limiters during the Radiated Interference Test, but they were not condidered EMI test failures. This problem of system incompatibility is bypassed for Apollo XI by deletion of fan and pump current limiters and the institution of fan and pump switching sequence restrictions.

7.3.9 Structural Endurance (Vibration, Lunar Landing Shock, EV Impact)

Vibration test requirements are earth launch and boost, lunar ascent and descent, random and sinusoidal vibrations to design limit and double nominal mission levels.

The dash 6 PLSS and the RCU were subjected to double exposure of their respective design limit vibration levels per SS/SSP 3049, thus utilizing a single unit to satisfy both double nominal mission and design limit requirements. The test was conducted with the PLSS nonoperating but fully charged with all expendables. There were no hardware failures as a result of this testing.

The RCU SV721783-3 was subjected to the test per SS/SSP 3049 while mounted in a fixture simulating the vehicle mounting configuration as defined by GAEC drawing LID-340-11124. The RCU was in a stowed configuration and not powered. There were no hardware failures as a result of this testing. The SV721783-5 RCU is qualified by similarity.

Lunar landing shock test requirements are to perform two applications of Design Limit Lunar Landing Impact Shock in each direction in each plane of the test item for a total of twelve (12) impacts, thus utilizing one PLSS and RCU to satisfy both double nominal mission and design limit impact shock test requirements.

The dash 6 PLSS was subjected to the design limit lunar landing shocks per SS/SSP 3049. There were no hardware failures as a result of this testing.

The RCU SV721783-3 was subjected to the design limit lunar shocks per SS/SSP 3049. There were no hardware failures as a result of this testing. RCU SV721783-5 is qualified by similarity.

Extravehicular (EV) Impact Shock test requirements are two (2) impact shocks of 360 in lbs each applied over a 3-inch diameter area of the hardcover. The second shock to be applied three (3) inches from first. The PLSS less RCU was subjected to double exposure of design limit level, thus utilizing a single unit to satisfy both double nominal mission and design limit requirements simultaneously.

The PLSS-6 was subjected to the EV shock test per SS/SSP 3049 while restrained to simulate manned PGA mounting. The PLSS was fully charged and operating fan, pump, and SSC for first shock; pump, SSC, and O_2 regulator for second shock.

RDR 260-2: Transport Water Loop Flow.

Transport Water Loop flow versus Delta-P below minimum specification limits. Evaluation of systems compatibility identified requirement for utilization of deaerated water which has subsequently been implemented as an EMU requirement.

RDR 273-18: Primary Oxygen Regulator.

Internal leakage of Primary Oxygen Regulator temporarily above specification limits. Subsequent testing showed that leakage has returned to acceptable levels. No degradation of regulator performance encountered even at highest leakage rates.

The following six RDR's were generated in testing of four operational simulations per SS/SSP 3049.

RDR 200-94: Transport Water Loop.

Transport water flow rate versus Delta-P below minimum specification limits resulting from combined effects of inadequate deaeration of the water and poor pump efficiency. Water deaeration problems were due to test facility leakage, which when corrected, provided increased pump performance. Poor pump efficiency is a suspect manufacturing defect found on other pumps manufactured in the S/N sequence including this unit. Revision of manufacturing procedures and tests, combined with field test of suspect units, have located and corrected defective units.

RDR 200-95: Transport Water Loop.

Same as 200-64.

RDR 200-98, 99: Sublimator Breakthrough.

Sublimator breakthrough during test sequence. Procedural errors resulted in unrealistic transient heat loads imposed on the transport water loop. Retest with corrected procedures met test objectives.

RDR 200-100: Oxygen Temperature Above Specification.

Same as 200-72 except new requirements to accept data stated in ECP-217-74-E33851R.

7.3.10 Transport Water Make-up Line Relocation and Gas Trap Addition

Functional test requirements for verification at system level of the relocation of the water make-up line and addition of the gas separator include integrated compatibility tests and gas trap component tests for environmental and cyclic endurance.

Systems Tests were conducted per SS/SSP 3080 for vibration and impact shock followed by system performance in a simulated mission profile. Component tests were conducted per SS/SSP 4048 for Salt Fog, Humidity, Sand and Dust, Thermal Vacuum Soak, Endurance and Structural requirements.

7.4 Battery Test Description and Results

7.4.1 Structural Endurance (Vibration, Lunar Landing Shock, and EV Impact)

Vibration test requirements for the Apollo XI mission are based on battery stowage within the PLSS only. Design Limit levels were defined for Launch and Boost and Lunar Descent and Ascent. The SV701900-5 battery was subjected to the test per SS/SSP 3048 while non-activated and installed in the dash 5 PLSS. The test was successfully passed based on the successful utilization of the battery in a subsequent simulated discharge per DAR P-3045-78 conducted after the EV Impact Shock Test. There were no hardware failures associated with this testing. The SV701900-9 and 10 batteries are qualified by similarity.

Lunar Landing Shock test requirements for Apollo XI mission are based on battery stowage within the PLSS only. Design limit levels were defined for Launch/Boost and Descent/Ascent. A SV701900-5 battery was subjected to Lunar Landing Shock per SS/SSP 3048. The test was successfully passed; there were no hardware failures associated with this testing. Battery -9/-10 is qualified by similarity.

EV Impact Shock test requirements are two (2) impact shocks of 360 in. lbs. each applied over a three inch diameter area of the hardcover. The second shock to be applied three inches from the first.

The battery was subjected to the test per SS/SSP 3048 while nonactivated and installed in the dash 5 PLSS. The test was successfully passed based on the subsequent successful simulated discharge per DAR 3049-78 (Ref. paragraph 7.4.1). There were no battery failures as a result of this testing.

7.4.2 Hot Soak, Cold Soak Endurance Cycle (Life Verification and Pressure Relief Valve Endurance)

Life verification test requirements were to subject the battery to activated life cycle temperature extremes and verify functional performance.

A. Test was initiated within 45-60 minutes of obtaining the temperature of the discharge period. Discharge was initiated through a 4.7 ohm ± 0.1 ohm load.

B. Battery was subjected to a two (2) to four (4) second discharge pulse through a 3.15 ohm ± 0.1 ohm load between 3 and 3.5 minutes after initiation of the discharge or a previous pulse until a total of four pulses have been imposed on the battery. The 4.7 ohm ± 0.1 ohm load was to be reapplied immediately after each pulse.

C. The test was to be terminated after four (4) hours of discharge when voltage fell below 16.0 volts which ever occurred first.

The battery SV701900-5 was subjected to the tests (conducted after hot soak and cold soak) per SS/SSP 5083. The tests were successfully passed. There were no anomalies reported. The -9 and -10 are qualified by similarity as structure and material are identical.

Pressure Relief Valve endurance test requirements were to subject the Pressure Relief Valve to 500 relief and reset cycles. The Pressure Relief Valve of battery SV701900-5 was subjected to the cycling test per SS/SSP 5083 after each battery life verification test. The tests were successfully passed. There were no anomalies reported. The SV-701900-9 and -10 are qualified by similarity as structure and materials are identical.

7.5 LiOH Cartridge Test Description and Results

7.5.1 LM ECS Stowage and Operation

Vibration and shock test requirements were to subject the cartridge to design limit random and sinusoidal vibration and lunar landing shock levels. The SV710854-5 cartridge (same unit subjected to thermal soak) was subjected to the test per SS/SSP 4027A. The test was completed successfully. There were no failures as a result of this testing. The SV710854-6 and -7 cartridges are qualified by similarity.

Thermal soak test requirements were to subject the cartridge to a design limit hot thermal soak. The SV710854-5 cartridge was subjected to the test per SS/SSP 4027A. The test was completed successfully. There were no failures as a result of this testing. The SV710854-6 and -7 cartridges are qualified by similarity.

