SATURN AS-501

EVALUATION BULLETIN

NO. 1

NOVEMBER 14, 1967

SATURN FLIGHT EVALUATION WORKING GROUP

THE FINDINGS HEREIN ARE PRELIMINARY. SEE FUTURE BULLETINS FOR LATEST INFORMATION

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

Memorandum

TO : Addressees

DATE : November 14, 1967

FROM : Chairman, Saturn Flight Evaluation Working Group, R-AERO-F

In Reply Refer to: R-AERO-F-187-67

SUBJECT : AS-501 Flight Evaluation Bulletin No. 1

1. Summary

The early engineering evaluation of the Saturn V Launch Vehicle, AS-501 indicated that all primary and secondary mission objectives were accomplished. Launch occurred at 7:00 am EST on November 9, 1967. All systems and subsystems appear to have performed near nominal.

Preliminary results indicate adequate clearance with close in support equipment. A yaw maneuver was accomplished as programmed and tower clearance was maintained during liftoff.

The S-IC Stage flight was near nominal with the outboard engines being cut off 1.2 seconds earlier than predicted. The maximum angle of attack was 1.3 degrees and the maximum engine deflections were 0.6 degrees during first stage burn.

Camera film showed the S-IC/S-II separation and S-II second plane separations to be smooth and the clearances adequate.

The S-II stage burn time was 4.7 seconds longer than nominal. The LH_2 tank insulation performed satisfactorily with no defects noted during countdown or in flight.

The S-IVB first and second burn times were 6.2 seconds longer and 15.2 seconds shorter than predicted, respectively.

2. Introduction

The findings reported herein are the results of the combined evaluation efforts of the various Laboratories of Research and Development Operations at MSFC, The Boeing Company, North American Rockwell/Space Division, Douglas Aircraft Company, International Business Machines, and Rocketdyne. The results quoted are preliminary and are subject to change as the evaluation progresses. This memo is the first of a series of evaluation bulleten to be published during the AS-501 flight test evaluation period. These bulletins are intended for internal use only.

3. Event Times

The following event times indicate a near nominal flight:

AS-501 Significant Event Times

EVENT	RANGE TIME (SEC)		
	ACTUAL	PRED	ACT-PRED
First Motion	-0.48	--	--
Liftoff Signal (IU)	0.265	--	--
Start Yaw Maneuver	1.3	--	--
Start Pitch and Roll	11.7	10.5	1.2
S-IC IECO	135.5	135.0	0.5
S-IC OECO	150.8	151.9	-1.1
S-II	151.2	152.4	-1.2
S-IC Retro Motor Ignition	151.4	152.6	-1.2
S-IC/S-II Separation	151.4	152.7	-1.3
S-II Engines Start Command	152.2	153.3	-1.1
S-II 2ND Plane Separation	181.4	182.6	-1.2
Jettison LET	187.1	188.3	-1.2
Jettison S-II AFT Cameras	189.8	191.0	-1.2
Initiation of IGM	190.2	191.9	-1.7
S-II ECO	519.8	516.3	3.5
S-IVB Ullage Motor Ignition	520.4	517.0	3.4
S-II Retro Motor Ignition	520.5	517.1	3.4
S-II/S-IVB Separation	520.5	517.2	3.3
S-IVB Engine Start Command	520.7	517.3	3.4
S-IVB Ullage Case Jettison	532.5	529.1	3.4
S-IVB First Guidance Cutoff	665.6	656.0	9.6
Insertion Into Parking Orbit	675.6	666.0	9.6
S-IVB Restart Preparations (TB6)	11,159.6	11,158.5	1.1
S-IVB Restart Command	11,486.6	11,484.5	2.1
S-IVB Second Guidance Cutoff Signal	11,786.3	11,799.4	-13.1
Waiting Orbit Injection	11,796.3	11,809.4	-13.1
S-IVB/CSM Separation	12,386.5	12,399.4	-12.9

4. Trajectory

A preliminary powered flight trajectory has been established through S-IVB first burn. The performance of all three stages was satisfactory as indicated by comparisons at S-IC cutoff, S-II cutoff, and S-IVB (first burn) cutoff which are as follows:

