LM AGS

FLIGHT PROGRAM 8/APOLLO 17

FLIGHT SOFTWARE READINESS REVIEW

26 OCTOBER 1972

CONTENTS

FP 8/APOLLO 17

PROGRAM DELIVERABLES

- ACE FILE TAPE ID 3025 0000
- CONSTANTS LISTING, FP 8/LM 12/ASA 022
- BTME TAPE, ID 4049
- UPDATED ABSOLUTE DECK - ID 4049

FP 8 TEST HISTORY

- VERIFIED PROGRAM DELIVERED 28 APRIL 1971
- INDEPENDENT VERIFICATION TESTING BY LEC/GCD
- CONSTANTS UPDATE TESTING FOR APOLLO 15 & 16
- FMES/FCI APOLLO 15 MISSION TESTING FOR APOLLO 15 & 16
- APOLLO 15 & 16 FLIGHT
  - PROGRAM EXCERCISED EXCEPT FOR CSI, CDH
  - NO SOFTWARE ANOMALIES
- FMES/FCI APOLLO 17 MISSION TESTING
- CONSTANTS UPDATE TESTING FOR APOLLO 17

RELATED ACTIVITIES

- DATA PRIORITY SUPPORT
  - PRESENTATION OF APOLLO 16 POSTFLIGHT RESULTS
  - PRE-PDI STATE VECTOR UPDATE REQUIREMENTS FOR AGS
  - AGS COMPUTED PERILUNE/APOLUNE CHARACTERISTICS
  - STUDY FOR FEASIBILITY OF ZEROING AGS OUT-OF-PLANE AND DOWNRANGE ERRORS DURING DESCENT
  - APOLLO 17 ALTITUDE/VELOCITY UPDATE PROCEDURE
- MISCELLANEOUS
  - CONFIRMATION OF LOI ABORT ENGINE ON PROCEDURES
  - FEASIBILITY OF VELOCITY UPDATE (ALTITUDE RATE) DURING ASCENT FOR DISCRETE FAILURE

APOLLO 16 POSTFLIGHT SUMMARY

- ALTITUDE/VELOCITY UPDATE DURING DESCENT

		Altitude Update		Velocity Update		Touchdown
		Pre	Post	Pre	Post	
- AGS-PGNCS	h(ft)	+222	-245	-245	-245	-657
	$\dot{h}$(fps)	+0.1	0.0	0.0	-0.5	-0.4

- PGNCS/AGS STATE VECTOR TRANSFERS
  - LARGEST COMPONENT DIFFERENCES ON 2 TRANSFERS
    - POSITION - 307 FT
    - VELOCITY - 0.54 FPS

- AGS PERFORMANCE SUMMARY

- DESCENT	$\Delta V_X \approx$ -3.0 fps (Hi-Gate)	- ASCENT ΔV_X = +.75 fps
	$\Delta V_Y \approx$ +28.0 fps (TD)	ΔV_Y = +2.8 fps
	$\Delta V_Z \approx$ -1.5 fps (Hi-Gate)	ΔV_Z = -.2 fps
	$\Omega_X \approx +1700 \widehat{\text{SEC}}$	$\Sigma_X = +960 \widehat{\text{SEC}}$
	$\Omega_Y \approx -50 \widehat{\text{SEC}}$	$\Sigma_Y < 120 \widehat{\text{SEC}}$
	$\Omega_Z \approx 0$	$\Sigma_Z < 120 \widehat{\text{SEC}}$