Endurance test requirements were to subject the cartridge to a design limit endurance test. The SV710854-5 cartridge (same unit subjected to vibration/shock) was subjected to the test per SS/SSP 4027A. The test was completed successfully. There were no failures as a result of this testing. The SV710854-6 and -7 cartridges are qualified by similarity.

7.5.2 PLSS Structure and Operation

Vibration and Lunar Landing Shock test requirements were to subject the cartridge to design limit random and sinusoidal vibration and lunar landing shock levels. The SV710854-5 cartridge was subjected to the test per SS/SSP 3048 while installed in the PLSS. The test was successfully passed. There were no failures as the result of this testing. The SV710854-6 and -7 cartridges are qualified by similarity.

Endurance test requirements were to subject the cartridge to design limit high temperature functional test, and to determine during the test the LiOH dust level. The SV710854-5 cartridge (same unit subject to vibration and shock) was subjected to the test per SS/SSP 3048 while installed in the PLSS. The test was successfully passed. There were no failures as a result of this testing. The SV710854-6 and -7 cartridges are qualified by similarity.

7.6 RCU Camera Mount and PGA Positive Locking Device Test Description and Results

7.6.1 Structural Endurance

Vibration and Lunar shock test requirements were to subject the fittings to design limit random and sinusoidal vibration and double lunar landing shock levels. The SV721783-7 RCU was subjected to the test per SS/SSP 3082. The test was successfully passed. There were no failures as a result of this testing.

7.6.2 Operation

Force to actuate test requirements were:

A. The force to operate the PGA release hatch shall be 0.7 - 0.8 lbs.

B. The force required to install the camera mount adapter shall not exceed 14 lbs.

Test conducted before and during cycle test, after vibration and lunar landing, and after four (4) hour hot and cold wall environmental tests. The SV721783-7 RCU was subjected to the test per SS/SSP 3082. The test was successfully passed. There were no failures as a result of this testing.

Cycling test requirements were:

A. Camera mount adapter attached/removed 200 times.

B. Positive lock device installed/removed 200 times.

C. Acceptance of cycling contingent upon meeting force to actuate requirement.

The SV721783-7 RCU was subjected to the test per SS/SSP 3082. The test was successfully passed. There were no failures as a result of this testing.

8.0 OPS QUALIFICATION SUMMARY

8.1 Summary

The OPS qualification test was conducted on two specimens as described in paragraph 8.3. The changes required to correct deficiencies revealed during qualification testing were verified during the OPS Delta qualification test described in paragraph 8.4.1. Configuration changes made after the OPS qualification and the qualification rationale are included in Table 8-1 with reference to the applicable qualification documentation. The rationale for omission of test is included in paragraph 8.5.

The OPS high pressure bottle qualification was conducted on seven (7) specimens as described in paragraph 8.6.

The qualification test requirements of NASA ASPO-RQA-11A are shown in paragraph 8.7 with the rationale and/or reference for each test.

The functional qualification of the OPS with an insulated actuator assembly was verified by test, as shown in paragraph 8.4.2.

8.2 Conclusions

Based on the results of the qualification test contained herein, it is concluded that the Oxygen Purge System (OPS) (P/N SV730101-2-8) is qualified to support the Apollo XI Mission and all Lunar EV missions within the following limits:

Cold Case: Egress from a 60°F LM Cabin. Cold soak for 45 minutes in the shadow of the LM prior to actuation.

Hot Case: Egress from 90°F LM Cabin. Hot soak for $3\frac{1}{2}$ hours at Lunar day maximum thermal flux prior to actuation (reference NASA Memo No. PD8/M1851).

8.3 OPS Qualification Tests

Reference documents:

Test Procedure	SSP 3050
Test Report	SVHSER 5150 Vol. I-IV

8.3.1 Nominal Mission Test

The following tests were conducted on the nominal mission unit, P/N SV730101-1-2 P1 Rev. A, S/N 003.

(1) Predelivery Acceptance Test

(2) Examination of Product (page D-3, D-4)*7-12-68

(3) Mission Test, (page D-5 through D-10) 7-17-68

(a) Temperature (Test chamber shroud) 250°F

Flow 0.07 and 0.36 lb/hr

OPS initial average temp. 35°F

Ambient Pressure 0.4×10^{-4} mm Hg

RDR 521-1 Battery voltage in test procedure was incorrect - no actual failure existed.

(b) Mission Test

RDR 534-4 OPS did not function due to actuator failure. Rack unscrewed from cable--assembly procedure was changed to insure that Nylock insert was engaged.

(4) Mission Test, (page D-11 through D-13) 7-22-68.

Temperature (Test chamber shroud) 250°F

Flow 8.1 lb/hr

OPS initial temperature 35°F

Ambient Pressure 1×10^{-6} mm Hg

The outlet temperature was below the acceptable specification limits. Reference RDR 500-5.

(5) Performance Record, (page D-14 through D-26) 7-22-68:7-25-68

The performance record test includes an examination of product functional test, internal leakage, and external leakage test.

* Page numbers in parenthesis refer to data sheets in the applicable test report. The date following the parenthesis is the actual test date.

RDR 534-2 - During the preparation for the minimum functional test, the actuator failed to function. The rack unscrewed from the cable. Corrective action was to change assembly procedure to insure that the Nylock insert is engaged.

(6) Mission Test (page D-27 through D-39) 8-2-68:7-18-68

This test was aborted due to difficulty in maintaining test chamber vacuum. Reference RDR 500-6, Loss of Test Chamber Vacuum. No cause determined.

(7) Performance Record (page D-40 through D-49) 8-3-68:8-4-68

The test results were acceptable.

(8) Mission Test (page D-50 through D-53) 8-5-68

Temperature (Test Chamber Shroud)	250°F
Flow	8.1 lb/hr
OPS initial average temperature	19.25°F *
Ambient Pressure	$.13 \times 10^{-4}$ mm Hg

The outlet temperature was below the acceptable specification limits. Reference RDR 500-9.

(9) Vibration and Lunar Landing Shock (pages D-54 through D-58) 8-6-68:8-7-68

Two (2) shocks in each direction of three (3) mutually perpendicular axies at 17.5 to 23.5 g's (twelve shocks total).

See SSP 3050, paragraph 6.1.4, for vibration levels.

(10) Performance Record (page D-59 through D-73) 8-7-68:8-10-68

(11) Mission Test (pages D-74 through D-79) 8-10-68:8-11-68

(a)	Temperature (Test Chamber Shroud)	70°F
	Flow	8.1 lb/hr

* Spec. requires 35°F - the test was more severe than required.

OPS initial average temp.	70°F
Ambient Pressure	1×10^{-4} mm Hg

The test results were acceptable.

(b)	Temperature (Test Chamber Shroud)	70°F
	Flow	0.07 to 0.36 lb/hr
	OPS initial average temp.	70°F
	Ambient Pressure	0.1×10^{-4} mm Hg

The test results were acceptable.

(12) Performance Record (pages D-81 through D-90) 8-11-68:8-12-68

(13) Mission Test (pages D-94 through D-102) 8-13-68:8-14-68

(a)	Heat Flux	300 BTU/hr. ft.^{2}
	Flow	0.07 to 0.36 lb/hr
	OPS initial average temp.	Not recorded
	Ambient Pressure	1×10^{-4} mm Hg

RDR 500-10 - The outlet oxygen temperature was above spec. requirements.

RDR 534-3 - The actuator cable failed to provide a full stroke due to worn Molycote. The heater switch was not actuated. Modification changed Molycote to Teflon. Qualification of the modified actuator cable was accomplished by system Delta qualification and component test.