S-IC OECO

PARAMETER	ACTUAL	NOMINAL	ACT - NOM
Range Time(SEC)	150.75	151.91	-1.16
Altitude(KM)	63.54	63.61	-0.07
Range(KM)	82.63	85.01	-2.38
Cross Range(KM)	0.57	1.12	-0.55
Cross Range Velocity(M/SEC)	6.0	21.2	-15.2
Space-Fixed Velocity(M/SEC)	2693.3	2711.6	-18.3

S-II ECO

PARAMETER	ACTUAL	NOMINAL	ACT - NOM
Range Time(SEC)	519.85	516.33	3.52
Altitude(KM)	191.41	189.74	1.67
Range(KM)	1477.99	1471.79	6.20
Cross Range(KM)	22.35	22.99	-0.64
Cross Range Velocity(M/SEC)	158.5	152.9	5.6
Space-Fixed Velocity(M/SEC)	6807.4	6852.6	-45.2

S-IVB ECO (First Burn)

PARAMETER	ACTUAL	NOMINAL	ACT - NOM
Range Time(SEC)	665.64	656.00	9.64
Altitude(KM)	191.39	191.44	-0.05
Range(KM)	2448.94	2404.08	44.86
Cross Range(KM)	52.44	51.03	1.41
Cross Range Velocity(M/SEC)	259.5	255.2	4.3
Space-Fixed Velocity(M/SEC)	7791.21	7791.00	0.21

MACH one was reached at 61.5 seconds at an altitude of 7.4 KM. This occurred approximately 0.1 seconds early at an altitude of 0.1KM lower than nominal. Maximum dynamic pressure (3.440 N/CM_2) was reached in 78.0 seconds at an altitude of 13.1 KM, which is approximately 0.4 seconds earlier and 0.1 KM lower than nominal. S-IVB second burn cutoff was given by the

guidance system based on vehicle energy (a function of velocity and radius). Preliminary telemetered guidance data indicated a space-fixed velocity of 9390.4 M/SEC compared with a predicted value of 9399.9 M/SEC. Radius at cutoff was 6,904,070 meters.

5. Guidance and Control

Based on available inertial platform instrumentation, the ST-124M inertial platform performed as predicted with no anomalies. Vehicle control was satisfactory for the entire flight.

The maximum observed noise on the unfiltered roll and pitch body rate gyros at liftoff were 8 DEG/SEC and 4 DEG/SEC peak-to-peak, respectively. During transonic flight, noise amplitudes were 8 DEG/SEC in roll and 4 DEG/SEC in pitch. The maximum noise on yaw rate gyro was 1 DEG/SEC peak-to-peak. The electrical filter network was effective in reducing gyro signal noise such that the input to the Emergency Detection System was satisfactory.

6. Propulsion

The S-IC and S-II quick-look data indicated that the engine performance, stage propellant utilization systems, pressurization systems, and pneumatic control pressure systems operated satisfactorily and were within expected tolerances on both stages. Also there were no apparent anomalies in the propulsion system performances.

The S-IVB Stage operated satisfactorily and within limits except that the LH_2 ullage pressure and the pneumatic control system pressure were below the predicted during second burn operation. The LH_2 ullage pressure decreased to a minimum of 19.0 N/CM^2 (28 PSIA) prior to engine restart. After engine start the ullage pressure increased to approximately 21 N/CM^2 (31 PSIA) and stabilized there for the duration of the burn. The lower than expected LH_2 ullage pressure had no adverse effects on engine operation.

After propulsive vent cutoff approximately 326 seconds prior to S-IVB restart, the measured pressure in the vent lines showed an extremely slow decay rather than the rapid decrease expected when the vent valve was closed. Possible causes of this slow decay include the propulsive vent valve not seating properly, or the transducer line being partially blocked causing a slow decay in the pressure transducer line.

The S-IVB pneumatic control system operated properly during both burns. However, the stage pneumatic pressure was low during second burn with a sphere pressure of approximately 1034.2 N/CM^2 (1500 PSIA). Sufficient pneumatics were available to perform all S-IVB programmed functions.

Further investigation of the above problems is continuing.