  - X GYRO LOOP PROBLEM ⤳ SUMMARY FOLLOWS

X GYRO LOOP PROBLEM SUMMARY

- PERFORMANCE:
  - DESCENT ⤻ LARGE INITIAL OFFSET COUPLED WITH 1.94°/HR
  - LUNAR SURFACE ⤻ 1.2°/HR Δ IN CALIBRATION
  - ASCENT ⤻ INSERTION + 2 MIN CHANGE FROM -1.5°/HR TO -.5°/HR
- ERROR SOURCE:
  - UNABLE TO SEPARATE BETWEEN GYRO AND LOOP ELECTRONICS
    - GYRO ⤻ LARGE BUBBLE, CONTAMINATION
    - ELECTRONICS ⤻ PULSE TORQUE SERVO AMP INTERMITTENT
  - GYRO PREFLIGHT DATA DISPLAYS NO EVIDENCE OF ANY OF THESE FAILURE MODES
- APOLLO 17 CONSIDERATIONS
  - ALL DATA ON THREE POTENTIAL ASA'S METICULOUSLY SCREENED
  - SPECIAL SETTLING TESTS FOR THREE ASA'S IN JUNE AND IN OCTOBER
  - PERFORMED ADDITIONAL GYRO CALIBRATION AT ALTITUDE CHAMBER DURING TCP-KL-0013
  - TWO ADDITIONAL CALIBRATIONS ON EACH ASA IN OCTOBER
  - BROKE SEAL ON TWO GYROS AND VACUUM SOAKED TO INVESTIGATE POTENTIAL FOR FLUID CAVITATION DUE TO POSSIBLE LEAK. NEGATIVE RESULTS.

CONSTANTS SUMMARY

- CHANGES FROM APOLLO 16
  - 13 ASA HARDWARE CONSTANTS
  - 13 MISSION CONSTANTS

    1K28 - LUNAR ALIGN CONSTANT (FUNCTION OF RLS)

    4K25 - APS TAILOFF ΔV

    4K10, 7J, 8J, 10J, 11J, 12J - DESCENT ABORT CONSTANTS

    5J - LANDING SITE RADIUS

    W_{BX}, W_{BY} - YAW STEERING VECTOR

    IS: 30° YAW RIGHT FOR DESCENT/ASCENT

    WAS: 180° FOR POST INSERTION (TPI MANEUVER)

    6J1, 6J2 - LUNAR RATE COMPENSATION FOR GYRO CALIBRATION

CONSTANTS SUMMARY (continued)

- KSC LOAD AND VERIFY CHECKS
  - LM DICTIONARY ANALYSIS LISTS DIFFERENCES BETWEEN

    ID 4039 DELIVERED 28 APRIL 1971 - MASTER FILE

    ID 4049 TO BE DELIVERED 26 OCTOBER 1972 FOR APOLLO 17
  - NON-COMPARES ARE:

    12 HARDWARE CONSTANTS CHANGES (ONE BIAS ZERO)
    15 MISSION DEPENDENT CONSTANTS
     1 NEW CHECKSUM
    ---
    28 TOTAL

VERIFICATION TESTING FOR CONSTANTS UPDATE ON APOLLO 17

OBJECTIVE:

- VERIFY ALL CONSTANTS FOR PROGRAM AND MISSION COMPATIBILITY
- DEMONSTRATE FLIGHT PROGRAM TAPE CONTAINING FINAL APPROVED CONSTANTS
- DEMONSTRATE ABILITY OF AGS TO PERFORM SPECIFIED MISSION FUNCTIONS
- DEMONSTRATE THAT THE FLIGHT PROGRAM OPERATES PROPERLY WITH THE APPROVED CONSTANTS

TEST REQUIREMENTS:

- DIGITAL SIMULATIONS
  - ICS/FS
  - SFS
  - PERFORMANCE ANALYSIS
- FMES/FCI
  - AGS CONTROLLED
  - NOMINAL FOLLOW-UP

VERIFICATION TESTING AND RESULTS

TEST CASES:

- ICS/FS CASES
  - LUNAR SURFACE OPERATIONS
  - NOMINAL ASCENT
  - TPI MANEUVER (DIRECT RENDEZVOUS)
- SFS AND BUGS CASES
  - NOMINAL DIRECT RENDEZVOUS
  - DIRECT RENDEZVOUS WITH EARLY LIFTOFF (10 SEC EARLY - INCLUDING A TWEAK BURN)
  - DIRECT RENDEZVOUS WITH LATE LIFTOFF (10 SEC LATE - INCLUDING A TWEAK BURN)
  - LUNAR LIFTOFF TO RENDEZVOUS INCLUDING CSI AND CDH
  - PDI+180 ABORT
  - PDI+360 ABORT
  - PDI+540 ABORT
  - PDI+720 ABORT
  - PDI+900 ABORT