(b)	Heat Flux	300 BTU/hr. ft.^{2}
	Flow Rate	8.1 lb/hr
	OPS initial average temp.	
	Ambient Pressure	0.2×10^{-4} mm Hg

RDR 500-11 - The OPS outlet temperature was not within specification limits.

(14) Performance Record (pages D-103 through D-112) 8-15-68:8-18-68

RDR-500-16 - Split strain relief potting on connector was due to installation difficulties in the test chamber.

(15) Mission Test (D-113 through D-114) 8-18-68

Temperature (Test Chamber Shroud)	-250°F
Flow Rate	8.1 lb/hr
OPS initial average temp.	*
Ambient Pressure	0.1 x 10^{-4} mm Hg

* Not recorded. Average temperature at end of 3.5 hour cold soak was 46.25°F. Test conditions were not adequate.

RDR 500-15 - The OPS outlet temperature was not within specification limits.

(16) Final Examination of Product (page D-115, D-116) 8-19-68

8.3.2 Design Limit Test

The following tests were conducted on P/N SV730101-1-2, S/N 001:

(1) PDA

(2) Examination of Product (page A-116, A-117)
Omitted by HSD - substituted E.O.P. from PDA.

(3) Salt Fog (page A-3 through A-7) 7-7-68. This test was conducted without the thermal garment, SV731814-1, in a 1.0% NaCl solution, 95°F for 48 hours.

(4) Insulation Resistance Test (page A-8 through A-15) 7-9-68. Reference RDR 525-1, Insulation Resistance Failure. See RDR 525-2 on Qual Failure for Corrective Action.

(5) Humidity (page A-16 through A-20) 7-13-68. The unit was subjected to 100% relative humidity at 40 to 110°F for 72 hours.

(6) Insulation Resistance (page A-21 and A-22) 7-16-68

(7) Sand and Dust (pages A-23 through A-27) 7-16-68. The unit was exposed to 0.1 lb/ft.^{3} sand and dust density for four (4) hours at 100°F and less than 20% relative humidity.

RDR 534-1 - During the post-test examination of product, the OPS actuator was inoperative. Failure investigation showed that the actuator assembly had been improperly assembled.

(8) Humidity (RETEST) (page A-28 through A-32) 7-24-68.

(9) Performance Record (page A-33 through A-43) 7-25-68.

(10) Thermal Soak (page A-44 and A-45) 7-29-68. The unit was subjected to 143±3°F for eight (8) hours and - 50±3°F for eight (8) hours.

(11) Insulation Resistance, 7-30-68.

(12) Performance Record (pages A-48 through A-60) 7-30-68 through 8-3-69.

(13) Cycling Tests (pages A-61 through A-64). 8-3-68 through 8-6-68.

Actuator Assembly	201 cycles
O_2 Connector	202 cycles
Check-out Switch	204 cycles
OPS/PLSS Interface	100 cycles (RDR 500-8)
Antenna Connector	200 cycles (RDR 535-1)
Examination of Product	

(14) Pressure Cycling (page A-65 and A-66) 8-6-68

10 cycles	0-6900-0 psig

(15) Performance Record (page A-67 through A-79) 8-7-68 and 8-8-68

RDR 512-1-2, 512-1-3 - Low outlet pressure, cause was determined to be due to test rig instrumentation.

RDR 512-3-3 - Damage [illegible] fitting threads due to defective fitting nut on test rig.

(16) Vibration and Lunar Landing Shock (pages A-80 through A-83) 8-10-68 thru 8-12-68. The unit was subjected to two (2) shocks in each direction of three (3) mutually perpendicular axies. (Twelve shocks total).

See pages A-82, A-83, and Volume II of SVHSER5150 for vibration levels and test time.

(17) Performance Record (page A-84 through A-93) 8-12-68 and 8-13-68.

(18) Impact Shock (Astronaut Fall) and Static Load. (pages A-9 through A-96) 8-14-68.

(19) Performance Record (pages A-97 through A-107) 8-14-68 and 8-15-68.

(20) Mission Test (pages A-108 through A-110) 8-15-68.

Shroud Temperature	70 to 75°F
Flow Rate	0.36 to 8.1 lb/hr
Ambient Pressure	0.7×10^{-4} mm Hg

The heater switch was not actuated.

(21) Locking Pin Cycling (Retested) (page A-111 and A-112) 9-3-68. The locking pin handle was loose after cycling and the retaining ring was bent. The handle was redesigned and qualified by system Delta qualification. RDR 500-8.

(22) Examination of Product (page A-113 through A-115) 8-20-68.

8.4 OPS Delta Qualification

8.4.1 System Delta Qualification

HSD Documents:

Test Plan	SS 3075
Test Procedure	SSP 3075
Test Report	SVHSER 5265

P/N SV730101-1-5/21295
S/N 003

(1) Performance Record (page 12-22) 11-2-68

(2) Vibration and Shock (page 47-173) 11-5-68:11-8-68

(3) OPS/PLSS Interface Cycling (200 cycles) (page 174-176) 11-8-68: 11-12-68.

(4) Mission Test, Low Temp. - Cold Start - High Flow (page 26-27) 11-14-68.

(5) Mission Test, High Temp. - Hot Start - High Flow (page 28-29) 11-15-68.

(6) OPS Actuation Cycling (200 cycles) (page 23-25) 11-17-68.

(7) Performance Record (page 33-46) 11-18-68 and 11-19-68.

8.4.2 Actuator Insulation Sheath Delta Qualification

HSD Documents: TBD

Test Plan TBD

Test Procedure TBD

Test Report TBD

P/N SV 730101
S/N 010

(1) Endurance Test
The purpose of this test was to provide handling history to the sheath prior to the mission test. The test unit, S/N 010, has completed two PDA tests prior to this Delta qualification test.

(2) Mission Tests
This test verified the ability of the actuator assembly to function at extreme Lunar conditions during and after three (3) cycles of exposure to LM and Lunar environment.

(a) Cold Start - Cold Wall Test (3 cycles)
-250°F Shroud Temperature - Lunar - 4 hours
60°F Shroud Temperature - LM - 2 hours

Ambient Pressure 1×10^{-4} mm Hg

OPS Initial Average Temp. 60°F

(b) Hot Start - Hot Wall Test (3 cycles)

Shroud Temperature - Lunar	- 4 hours	+250°F
Shroud Temperature - LM	- 2 hours	+100°F
Ambient Pressure		1×10^{-4} mm Hg
OPS Initial Average Temp.		100°F

(3) Performance record

8.5 OPS Qualification Rationale for Tests Not Conducted

(1) Acceleration (Reference SS 3050, page 6). The OPS is not required to function during acceleration. The ability of the OPS to function after acceleration is demonstrated by its ability to function after vibration. The test vibration levels are considerably higher than the mission acceleration levels. Acceleration test was conducted on OPS bottles as shown in paragraph 8.6.

(2) Acoustical Noise (Reference SS 3050, pages 6-7). The stress levels generated by the mission acoustical noise levels are insignificant. MIL-STD-810A, Method 515, supports this rationale, in that acoustical noise testing is not required on equipment located in areas where the noise levels are 130 db overall or less.

(3) Odor and Toxicity. The OPS is qualified by similarity to the PLSS. Reference SVHSER 5176.

(4) OPS Actuator Insulation Sheath. The insulation sheath is qualified by similarity to the OPS insulation, except for tests stated in paragraph 8.4.2.