7. Ground Engineering Cameras

Camera malfunctions were responsible for an estimated 75 percent of lost filmed data. The cameras and problems encountered are as follows:

a. The KSC perimeter tracking cameras dumped backwards when power was applied at T-30 seconds and could not be returned.

b. Eight cameras used for optical verification of stage structured integrity and tower clearance malfunctioned. All tower clearance optical data was lost.

c. The IGOR tracking camera at Patrick gave an extremely erratic track. Additionally, timing was erratic. This caused loss of S-IC stage track and tumble rate data after separation.

d. One second prior to launch the entire camera system on the launch table LUT and perimeter sites lost control power and time for a period of approximately one second, causing several jams in the rotary prism type cameras. This makes it impossible to project a time curve, resulting in loss of all GSE timed events, particularly optically determined vehicle first motion.

e. Alots camera broke film before staging occurred.

J. P. Lindberg

ADDRESSEES: (CONT)

R-QUAL

Mr. Chandler, R-QUAL-R
Mr. Wittmann, R-QUAL-T

R-SSL

Dr. Stuhlinger, R-SSL-DIR
Mr. Heller, R-SSL-DIR

R-TEST

Mr. Heimburg, R-TEST-DIR
Mr. Tessmann, R-TEST-DIR
Dr. Sieber, R-TEST-I
Mr. Driscoll, R-TEST-S
Mr. Reilmann, R-TEST-SB

MS

MS-I
MS-IP (4)
MS-IPL (15)

CC-P

Mr. Wofford, PAT

KSC

Dr. Debus, AA-DIR
Mr. Poppel, MD
Mr. Sparks, NAA-ZK-64
Mr. Darby, MJ-4
Mr. Sendler, PA
Dr. Bruns, PB
Mr. Jelen, PB-1
Mr. Collins, PF
Col. Bagnulo, MA
Lt. Col. Petrone, LO (3)
Mr. Mathews, DG
Mr. Body, DD
Dr. Knothe, CA

KSC

Dr. Gruene, LVO
Mr. Rigell, LVO-2
Mr. G. Williams, MJ
Mr. Pickett, LVO-3
Mr. O'Hara, LVO-7

MSC

Mr. Mardell, MSC/ASPO PK
Mr. McKann, MSC/ASPO PK

DAC

Mr. Schar (10)

IBM

Mr. Weaver (5)

Rocketdyne

Mr. Johnson (2)

TBC/Michoud

Mr. Kornell (10)

TBC/Huntsville

Mr. Krausse (10)

NAR/SD

Mr. Garcia (10)

ADDRESSEES: AS-501 Evaluation Bulletin No. 1, November 14, 1967 FROM: R-AERO-F

Dr. von Braun, DIR
Mr. Sheperd, DIR
Dr. Rees, DEP-T
Mr. Gorman, DEP-A

E-S

Mr. Maus, E-DIR
Mr. Rhodes, E-D
Mr. Smith, E-S

I

Gen. O'Connor, I-DIR
Dr. Hueter, I-DIR
Dr. Mrazek, I-DIR
Mr. Wear, I-E-J
Mr. Wheeler, I-E-F
Mr. Wood, I-SC-C (3)
Dr. Rudolph, I-V-MGR
Mr. Peters, I-V-S-IVB
Mr. Galey, I-V-IU
Dr. Speer, I-MO-MGR (4)
Dr. Constan, I-MICH-MGR
Mr. Reimer, I-MICH-QP
Mr. Balch, I-MT-MGR
Mr. Auter, I-MT-H
Mr. Schmidt, I-K-Q
Mr. Simmons, I-I/IB-U
Col. Teir, I-I/VB MGR
Mr. Haley, I-V-SIC
Mr. Odom, I-V-SII
Mr. Higgins, I-V-SIVB
Mr. Sanders, I-V-G
Mr. Ginn, I-V-E
Mr. Cushman, I-V-T
Mr. Robertson, I-V-T
Mr. Belew, I-S/AA-MGR
Mr. Bell, I-V-E
Mr. Burns, I-V-T
Mr. Urlaub, I-V-SIC
Mr. Godfrey, I-V-SII
Mr. McCulloch, I-V-SIVB
Mr. Duerr, I-V-IU
Mr. Rowan, I-V-F
Mr. Smith, I-V-G
Mr. Sneed, I-V-P
Mr. Moody, I-V-Q
Lt. Col. Murphy, I-K-V

R&D

Mr. Weidner, R-DIR
Mr. Cook, R-DIR
Mr. Williams, R-AS-DIR (2)
Mr. Hamilton, MSC/RL (11)

R&D

Mr. Richard, R-TO-DIR
Dr. Johnson, R-EO-DIR
Mr. Vreuls, R-TO-DIR
Mr. Fellows, R-OM-DIR