ICS/FS

TEST RESULTS

- LUNAR SURFACE OPERATIONS
  - VERIFY LUNAR ALIGN MODE AND LUNAR CALIBRATION MODE, CONSTANTS 6J1, 6J2, 6J3, 1K28
  - RESULTS:
    - ALIGN ERRORS AFTER 60 SEC

	ACTUAL	SHOULD BE
Y	0.147 $\widehat{\text{min}}$	0.18 $\widehat{\text{min}}$
P	0.905 $\widehat{\text{min}}$	0.51 $\widehat{\text{min}}$ (DUE TO PITCH RATE OF .5 deg/hr, @ T.D. +1:00)
R	0.43 $\widehat{\text{min}}$	0.0 $\widehat{\text{min}}$

    - GYRO CALIBRATION RESULTS - VERIFIED GYRO BIAS COMPENSATION VALUES

	BEFORE	AFTER	CHANGE
X	0.0	-.009605	-0.0096
Y	-1.0085	-1.02773	-0.01921
Z	-0.2305	-0.2305	0.0

- TPI BURN
  - VERIFY NOMINAL TPI PROCEDURES, TARGETING, CONSTANTS 1K9, 5J
  - RESULTS:
    - TPI SOLUTION

      OT VG = 76.56 FPS

      AGS VG = 75.75 FPS
    - POST TPI ORBIT

      OT 64.45 x 46.71

      AGS 64.27 x 46.83

*TARGETTED 50 SECONDS LATE
BUGS SOLUTIONS WERE:

(1) ON TIME	(2) 50 SECONDS LATE
VG 76.6	VG 75.9

NOMINAL ASCENT

INSERTION PARAMETERS	AGS	ENVIRONMENT	OT	BUGS
H_a	47.367	47.98	47.85	47.75
H_p	9.069	9.093	9.06	9.07
V_h	5539.625	5539.74	5539.7	5539.84
$\dot{h}$	31.875	31.92	31.878	31.52
Y	-384	-132		-428
V_{yo}	-1.25	-0.89		-.39
H	60096	60,173	59997.3	60,068