8.6 OPS Bottle Qualification

Test Plan SS 3052

Test Procedure SSP 3052

Test Report SVHSER 5249

Specimen 1 (S/N 16)

(1) Production Acceptance Test (PAT)

Examination of Product

Proof and Dye Penetrant

External Leakage

(2) Burst Pressure Test (15,200 psig)

(3) Metallurgical Examination

Specimen 2 (S/N 11)

(1) PAT

(2) Operating Pressure Cycling to Failure (59,354 cycles)

(3) Metallurgical Examination

Specimen 3 (S/N 17)

(1) PAT

(2) Proof Pressure Cycling to Failure (7,736 cycles)

(3) Metallurgical Examination

Specimen 4 (S/N 21)

(1) PAT

(2) Proof Pressure Cycling to Failure (4,485 cycles)

(3) Metallurgical Examination

Specimen 5 (S/N 24)

(1) PAT

(2) Salt Fog

(3) Humidity

(4) PAT

(5) Burst Pressure Test (15,200 psig)

(6) Metallurgical Examination

Specimen 6 (S/N 13)

(1) PAT

(2) Cleanliness Check

(3) Vibration

(4) Acceleration

(5) Shock

(6) Cleanliness Check

(7) PAT

(8) Burst Pressure Test (14,800 psig)

(9) Metallurgical Examination

Specimen 7 (S/N 15)

(1) PAT

(2) Cleanliness Check

(3) Vibration

(4) Acceleration

(5) Shock

(6) Cleanliness Check

(7) PAT

(8) Burst Pressure Test (14,700 psig)

8.7 Qualification Test Requirements

8.7.1 Design Proof (from Chart 2 ASPO-RQA - 11A)

Environment	Verification by Test
Acceptance	PDA
Sea-Air/Humidity	Salt fog and humidity were conducted as separate test.
Oxygen	Normal functioning of the unit during Mission Test verifies the units compatibility with oxygen.
Acceleration	Not conducted - see paragraph 8.5
Vibration	Nominal mission vibration test; Design limit vibration test; Delta Qualification Test
Acoustics	Not conducted - see paragraph 8.5
High Temperature/Vacuum	Tested in shipping container uncharge at ambient pressure and 145 to 5°F for 8.0 to 0.2 hours. Extensive thermal-vacuum testing is conducted on the mission test unit.
Low Temperature/Vacuum	Tested uncharged at ambient pressure and -50°F for 8.0 ± 0.2 hours.
Landing Shock	Tested with unit pressurized to 6,700 psig -6 shocks 10 to 12 g's. (Test also on Nom. Mission Unit).
Salt Immersion	Not applicable--the units are not returned to Earth.

Environment	Verification by Test
Sand and Dust (not required)	Sand and Dust Test was added to represent possible Lunar contamination.
Impact Shock (not required)	Impact shock was added. The unit was tested with bottles charged to 7,000 psig. One 360 in. lb. shock was applied normal to cover to simulate a maximum energy lunar fall.
Static Load (not required)	Static load was added. The unit withstood 71.4 lb. for five (5) minutes.

TABLE 8 - 1

NAME	PART NUMBERS		REMARKS
OPS	SV730101-2P1 Rev. A Qual Unit S/N 001	SV730101-2-12/P1 Flight Units	
Flat Hd Screw	NAS 1102C06-1 (4)	None	Qualified by Delta Qual Test SVHSER 5265
Preformed Packing	STSV047C10	69494G10	Qualified by Regulator DVT Ref. SVHSER TBD
Preformed Packing	STSV047C7	69494G7	
Preformed Packing	STSV052C070-333	STSV52G070-333	
Adhesive Tape	None	STSV102B2 (AR)	Qualified on Delta Qual Test SVHSER 5265
Flat Washer	None	SV585350U92	Qualified by Regulator DVT Ref. SVHSER TBD
Flat Washer	SV585350X90	SV585350Y92	
Flat Washer	SV585350X91	SV585350Y91	
Flat Hd Screw	SV714006-1032-10 (4)	None	Qualified on Delta Qual Test SVHSER 5265
Harness Block Insert	SV721740	None	
Control Bracket & Lever	SV723640-1	None	
Remote Control Actuator	SV721920-2	SV721920-4	Qualified by similarity to the SV721920-3 actuator assembly. Ref. CCBD 9E110. See Note 1.
Regulator	SV730111-4	SV730111-7	Qualified by reg. DVT
Delta Ring Seal	SV731608-1	SV731608-7	Qualified by Regulator DVT. Ref.

TABLE 8 - 1
(CONTINUED)

NAME	PART NUMBERS		REMARKS
Delta Ring Seal	SV731608-2	SV731608-8	Qualified by Regulator DVT. Ref.
Delta Ring Seal	SV731608-4	SV731608-6	
Delta Ring Seal	SV731608-3	SV731608-5	
Frame & Inserts	SV731670-1	SV731670-3Pl	Qualified by Delta Qual Test SVHSER 5265
Locking Bracket	SV731673-1	SV731673-3	
Thermal Cover	SV731814-1	SV731814-3	Qualified by similarity to the -2 configuration used on Delta qualification.
Hardcover	SV731816-2	SV731816-4	Qualified on Delta Qual Test SVHSER 5265
Antenna	SV713932-3	SV713932-4	SVHSER 5244
Actuator Thermal Sheath	None	SV723006-1	Qualified by Delta Qual Test & Similarity. Ref. para. 8.4.2 & 8.5.
Lacing Tape	Note 2	SV72650	

TABLE 8 - 1
(CONTINUED)

NAME	PART NUMBERS		REMARKS
	REGULATOR DVT/Qual Unit	Flight Units	
Regulator	SVSK 73499	SV730111-7	Seal material change ECP E34768 was qualified by Regulator DVT. See comment (9)
Hose & Sheath	SV718775-5	SV718775-8	Reduce number of layers of insulation from 7 to 5. Qual by component test.

NOTE 1: Rationale for Qualification of the SV721920-4 Actuator Assembly

The cable construction consists of a fixed section solidly mounted between the OPS frame and regulator and a flexible section which is affixed to the actuator mechanism. The inner braided steel stroking cable is concentric with a thick walled Teflon liner on the flexible portion and is covered by an outer braided steel blanket which holds the assembly together and provides a slight axial compression on the Teflon liner. The inner cable extends unbroken through the fixed portion which is Teflon lined steel tubing.

The change, which was implemented after the formal qualification program was completed consists of four parts. They are:

a. Added a swivel on the actuator cable at the OPS interface.
b. Replaced Teflon liner on the actuator cable with better bonded Teflon composition.
c. Replaced the actuating cam with a higher rise cam.
d. Bonded the switch to the regulator case after final adjustment.

NOTE 1 (Cont.)

The necessity for making the change and the rationale for proposing qualification by similarity follows:

Swivel Change:

The outer steel braid has distorted on several occasions. This distortion, known as "birdcaging", is primarily a separation of the weave and is due to twisting of the cable during handling. Both the cable vendor and Hamilton Standard determined that severe distortion could result in loss of cable output stroke; further review determined that this condition would be minimized or eliminated by replacing the fixed end of the flexible conduit with a swivel joint identical to the swivel joint currently utilized at the actuator/cable interface.

The actuator/cable interface was subjected to the complete qualification spectrum of tests which consisted of both environmental and functional nominal and design limit values. There were no failures of this swivel joint. Due to similarity of application on the opposite end of the flexible conduit, a reapplication of the test requirement is not considered to be necessary.