R-AERO

Dr. Geissler, R-AERO-DIR
Mr. Jean, R-AERO-DIR
Mr. Dahm, R-AERO-A (2)
Mr. Holderer, R-AERO-A
Mr. Horn, R-AERO-D
Mr. Deaton, R-AERO-DA
Mr. Ryan, R-AERO-DD
Mr. Baker, R-AERO-G
Mr. McNair, R-AERO-P (3)
Mr. Teague, R-AERO-P
Mr. Reed, R-AERO-AU
Mr. Cummings, R-AERO-T
Mr. Vaughan, R-AERO-Y (3)
Mr. Lindberg, R-AERO-F (25)

R-ASTR

Dr. Haeussermann, R-ASTR-DIR
Mr. Hoberg, R-ASTR-DIR
Mr. Digesu, R-ASTR-A
Mr. Fichtner, R-ASTR-E
Mr. Stroud, R-ASTR-EA
Mr. Vann, R-ASTR-EAA
Mr. Robinson, R-ASTR-ESA
Mr. Hosenthien, R-ASTR-F
Mr. Blackstone, R-ASTR-F
Mr. Justice, R-ASTR-F
Mr. Mandel, R-ASTR-G
Mr. Ferrell, R-ASTR-GSA
Mr. Powell, R-ASTR-I
Mr. Avery, R-ASTR-IMD
Mr. Ely, R-ASTR-IRD
Mr. Threlkeld, R-ASTR-ITP
Mr. Boehm, R-ASTR-M
Mr. Moore, R-ASTR-N
Mr. Krume, R-ASTR-NFE
Mr. Lominick, R-ASTR-NFS
Mr. Nicaise, R-ASTR-NGI
Mr. Taylor, R-ASTR-R
Mr. Wolfe, R-ASTR-S
Mr. Mack, R-ASTR-S
Mr. Mink, R-ASTR-FO
Mr. Hammers, R-ASTR-S
Mr. Erickson, R-ASTR-ESA

R-COMP

Dr. Hoelzer, R-COMP-DIR

R-COMP

Mr. Fortenberry, R-COMP-A
Mr. Prince, R-COMP-R
Mr. Conchran, R-COMP-RR

R-ME

Mr. Kuers, R-ME-DIR
Mr. Crumpton, R-ME-A (4)

R-P&VE

Dr. Lucas, R-P&VE-DIR
Mr. Hellebrand, R-P&VE-DIR
Mr. Palaoro, R-P&VE-DIR
Mr. Goerner, R-P&VE-A
Mr. Stein, R-P&VE-A
Mr. Kingsbury, R-P&VE-M
Mr. Brooksbank, R-P&VE-X
Mr. McCool, R-P&VE-X
Mr. Paul, R-P&VE-P (2)
Mr. Thompson, R-P&VE-PA
Mr. Fuhrmann, R-P&VE-PM
Mr. McKay, R-P&VE-PP (2)
Mr. Cobb, R-P&VE-PPE
Mr. Black, R-P&VE-PPE
Mr. Nelson, R-P&VE-PPE
Mr. Wood, R-P&VE-PT
Mr. McAnelly, R-P&VE-PTD
Mr. Platt, R-P&VE-PTF
Mr. Kroll, R-P&VE-S
Mr. Hunt, R-P&VE-S
Mr. Blumrich, R-P&VE-SA
Mr. Garrett, R-P&VE-SE
Mr. Katz, R-P&VE-SER
Mr. Showers, R-P&VE-SL
Mr. Frederick, R-P&VE-SS
Mr. Farrow, R-P&VE-SV (4)
Mr. Green, R-P&VE-SVM
Mr. Aberg, R-P&VE-V
Mr. Glover, R-P&VE-VA
Mr. Marmann, R-P&VE-VAW
Mr. Devenish, R-P&VE-VNW (2)
Mr. Sells, R-P&VE-VOO
Mr. Schulze, R-P&VE-VS (2)
Mr. Rothe, R-P&VE-XF
Mr. Griner, R-P&VE-XJ
Mr. Boone, R-P&VE-XK

R-QUAL

Mr. Grau, R-QUAL-DIR
Mr. Henritze, R-QUAL-A
Mr. Klauss, R-QUAL-J
Mr. Brooks, R-QUAL-P
Mr. Corder, R-QUAL-DIE