SCIENTIFIC SIMULATION RESULTS

PDI SUMMARY DATA

8/30/72 Final

PAGE	ABORT	INS			BOOST	HAM	CSI		CDH			TPI	AIM		
	TIME PDI+	TIME PDI+	N76	HA/HINS	TIME INS+	TIME INS+	TIME INS+	ΔVX	TIME INS+	ΔVX	ΔVZ	TIME PDI+	TIME PDI+	ΔVX	ΔVZ
A-1	NO 1+12	NA	NA	NA	NA	NA	1+07+00*	58.4	2+09+35*	-126.1	8.4	2+47+26	12+00	106.5	-50.0
	NO 1+12Δ	NA	NA	NA	NA	NA	1+07+00*	49.4	2+09+15*	-118.2	13.1	2+47+25	12+00	93.0	-50.0
A-2	1+00	2+05	5656.2	132.6/53784.	NA	NA	0+55+00	57.2	1+57+08	-115.2	-42.4	2+47+30	NA	NA	NA
	2+00	4+00	5651.9	131.8/58323.	↓	↓	↓	55.5	1+57+03	-113.0	-38.2	↓	↓	↓	↓
	3+00	5+43	5646.3	128.3/60018.	↓	↓	↓	54.7	1+56+54	-108.5	-31.4	↓	↓	↓	↓
	4+00	7+18	5639.5	122.9/60023.	↓	↓	↓	54.4	1+56+39	-101.6	-22.5	↓	↓	↓	↓
	5+00	8+49	5630.0	115.3/60030.	↓	↓	↓	54.4	1+56+18	-92.1	-11.3	↓	↓	↓	↓
	6+00	10+13	5617.5	105.5/60039.	↓	↓	↓	54.5	1+55+51	-79.8	1.5	↓	↓	↓	↓
	7+00	12+35	5596.3	91.9/64950.	↓	↓	↓	53.1	1+55+14	-61.8	17.7	↓	↓	↓	↓
A-3	8+00	14+27	5571.5	76.4/71046.	↓	↓	↓	51.5	1+54+31	-41.4	32.6	↓	↓	↓	↓
	9+00	16+06	5546.3	59.3/74249.	↓	↓	↓	50.7	1+53+45	-18.2	45.2	↓	↓	↓	↓
A-4	10+00	17+18	5564.0	71.7/72715.	50+00	1+50+00	2+40+00	38.9	3+39+14	-32.3	-59.4	4+46+26	NA	NA	NA
	11+00	18+21	5559.6	65.7/67727.	↓	↓	↓	41.8	3+39+01	-26.1	-43.6	↓	↓	↓	↓
	12+00	19+24	5555.9	59.9/62049.	↓	↓	↓	44.5	3+38+49	-19.8	-29.3	↓	↓	↓	↓
	13+00	20+27	5547.3	52.7/60251.	↓	↓	↓	46.4	3+38+32	-11.5	-12.3	↓	↓	↓	↓
	14+00	21+27	5539.6	47.2/60250.	↓	↓	↓	47.2	3+38+19	-4.8	.1	↓	↓	↓	↓
	15+00	22+26	5532.2	41.8/60248.	↓	↓	↓	47.9	3+38+05	2.2	11.8	↓	↓	↓	↓
	16+00	23+26	5524.6	36.3/60246.	↓	↓	↓	48.2	3+37+51	9.3	22.1	↓	↓	↓	↓
	17+00	24+25	5517.0	30.9/60244.	↓	↓	↓	48.5	3+37+37	16.7	31.4	↓	↓	↓	↓
A-5	T2-1	7+22Ω	5515.7	30.0/60154.	50+00	3+50+00	4+40+00	42.9	5+37+23	22.9	55.1	6+45+14	NA	NA	NA
A-6	NO 2+12	NA	NA	NA	1+12+00*	2+12+00*	3+12+00*	47.4	4+15+07*	-141.9	29.0	4+51+40	12+00	122.5	-50.0
	NO 2+12Δ	NA	NA	NA	1+12+00*	2+12+00*	3+12+00*	38.6	4+14+40*	-130.0	37.6	4+51+39	12+00	110.0	-50.0
A-7	1+00	2+07	5676.9	149.7/54128.	1+00+00	2+00+00	3+00+00	47.3	4+02+55	-136.4	-18.8	4+51+49	NA	NA	NA
	2+00	4+02	5672.6	149.1/59080.	↓	↓	↓	45.1	4+02+51	-134.8	-15.8	↓	↓	↓	↓
	3+00	5+44	5669.5	147.1/60019.	↓	↓	↓	44.6	4+02+45	-131.8	-8.7	↓	↓	↓	↓
	4+00	7+20	5666.3	144.5/60024.	↓	↓	↓	44.2	4+02+37	-128.2	.5	↓	↓	↓	↓
	5+00	8+50	5661.7	140.7/60031.	↓	↓	↓	43.8	4+02+26	-123.4	11.7	↓	↓	↓	↓
	6+00	10+15	5655.9	136.0/60040.	↓	↓	↓	43.5	4+02+13	-117.2	25.2	↓	↓	↓	↓
A-8	7+00	12+41	5665.0	146.4/65188.	NA	NA	0+55+00	50.4	1+57+38	-127.8	-57.1	2+52+54	NA	NA	NA
	8+00	14+33	5641.5	130.9/71212.	↓	↓	↓	49.9	1+56+57	-109.7	-32.3	↓	↓	↓	↓
	9+00	16+11	5617.9	113.9/74326.	↓	↓	↓	50.0	1+56+12	-89.3	-8.6	↓	↓	↓	↓
	10+00	17+20	5602.3	100.8/72751.	↓	↓	↓	50.9	1+55+37	-72.9	7.4	↓	↓	↓	↓
A-9	11+00	18+23	5590.1	88.7/67752.	↓	↓	↓	52.3	1+55+05	-57.5	20.2	↓	↓	↓	↓
	12+00	19+25	5578.4	76.7/62072.	↓	↓	↓	53.8	1+54+33	-41.9	31.1	↓	↓	↓	↓
	13+00	20+28	5560.6	62.5/60253.	↓	↓	↓	54.3	1+53+54	-22.9	42.0	↓	↓	↓	↓
A-10	14+00	21+27	5545.8	51.6/60250.	↓	↓	↓	54.2	1+53+25	-8.0	48.4	↓	↓	↓	↓
	15+00	22+26	5530.8	40.8/60247.	↓	↓	↓	54.0	1+52+56	7.3	53.6	↓	↓	↓	↓
A-4	T2-2	7+22Ω	5515.7	30.0/60154	50+00	1+50+00	2+40+00	48.4	3+37+34	17.8	32.9	4+51+43	NA	NA	NA