Teflon Liner Change

During visual examination after predelivery acceptance testing of the OPS, a break in the teflon liner between the cable and the outer braided steel jacket was observed. The actuator cable assembly was removed from the OPS and was disassembled for further examination. Several additional breaks were found in the teflon liner. Since the teflon liner is the load carrying portion of the flexible conduit, a test was conducted using the DVT actuator assembly to determine if the breaks in the liner were detrimental. The tests demonstrated that the breaks in the liner can result in a decrease in cable output stroke which could prevent actuation of the OPS. Therefore, the breaks in the teflon liner were discussed with the cable manufacturer, the teflon tube extruder, Dupont, whereby it was determined that they were due to a manufacturing defect called a "Poker Chip". It was determined that the "Poker Chip" is a slight discontinuity which can exist between extrusion slugs, as a result of the particular process used in the manufacture of the teflon tube. The present process used to form the tube is called granular extrusion and utilizes teflon Resin T-1 which is a general purpose powder normally used to fabricate heavy wall teflon tubing. The teflon tube fabricator indicated that the "Poker Chips" can exist undetected in granular extruded tubing and can result in breaks when the tubing is flexed. Both the tube fabricator and Dupont agree that the problem of "Poker Chip" and teflon tube breakage would be eliminated by changing to a "paste" or "plastic" extrusion process which utilizes teflon Resin T-6 which is a special-purpose teflon powder used to form thin wall and flexible tubing as well as wire coatings.

In addition to the improved resistance to the "Poker Chip" defect, the new Teflon has a tensile yield strength and elongation of 4500 psi and 300% as opposed to 2000 psi and 200% for the replaced material. The dimensions and weight of the replacement sheath are not affected. Due to

NOTE 1 (Cont.)

the fact that earlier teflon liner completed qualification with no failures, and due to confidence of both the cable manufacturer and Hamilton Standard that the material change eliminates the manufacturing problem, reapplication of the qualification test requirements is not considered to be necessary.

Cam Rise Change & Switch Bonding

Analysis of the OPS heater checkout anomaly which occured during the Apollo 9 flight revealed the most probable cause to be relative movement between the heater switch and the mounting bracketry. The cam rise change to provide more positive actuation and the switch bonding chang were implemented to eliminate any reoccurrance of the anomaly.

Cam Rise - The cam rise was changed from a nominal .040 to a nominal .055 in. This results in a 0.0017 pound weight increase. Both analysis and project personnel at Hamilton Standard have agreed that the weight change is entirely negligible and cannot affect the vibration characteristics of the OPS. All other characteristics of this cam remain unchanged. PIA procedures verify actuation of the heater circuit after installation of the higher rise cam. No requalification of this change is considered to be necessary.

Switch Bonding Material - The switch is carefully adjusted during installation to insure proper positioning with relation to the cam. After adjustment is complete, the switch is bonded in place with EC 2216 epoxy. This bonding material is used structurally in several other PLSS applications and has successfully passed exposure to the complete environmental spectrum. The functional performance of the installation is verified during PIA. No requalification of this change is considered to be necessary.

Independent Functioning of the OPS Regulator

The independent function of the heater system was demonstrated during the mission test conducted 8/15/68. Reference paragraph 8.3.0 (20). The OPS outlet temperature will be below the specification requirements without the heater system under some conditions.

Note 2 - The actuator insulation sheath was qualified by a Delta Qualification Test on OPS S/N 010. The test is described in paragraph 8.4.2 and 8.5.

9.0 EMU TEST DOCUMENTATION MATRIX

This section contains a matrix of qualification documentation related to EMU garments and associated equipment for the total Apollo program. Procedures and reports for all qualification tests are related to the appropriate certification test requirements (CTR's) and the mission applicability for each document is shown. It should be noted that since the EMU qualification program has been based on incremental testing, previous mission qualification data is applicable to all subsequent missions with additional segments of data being included as cinfigurations change and more sophisticated mission usage is required. Therefore, as an example, all previous experience in oxygen and humidity environmental testing is used as a basis for qualification of hardware for Apollo XI and all previous documentation is included in the matrix.

CTR	TITLE	TEST PROCEDURE	TEST REPORT	APOLLO MISSION					
				VII C	VIII C'	IX D	X F	XI G	SUBS
1-1	Cycling	8812700449		X	X	X	X	X	X
		8812700483		X	X	X	X	X	X
		8812700483		X	X	X	X	X	X
			8812700513	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
		8812700531			X	X	X	X	X
			8812700541		X	X	X	X	X
			CSD-A-870		X	X	X	X	X
		8812700539				X	X	X	X
			8812700561			X	X	X	X
			CSD-A-888			X	X	X	X
		8812700575						X	X
			8812700620					X	X
2-1	O_2 and Humidity	CSD-A-604		X	X	X	X	X	X
		TTA-TP-2T462-01		X	X	X	X	X	X
		TTA-TP1-2T442-01		X	X	X	X	X	X
			CSD-A-762	X	X	X	X	X	X
			CSD-A-820	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
			CSD-A-849		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
		TPS11921815						X	X
			CSD-A-900					X	X
2-2	Salt Fog	CSD-A-475		X	X	X	X	X	X
			CSD-A-762	X	X	X	X	X	X
			CSD-A-820	X	X	X	X	X	X
			CSD-A-849		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
2-3	Sand and Dust	CSD-A-476						X	X
			CSD-A-900					X	X

CTR	TITLE	TEST PROCEDURE	TEST REPORT	APOLLO MISSION VII C	VIII C'	IX D	X F	XI G	SUBS
2-4	Stowage Low Temp	CSD-A-730		X	X	X	X	X	X
		TPR-2T442-02		X	X	X	X	X	X
		TTA-TP-2T442-02		X	X	X	X	X	X
		TTA-TP-2T442-30		X	X	X	X	X	X
		TTA-TP1-2T442-02		X	X	X	X	X	X
			CSD-A-820	X	X	X	X	X	X
			CSD-A-762	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
			CSD-A-849		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
2-5	Vibration	CSD-A-477		X	X	X	X	X	X
			CSD-A-762	X	X	X	X	X	X
			HAFB 6/21/68	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
			CSD-A-900					X	X
2-6	Shock	CSD-A-480		X	X	X	X	X	X
		CSD-A-483		X	X	X	X	X	X
			CSD-A-762	X	X	X	X	X	X
			CSD-A-820	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
		CSD-A-395			X	X	X	X	X
			CSD-A-849		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
		CSD-A-482						X	X
			CSD-A-900					X	X
			CSD-A-938					X	X
2-7	Acceleration	CSD-A-603		X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
			CSD-A-849		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X

CTR	TITLE	TEST PROCEDURE	TEST REPORT	APOLLO MISSION					
				VII C	VIII C'	IX D	X F	XI G	SUBS
2-9	Odor and Toxicity	CSD-A-718		X	X	X	X	X	X
			WS68-1080	X	X	X	X	X	X
			WS68-1081	X	X	X	X	X	X
			WS68-1082	X	X	X	X	X	X
			WS68-1083	X	X	X	X	X	X
			WS68-1084	X	X	X	X	X	X
			WS68-1085	X	X	X	X	X	X
			WS68-1086	X	X	X	X	X	X
			WS68-1087	X	X	X	X	X	X
			WS68-1088	X	X	X	X	X	X
			WS68-1089	X	X	X	X	X	X
			WS68-1090	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
			WS68-1169		X	X	X	X	X
			CSD-A-887			X	X	X	X
			CSD-A-888			X	X	X	X
		TPS1122613	WS69-1358					X	X
			CSD-A-900					X	X
3-1	Spacecraft Interface	CSD-A-562		X	X	X	X	X	X
			CSD-A-803	X	X	X	X	X	X
			CSD-A-848		X	X	X	X	X
			CSD-A-890			X	X	X	X
3-2	Lunar Surface	No Number						X	X
			CSD-A-910					X	X
3-3	EMI and Acoustic Noise	EMC-P-25A08-104		X	X	X	X	X	X
			EMC-R-25A08-104	X	X	X	X	X	X
			CSD-A-818	X	X	X	X	X	X
			CSD-A-824	X	X	X	X	X	X
		EMC-P-25A08-105				X	X	X	X
			EMC-R-25A08-105			X	X	X	X
			CSD-A-888			X	X	X	X
3-4	Earth Orbital EV Activity	SS-2127				X			
			SVHSER 5575			X			
			CSD-A-888			X			

APPENDIX A
TO
CSD-A-945

SUMMARY OF
DISCREPANCY REPORTS

QUALIFICATION TESTS
IN SUPPORT OF
APOLLO XI

This appendix contains summary listings of all discrepancy reports (DR's) written during the qualification test activity in support of the Apollo XI mission. The tests covered are shown below:

Design Limit Cycling Tests
Environmental Tests
    Sand and Dust Test
    Odor and Toxicity Test
Lunar Surface Functional Demonstration

All formal EMU qualification testing in support of Apollo XI is complete. All discrepancy reports applicable to the test program and the dispositions of each have been identified.