Ω INDICATES TIME IS REFERENCED TO LIFT-OFF. * INDICATES TIME IS REFERENCED TO PDI. Δ ASSUMES NO DOI-2

DESCENT ABORTS

CASE	ABORT TIME	SOURCE	INSERTION RESIDUAL (FPS)	INS. ALT. (FT)	ha (nm)	CSI ΔV FPS	CSI Δh NM	CDH ΔV_X	CDH ΔV_Z	TPI ΔV_X	TPI ΔV_Y	TPI ΔV_Z	TPI θ_{LOS}	BRAKING ΔV
2.5	PDI +3 MIN	BUGS LMTL SFS	.09,.50 -	60080 60018	128.4 128.3	54.3 54.7	15.2 -	-110.0 -108.5	-33.1 -31.4	+22.5	.4	-14.8	26.6	31.4
2.6	PDI +6 MIN	BUGS LMTL	.04,.56 -	60091 60039	106.6 105.5	53.5 54.5	15.7 -	-82.6 -79.8	-1.0 1.5	23.3	.3	-14.0	26.6	32.1
2.7	PDI +9 MIN	BUGS* LMTL BUGS	.05,.31 -	71644 74249 65977	60.9 59.3 62.0	50.6 50.7 51.3	15.6 - 16.1	-21,4 -18.2 -23.4	43.9 45.2 42.5	23.1 23.7	0. .6	-13.8 -14.2	26.6 26.6	32.7 33.4
2.8	PDI +12 MIN	BUGS LMTL	-.05,-.27 -	60093 62049	61.5 59.9	42.3 44.5	16.4 -	-24.1	-35.7	24.0	.6	-13.5	26.6	34.5
2.9	PDI +15 MIN	BUGS LMTL SFS	.13,-.51 -	60050 60248	43.1 41.8	46.0 47.9	16.2 -	-1.2 2.2	8.0 11.8	23.5	.2	-12.2	26.6	33.6

*No APS cant

ASCENT FROM LUNAR SURFACE (DIRECT RENDEZVOUS)

	OT NOMINAL	BUGS		
		NOMINAL CASE 2.1	10 SEC EARLY CASE 2.2	10 SEC LATE CASE 2.3
INSERTION ORBIT (NM)	9.06 x 47.85	9.1 x 47.8	9.1 x 47.8	9.1 x 47.8
TWEAK ΔV_X, ΔV_Z	-	-	-4., -20.	4., 20.
TPI				
V_G(FPS)	76.6	78.3	79.5	82.3
V_{GX}(FPS)	-	75.3	79.5	72.3
V_{GY}(FPS)	-	.2	0.2	.2
V_{GZ}(FPS)	-	19.4	0.0	39.5
LOS(DEG)	26.4	25.17	25.12	25.04
BRAKING ΔV (FPS)	31.2	33.1	33.4	32.8
INSERTION RESIDUAL	0.0	.12, -.48	.12, -.48	.12, -.48

NOMINAL COELLIPTIC RENDEZVOUS (CASE 2.4 BUGS RESULTS)

LIFTOFF TIME: 132 SECONDS LATE

INSERTION ORBIT 47.8 x 9.1 N.MI.					
	ALTITUDE 60089. FEET				
	VELOCITY 5540.2 FT/SEC				
CSI	ORBIT	47.9 x 47.3 N.MI.			
	ΔVGX	53.6 FT/SEC			
CDH	ORBIT	47.2 x 46.4 N.MI.	Δh = 15.1 N.MI.		
	ΔVGX	-1.8 FT/SEC			
	ΔVGZ	0.5			
TPI	ORBIT	63.2 x 46.7 N.MI.	θLOS = 26.6		
		TPI	MCC1	MCC2	
	ΔVGX	22.3	.2	.7	FT/SEC
	ΔVGY	.5	-.1	-.2	
	ΔVGZ	-11.7	.6	1.4	
BRAKING VELOCITY		31.6 FT/SEC			
CSM	ORBIT	62.4 x 61.8 N.MI.			