At this time, three DR's remain open. None of these three have any impact on qualification of the EMU for the Apollo XI Mission as shown below:

DR No. 11931103, PGA-S/N 050, EXCESSIVE LEAKAGE
This excessive leakage occured during conduct of Lunar Surface qual at SESL, (reference DR No. 11930917). The suit was patched and the disposition was to use as is to complete the test. DR No. 11930917 was thus closed. After the test, DR No. 11931103 was written to prohibit further manned chamber tests on this PGA until a rework of the affected areas is complete. A waiver was then obtained to permit use of this item for unmanned thermal-vacuum tests at LTV (Memo EC951 NA 1186). DR No. 11939903 will probably not be closed prior to the flight of Apollo XI. The disposition action is dependent on planned future usage of this PGA only and in no way impacts qualification of the mission PGA's.

DR No. 13930666, PLSS-S/N 017, BATTERY VOLTAGE LOW
This low battery voltage was noted during conduct of the Lunar Surface Qualification Test at SESL. An interim disposition of "use as is" to complete the test was made since no hazards were involved and the fault was known to be lack of modification of the current limiters. Since the test, the modification has been accomplished in accordance with service instruction number 182 and final DR closure is emminent.

DR No. 13931988, PLSS-S/N 017, SCRATCHED HARDCOVER
This scratch was noted during conduct of the Lunar Surface Qualification Test at SESL. An interim disposition of "Use as is" was made since this discrepancy does not effect PLSS form, fit, or function. Final closure of this DR will probably not be made prior to the flight of Apollo XI. The final disposition is contingent on planned future use of the PLSS, S/N 017, and in no way impacts qualification of the EMU. If this item is scheduled for future flight use, a complete rework of the unit is required since it was the test item for PLSS qualification at HSD and a new hard cover would be provided at that time. If no future critical applications are planned for this item, it will probably be downgraded and the DR will be closed appropriately.

DR's are arranged within test catagories by each test item. Information included is DR number, Fault, Disposition, Status, and Comments. All DR's written for each test exposure are included. The status of all items is correct as of 7 July 1969.

A recapitulation of the numbers of DR's related to tests and end items is presented in matrix form. This matrix shows the number of DR's written for each test item during each test accomplished in support of Apollo XI qualification.

NOMENCLATURE	Cycling	O_2 and Humidity	Sand and Dust	IV Vibration	IV Impact	Lunar Landing Impact	Lunar Surface Impact	Lunar Surface Demonstration	Odor and Toxicity	Total DR's per Item Type	DR's Open	DR's Closed	DR's Void	Total MR's	MR's Open	MR's Closed	Qual Failure
essure Garment Assembly	15	N/A	2	N/A	N/A	N/A	N/A	26	N/A	43	1,	42	0	11	1	10	8
Pressure gage	0	N/A	0	0	0	N/A	N/A	0	N/A	0	0	0	0	0	0	0	0
Pressure Relief Valve	0	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	0	0	0	0	0	0	0	0
Helmet	5	0	N/A	N/A	N/A	N/A	0	8	N/A	13	0	12	1	1	0	1	1
IV Gloves	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	0	1	0	0	0	0	0
Comfort Gloves	0	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	1	0	1	0	0	0	0	0
EV Gloves	5	N/A	N/A	N/A	N/A	0	N/A	8	N/A	13	0	13	0	0	0	0	0
Lunar Boots	2	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A	5	0	5	0	0	0	0	0
uid Cooling Garment	2	N/A	N/A	N/A	N/A	N/A	N/A	5	N/A	7	0	7	0	0	0	0	0
ar Extravehicular Visor	3	N/A	N/A	N/A	N/A	0	0	9	1	13	0	13	0	3	2	1	2
ge Valve	1	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	3	0	3	0	0	0	0	0
mmunications Carrier	1	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	2	0	2	0	0	0	0	0
Harness	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	0	1	0	0	0	0	0
Belt	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	0	1	0	0	0	0	0
stant Wear Garment	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	0	4	0	0	0	0	0
al Containment Subs.	2	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	2	0	2	0	0	0	0	0
ne Collection Trans. Assy.	2	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	3	0	3	0	1	0	1	0
met Stowage Bag - 05	2	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	2	0	2	0	0	0	0	0
met Stowage Bag - 07	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	0	3	0	0	0	0	0
Maintenance Kit	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	0	0	0	0	0	0	0	0
gen Purge System	0	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	2	0	2	0	0	0	0	0
table Life Support System	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14	N/A	14	2	12	0	0	0	0	0
al DR's per test type	50	0	2	0	0	0	0	80	1	133	3	129	1	16	3	13	11
DR's Open	0	0	0	0	0	0	0	3	0	3	3						
DR's Closed	49	0	2	0	0	0	0	77	1	129		129					
DR's Void	1	0	0	0	0	0	0	0	0	1			1				
Total MR's	10	0	2	0	0	0	0	3	1	16				16			
MR's Open	3	0	0	0	0	0	0	0	0	3					3		
MR's Closed	7	0	2	0	0	0	0	3	1	13						13	
Qual Failure	7	0	2	0	0	0	0	2	0	11							11

NOTE: N/A = not applicable, see sections 7 and 8 for additional data on OPS and PLSS

TABLE A-1 QUALIFICATION DR/MR/FR RECAPITULATION MATRIX

TABLE A-2
QUALIFICATION DR SUMMARY

APOLLO XI DESIGN LIMIT CYCLING TESTS AT ILCI

Document No. CSD-A-945
Revision
Release Date 7 July 1969
Page A-5 of A-12

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
EMA	A7L-100000-42	039	AA83-0294	ITMG Wear Areas	Use as is	Closed	Reliability Action Item 1-0014
			AA83-0312	Wear and scratches in area of Electrical Harness	Use as is	Closed	Normal Wear
			AA83-0313	Scratches on metal surfaces	Use as is	Closed	Clean items, Leakage Test, return to test.
			AA83-0321	Screw loose on upper torso buckle	Repair and use	Closed	Perform addition cycling to verify corrected installation
			AA83-0323	ITMG pulled loose from pressure gage	Use as is	Closed	Mission 3, day 6
			AA83-0338	Holes in outer layer of ITMG	Use as is	Closed	Considered to be normal wear
			AA83-0346	Excessive leakage (750 scc/min)	Repair and Continue test	Closed	Mission 4 post test, MR 03852-Closed
			AA83-0362	Connector cover zipper lanyard pulled loose	Replace lanyard and continue test	Closed	Mission 6, day 6.
			AA83-0365	Excessive leakage (900 scc/min	Repair	Closed	Mission 6 post test, MR 03919-Closed, See DR AA93-0001
			AA83-0366	Tears and abrasion	Use as is	Closed	Mission 6 post test, MR 03921-Void - Not a failure
			AA83-0370	Holes in comfort liner	Use as is	Closed	Does not effect function
			AA93-0001	Shoulder Convolute, Wear and Abrasion	Repair and return to test	Closed	MR 03925-Closed. New design initiated for flight
			AA93-0026	ITMG wear areas	Use as is	Closed	Considered normal wear
			AA93-0027	Excessive leakage (1250 scc/min	Repair and return to test	Closed	Mission 8 post test, MR 03927-Close, add patches for flight
			AA93-0048	Excessive leakage (0.9 scfm)	Repair and Return to test	Closed	Mission 9, day 5, MR 03860-Open-Item exceeded require.
Helmet	A7L-102043-01	001	AA83-0297	Valsalva device interferes with donning and doffing.	Use as is	Voided	Not a descrepency
			AA83-0311	Scratches on feedport "flapper"	Use as is	Closed	No effect on performance
			AA83-0341	Scratches on bubble	Use as is	Closed	
			AA83-0368	Valsalva device-latch malfunction	Use as is	Closed	MR 03920 - Closed, Change design of latch and spring
			AA93-0068	Feedport torque values incorrect	Change Spec. Valves	Closed	Higher torque valves added per EM-ILCI-A-5261