APOLLO 17/FP8/ASA 022 PERFORMANCE ANALYSIS RESULTS

NAVIGATION UPDATE SUMMARY

- STANDARD (NO CSM UPDATE FOLLOWING INSERTION)
  - INITIALIZATION ERRORS BASED ON MSFN DATA AT PDI-180°*
    - 1σ UNCERTAINTIES AT PDI-180°

      $U = 2140 \quad \dot{U} = 6.0$

      $V = 8500 \quad \dot{V} = 1.9$

      $W = 6100 \quad \dot{W} = 10.9$
  - ALTITUDE UPDATE AT 8000 FT (DESCENT ABORT)
  - RR UPDATING POST INSERTION THROUGH MCC2
- CSM UPDATE POST INSERTION (DESCENT ABORT)
  - INITIALIZATION, ALTITUDE UPDATE, RR AS ABOVE
  - AGS CSM VECTOR UPDATED AT HAM -35 MIN

    $U = 2100 \quad \dot{U} = 4.2$

    $V = 4500 \quad \dot{V} = 1.9$

    $W = 7300 \quad \dot{W} = 10.3$

*MSC 69-FM46-338

PERFORMANCE ANALYSIS SUMMARY

- APOLLO 17, DIRECT RENDEZVOUS:
  - SPEC ASA ΔV 179 (MEAN + 3σ) FPS
  - FLIGHT ASA ΔV 166 FPS
- APOLLO 17, NOMINAL RENDEZVOUS
  - SPEC ASA ΔV 190 FPS
  - FLIGHT ASA ΔV 178 FPS
- HOVER ABORT
  - NO CSM UPDATE AFTER INSERTION ΔV 463 FPS
    - TRACKING CLOSE TO BURN
  - CSM UPDATE AFTER INSERTION ΔV 367 FPS
    - TRACKING TO TIG - 8 MIN
  - EXTENDED TRACKING ΔV 309 FPS
    - TRACKING CLOSE TO BURN
  - FLIGHT ASA, CSM UPDATE ΔV 324 FPS
    - TRACKING TO TIG - 8 MIN

APOLLO 17/ASA 022 PERFORMANCE ANALYSIS RESULTS SUMMARY

		Early Rendezvous Lunar Surface Abort		Nominal Lunar Surface Abort		End-of-Hover Abort	
Performance Parameter	Statistical Quantity	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR	P&I SPEC ASA AUTO RR	ASA 022 AUTO RR	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR
Total ΔV (fps)	Mean σ Mean $+3\sigma$	135. 15. 179.	131. 12. 166.	143. 16. 190.	138. 13. 178.	218. 50. 367.	198. 42. 324.
Pericynthion Altitude (feet)	Mean σ Mean -3σ	42980. 1260. 39200.	43190. 1250. 39440.	41500. 1450. 37150.	41790. 1330. 37800.	56990. 6060. 38810.	57800. 4450. 44450.
Δh at CDH* (n mi)	Mean σ	15.1 1.17	15.1 0.85	15.2 1.15	15.4 1.10	14.6 2.61	14.7 2.29
Δh_{MAX} (n mi)	Mean σ	NA	NA	15.5 1.19	15.8 1.22	15.2 2.84	15.1 2.43
Δh_{MIN}	Mean σ	NA	NA	14.9 1.24	15.2 1.16	14.2 2.63	14.3 2.35
$\Delta\Delta h$ (n mi)	Mean σ	NA	NA	0.52 0.35	0.51 0.35	0.94 0.63	0.80 0.48
$\Delta\theta^{**}_{LOS}$ (deg)	Mean σ	0.4 5.0	1.1 4.2	0.4 1.0	0.1 1.0	0.2 2.9	0.2 2.8
TPI Time (sec)	Mean σ	NA	NA	9343. 360.	9282. 368.	16440. 555.	16438. 526.

*Δh AT TPI FOR THE EARLY RENDEZVOUS CASES

**$\Delta\theta_{LOS}$ = AGS ESTIMATED LINE-OF-SIGHT ANGLE AT TPI MINUS 26.6 DEGREES (TPI PERFORMED AT A FIXED TIME OF 47 MINUTES AFTER INSERTION FOR THE EARLY RENDEZVOUS CASE).

APOLLO 17/ASA 022 PERFORMANCE ANALYSIS MANEUVER ΔV ERROR SUMMARY

		Early Rendezvous Lunar Surface Abort		Nominal Lunar Surface Abort		End-of-Hover Abort	
Performance Parameter	Statistical Quantity	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR	P&I SPEC ASA AUTO RR	ASA 022 AUTO RR	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR
CSI ΔV ERROR (fps)	$\sigma_{\dot{T}}$	NA	NA	1.1	1.1	1.3	1.2
CDH ΔV ERROR (fps)	$\sigma_{\dot{T}}$ $\sigma_{\dot{R}}$	NA	NA	0.4 1.4	0.4 1.4	0.5 2.6	0.5 2.2
TPI ΔV ERROR (fps)	$\sigma_{\dot{T}}$ $\sigma_{\dot{N}}$ $\sigma_{\dot{R}}$	0.5 1.5 3.9	0.5 1.0 4.0	0.7 2.9 5.6	0.7 2.0 5.4	1.5 1.4 14.1	1.3 1.2 12.5
MCC1 ΔV ERROR (fps)	$\sigma_{\dot{T}}$ $\sigma_{\dot{N}}$ $\sigma_{\dot{R}}$	1.5 0.7 2.8	1.5 0.6 2.7	0.9 1.6 2.0	1.0 1.4 2.0	1.9 1.2 7.4	1.6 1.0 6.6
MCC2 ΔV ERROR (fps)	$\sigma_{\dot{T}}$ $\sigma_{\dot{N}}$ $\sigma_{\dot{R}}$	1.7 0.7 2.4	1.8 0.5 2.3	1.3 0.8 1.3	1.2 0.8 1.4	2.4 1.0 3.2	2.4 0.8 3.0

APOLLO 17/ASA 022 PERFORMANCE ANALYSIS MANEUVER ΔV SUMMARY

		Early Rendezvous Lunar Surface Abort		Nominal Lunar Surface Abort		End-of-Hover Abort	
Performance Parameter	Statistical Quantity	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR	P&I SPEC ASA AUTO RR	ASA 022 AUTO RR	P&I SPEC ASA MANUAL RR	ASA 022 MANUAL RR
BOOST ΔV (fps)	Mean σ	NA	NA	NA	NA	10.0 0.3	10.0 0.2
HAM ΔV (fps)	Mean σ	NA	NA	NA	NA	24.6 17.5	19.5 14.2
CSI ΔV (fps)	Mean σ	NA	NA	49.1 1.7	48.8 1.7	40.5 3.5	40.3 3.2
CDH ΔV (fps)	Mean σ	NA	NA	5.5 3.2	5.1 2.9	23.1 13.4	17.0 11.7
TPI ΔV (fps)	Mean σ	78.8 5.9	77.4 4.3	31.0 5.7	28.7 4.0	30.5 8.9	29.3 7.8
MCC1 ΔV (fps)	Mean σ	7.1 4.9	7.2 5.1	9.5 7.0	8.8 6.5	20.0 15.3	17.7 14.1
MCC2 ΔV (fps)	Mean σ	7.8 4.5	7.7 4.1	5.7 3.2	5.4 3.0	17.5 12.5	15.8 10.3
Braking ΔV (fps)	Mean σ	35.3 7.7	33.4 6.3	36.9 7.4	36.5 7.0	46.6 15.2	43.2 12.3

CONCLUSIONS AND RECOMMENDATIONS

- FP8 VERIFICATION HAS BEEN SUCCESSFULLY COMPLETED AND IS RECOMMENDED FOR FLIGHT USE.
- FP8 SOFTWARE FUNCTIONS AND INTERFACES PERFORM AS REQUIRED.
- THE AGS (FP8) IS CAPABLE OF SATISFACTORILY COMPLETING THE ABORT MISSION FUNCTIONS OF THE APOLLO LUNAR MISSION.
- COMPATIBILITY OF FP8 AND J3, ASA 022, LM 12 CONSTANTS HAS BEEN DEMONSTRATED.