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
IV Gloves	A7L-103000-05/06	084	AA83-0299	Torn and abraded in palms	Use as is	Closed	No effect on function
EV Gloves	A7L-203000	043	AA83-0298	Torn and abraded	Use as is	Closed	No effect on function
			AA83-0330	Flattening of wrist disconnect, LH	Use as is	Closed	Test subject dropped glove
			AA83-0336	Wear and abrasion	Use as is	Closed	No effect on function
			AA83-0367	Torn and abraded on palm	Use as is	Closed	Mission 6 post test
			AA93-0028	Holes in chromel "R" on palms	Use as is	Closed	Mission 8 post test
Lunar Boots	A7L-106043-01 /-02	029	AA83-0300	Abrasion and wear	Use as is	Closed	Mission 2 post test
			AA83-0340	Chip out of sole of left boot	Use as is	Closed	No effect on function
Liquid Cooling Garment	A6L-400000-09	061	AA83-0344	Stitches broken at right wrist	Use as is	Closed	No effect on function
			AA83-0369	Tack stitch broken on dosimeter pocket	Use as is	Closed	No effect on function
Lunar Extravehicular Visor Assembly	A7L-205000-01	004	AA93-0024	Wear and fabric frayed	Use as is	Closed	Written after 10 missions - Not failures
			AA93-0025	Polycarbonate cracked	Use as is	Closed	MR 03926- Open, Tech Agree.
			AA93-0033	Washer missing on pin of locking device	Use as is	Closed	MR 03928- Open, Tech Agree. Redesign washer
Purge Valve Communications Carrier	A6L-505000-02 16536G - 02	156 132	AA83-0337	Scratches on surface	Use as is	Closed	Not considered a failure
			AA83-0331	Plastic coating cracked, anchor thread on connector missing.	Use as is	Closed	No effect on form, fit, or function
Bio Harness	A7L-101054-	72	AA83-0301	Wear/Torn area around amplifier, connector, and 9-pin harness cover	Use as is	Closed	Not a qual. item. No effect on form, fit, or function
Bio Belt	SEB-13100084-202	1222	AA83-0302	Abraded and torn on amplifier pocket	Use as is	Closed	No effect on functional performance
Constant Wear Garment	SEB-13100061-208	1126	AA83-0316	Hole in material back of neck	Use as is	Closed	No effect on function, Missi 2 post test
			AA83-0317	Small holes in front torso area	Use as is	Closed	No effect on function, Missi 2 post test
			AA83-0342	Holes in material in neck area and dosimeter pockets #2 and #3	Use as is	Closed	No effect on function
			AA83-0343	Hole in material back of neck	Use as is	Closed	No effect on function

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAILURE	DISPOSITION	STATUS	COMMENTS
Fecal Containment System	AcL-501000-03	86	AA83-0294	Abraded and torn fibers	Use as is	Closed	Incorrect fit
		94	AA83-0339	Frayed and broken stitches	Use as is	Closed	No effect on functions
Urine Collection Transfer Assembly	14-0103-01	33-3	AA83-0285	Leaking water at inlet port	Complete assembly upon receipt of parts	Closed	Continue test upon completio of assembly Closed
			AA83-0335	Leaking water	Return to vender	Closed	MR 03917 written - Closed
Helmet Stowage Bag (Pre Apollo XI Configuration)	A7L-502000-05	023	AA83-0296	Foreign Material on Vison Support Assembly	Use as is	Closed	No effect on form, fit, or function
			AA93-0029	Zipper torn loose from fabric	Use as is	Closed	Mission 8 post test
Helmet Stowage Bag (Apollo XI Configuration)	A7L-502000-07	056	AA93-0122	EMU Maintenance Kit and glove holder wear	Use as is	Closed	No effect on function
			AA93-0123	Glove holder wear	Use as is	Closed	No effect on function
			AA93-0127	EMU Maintenance Kit, glove holder and fabric wear	Use as is	Closed	No effect on function
PLSS Mock-up (Test support equipment only, not qual. hardware)	HDA02-713901-11	007	AA83-0326	Left shoulder strap torn loose	Repair and return to test	Closed	Not a qualification item

TABLE A-3
QUALIFICATION TEST SUMMARY

DELTA ENVIRONMENTAL TESTS FOR APOLLO XI

Page 1 of 1

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
Pressure Garment Assembly (Sand and Dust Test)	ATL-100000-22	001	11930209	Left Outlet Gas Connector lock-lock would not disengage until being cycled 6 to 10 times after test exposure.	Return to vendor for failure analysis	Closed	MR MSC 03634 writt... Mission procedure deve... correct problem
			11930210	Right Inlet Gas Connector lock-lock would not disengage until being cycled 6 to 10 times after test exposure.	Return to vendor for failure analysis	Closed	MR MSC 03634 wri... ...ssion procedure deve... ...rect problem
Lunar Extravehicular Visor Assembly (Odor and Toxicity Test)	ATL-205000-01	004	11931747	Failed to meet the odor test requirements in that the average odor panel score was 2.8 as opposed to an acceptable score of 2.5 maximum.	Use as is. This DR was written in error since the method of determining the odor panel score did not consider an appropriate dilution factor The correct score is 1.84 which is acceptable.	Closed	MR MSC 03844 wri... ... close

TABLE A-4
QUALIFICATION DR SUMMARY

LUNAR SURFACE QUALIFICATION DEMONSTRATION ITMG

Page 1 of 4

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
GA	ATL-100000-42	050	11930903	Thermo couples inoperative	Rework to drawing	Closed	
			11930614	Improper Assembly	Rework to drawing	Closed	
			11930618	Frayed	Use as is	Closed	
			11930525	Torn	Use as is	Closed	
			11930597	Torn ITMG zipper flap	Rework to drawing	Closed	
			11930722	Holes in ITMG	Rework not to drawing	Closed	MR MSC 03645 - Closed. Modify PLSS interface
			11930743	Torn ITMG	Rework to drawing	Closed	
			11930752	Holes in ITMG at wrist	Use as is	Closed	
			11930763	Torn	Rework not to drawing	Closed	
			11930768	Deformed Boot Soles	Use as is	Closed	
			11930770	Improper Operation - Thermo couple	Rework	Closed	
			11930781	Improper Operation - Thermo couple	Rework	Closed	
			11930814	Worn ITMG, Cracked Boot Soles	Rework not to drawing	Closed	MR MSC 03693 - Closed. Repair procedure established
			11930816	Torn	Use as is	Closed	
			11930820	Elec., out of spec.- Thermo couple	Rework to drawing	Closed	
			11930821	Elec. out of spec.- Thermo couple	Rework to drawing	Closed	
			11930831	Dimensional Tolerance	Use as is	Closed	
			11930851	Torn	Use as is	Closed	
			11930852	Torn	Use as is	Closed	
			11930853	Torn	Use as is	Closed	
			11930904	ITMG wrist cover band came off	Rework to drawing	Closed	
			11930917	Excessive leakage (1940 scc/min)	Rework not to drawing	Closed	MR MSC 03695 - Closed, Change operational procedure
			11930507	Stripped Thread	Rework to drawing	Closed	
			11931103	Excessive leakage		Open	See 11930917
			11930659	Hole in zipper flap	Rework to drawing	Closed	

LUNAR SURFACE QUALIFICATION DEMONSTRATION ITEMS

Document No. CSD-A-945
Revision
Release Date 7 July 1969

Page 2 of 4

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
Helmet	A7L-102043-01	003	11930829	Lubrication stains	Use as is	Closed	
			11930524	Cut		Closed	
			11930581	Improper Assembly	Rework to drawing	Closed	
			11930737	Temperature Charact. out of spec. (condensation)	Use as is	Closed	
			11930739	Moisture in helmet	Use as is	Closed	
			11930740	Distorte vision due to condensation	Use as is	Closed	
			11930767	Scratched	Use as is	Closed	
			11930849	Cut	Use as is	Closed	
			11930920	Not tested, PIA/Funct. Test	OK for use as noted	Closed	
Comfort Gloves	A7L-103056-05 /-06	050	11930832	Slipping	Use as is	Closed	
EV Gloves	A7L-203025-01 /-02	057	11930478	Lacks Drawing	Provide required document	Closed	
			11930725	Torn Stitching	Rework not to drawing	Closed	MR MSC 03644-Closed. Design change for future units
			11930746	Wear of chromel "R" Torn	OK for use as noted	Closed	
			11930764	Torn	Rework not to drawing	Closed	
			11930815	Torn	Rework not to drawing	Closed	
			11930848	Torn	Rework not to drawing	Closed	
			11930658	Torn stitching on palm	Rework not to drawing	Closed	
			11930670	Hole in Beta cuff	Use as is	Closed	
Lunar Boots	A7L-106043-03 /-04	030	11930765	Torn	Use as is	Closed	
			11930744	Hole in bottom of Liner	Use as is	Closed	
			11930723	Hole in liner and sole cracked	Use as is	Closed	

TABLE A-4
QUALIFICATION DR SUMMARY

LUNAR SURFACE QUALIFICATION DEMONSTRATION ITEMS

Document No. CSD-A-945
Revision
Release Date

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
Liquid Cooling Garment	A6L-400000-09	72	11930054	Contaminated	Use as is	Closed	
			11930745	Worn and stained	Use as is	Closed	
			11930854	Contaminated	Use as is	Closed	
			11930721	Pressure point and red stain	OK for use as noted	Closed	
			11930738	Pressure point at both wrists	OK for use as noted	Closed	
LEVA	A7L-205000-01	001	11930451	Lacks drawing for inspection	Provide drawing	Closed	
			11930567	Improper Operation	Use as is	Closed	
			11930724	Stripped wire on thermo couple	Use as is	Closed	
			11930766	Hole in collar and scratches	Use as is	Closed	
			11930850	Torn	Use as is	Closed	
			11930622	Improper Operation	Rework to drawing	Closed	
			11930619	Improper Operation	Rework to drawing	Closed	
			11930620	Improper Operation	Rework to drawing	Closed	
			11930949	Gold Coating worn	Use as is	Closed	Replace visor after qual.
Purge Valve	A6L-505000-02	141	11930344	Orifice dimension incorrect	Rework drawing	Closed	
			11931169	Lacks Documentation	Rework to drawing	Closed	
Communications Carrier	16536G-04	133	11930950	Torn	Rework to drawing	Closed	
ECS	A6L-501000-02	039	(No DR's)				
CTA	14-0103-02	3343	11930830	Uncomfortable chaffing	Use as is	Closed	
Oxygen Purge Sys.	SV73101-2-2p1	10	11930841	Improper Operation	Use as is	Closed	
			13930678	02 Pressure Low	Modify procedure	Closed	

LUNAR SURFACE QUALIFICATION DEMONSTRATION ITEMS

NOMENCLATURE	PART NUMBER	S/N	DR NUMBER	FAULT	DISPOSITION	STATUS	COMMENTS
rtable Life Support System	SV70[illegible]100-6-4-pl	017					
			13930908	Improper Operation Instrumentation	Rework to drawing	Closed	
			13930731	Binding/Sticking	Use as is	Closed	
			13930905	Electrical Characteristics out of spec.	Use as is	Closed	
			13930907	Improper Operation-Instrumentation	Rework to drawing	Closed	
			13930697	Torn Thermal Cover	Use as is	Closed	
			13930736	Pressure Characteristics out-of-spec.-warning tone-no flag	Use as is	Closed	
			13930750	Electrical Characteristics out-of-spec.	Rework to	Closed	
			13930751	Thermocouple read in error	Rework to drawing	Closed	
			13930526	Improper Identification	Rework to drawing	Closed	
			13930749	Broken test lead	Rework to drawing	Closed	
			13931988	Cracked/Chipped Cover	Use as is	Open	MR Open
			13930732	Thermo couple # 12 inoperative	Rework to drawing	Closed	
			13930733	Vented to Ethyl alcohol environment	Test to applicable procedures	Closed	
			13930666	Battery Voltage Low	OK for use as noted	Open	Modify Current Limiter per service instruction number 182

APPENDIX B

EMU
QUALIFICATION WAIVERS
AND
CORRESPONDENCE SUMMARY

This appendix contains a summary of memorandums and waivers pertaining to qualification and testing of EMU items for the Apollo program.

DATE	MEMO/ WAIVER #	ITEM	COMMENTS
7/24/68	EC65-069	Communications Carrier	Material testing only on redesigned CCA for S/C 101 flight.
7/31/68	EC98100174	InFlight Coveralls InFlight Helmet Stowage Bag Neck Dam EMU Maintenance Kit Neoprene Cover Glove	Waiver for S/C 101 Vibration Acceleration Shock
8/22/68	EC951NB0263	PGA Acoustic Noise Tests	Conduct test at max. Q conditioning rather than at max abort conditions.
8/28/68	EC951NB0290	EMU Maintenance Kit	Delete Salt Fog Test
8/1/68	EC76EC128	Automatic Injectors	Qual of P/N EC20003-6-04, S/N 169 is valid for RMK 108 and RMK 109
8/16/68	EC951NC0244	Pressure Gage	MR 03504, salt fog test failure
8/5/68	EC911MA0195	EMU Test Items for EMI Test	Use environmental test hardware for EMI tests rather than interface test hardware
8/2/69	EC76EC079	InFlight Coverall Gar.	Delete Salt Fog and low temp Qual tests
8/28/68	NC3-68-8-495M	Odor & Toxicity Report	Approval of report by NC 23
	EC921EC2303	Neck Dam EMU MK	Delete: Vibration, Acceleration, Shock

DATE	MEMO/ WAIVER #	ITEM	COMMENTS
8/2/68	EC921EC2303	PGA Salt Water Immersion Test	Neck Dam required
10/4/68	EC921NA0413	Flourel Coating of IV Gloves A6L-103000-11/12	Qual test req'd Cycling, Oxygen and Humidity, Salt Fog, Low Temp; Waiver all others
1/16/69	EC65-0168	Bioinstrumentation Sys EMI requirements	Waiver EMI Spec. based on GAEC memo
1/15/69	EE36/69-7	Mission "D" EMC Tests of EMU	Report on out-of-spec. conditions
2/17/69	EC951NA1006	EVC use in L.S. Qual.	Use EVC2 to qualify EVC1 and 2
4/10/69	EC951NA1186	PGA S/N 050	Ship to LTV for unmanned tests with outstanding DR's
6/13/69	EC951NA1453	Feedwater Collection Bags	Delete the following from qualification: Oxygen and Humidity, Stowage Low Temp., Vibration, Shock.