SP-207

August 1, 1965

JOHN F. KENNEDY SPACE CENTER

APOLLO SPACECRAFT BP-15

A Chronology of Technical Progress at

KENNEDY SPACE CENTER

Prepared by

Planning and Technical Support

Spacecraft Operations

JOHN F. KENNEDY SPACE CENTER, NASA

A P O L L O

S P A C E C R A F T

B P - 1 5

A Chronology of Technical Progress at

K E N N E D Y S P A C E C E N T E R

Prepared by

Program Planning and Control Office

Spacecraft Operations

August 1, 1965

CONTENTS

ILLUSTRATIONS

GLOSSARY OF ABBREVIATIONS

AMR	Atlantic Missile Range; now, Eastern Test Range
ASPO	Apollo Spacecraft Program Office
BP	Boilerplate spacecraft
C/M	Command module
DR	Discrepancy Record; an Apollo procedure form
EBW	Electrical bridge wire
ECS	Environmental control system
EMI	Electro-magnetic interference
EO	Engineering order
EPS	Electrical power system
EST	Eastern Standard Time
ETR	Eastern Test Range; formerly Atlantic Missile Range
FRR	Flight Readiness Review
GSE	Ground support equipment
IU	Instrument Unit (portion of the S-IV Stage mating with the service module adapter)
KSC	Kennedy Space Center
LCD	Launch Countdown Demonstration
L/V	Launch vehicle
LC	Launch complex (i.e., LC-37B)
L-1	Launch Day minus One Day
LES	Launch escape system (or subsystem)
LET	Launch escape tower
LE	Launch escape (motor)
MSC	Manned Spacecraft Center (at Houston)
MSC-FO	Manned Spacecraft Center - Florida Operations
MSFC	Marshall Space Flight Center (Huntsville, Ala.)
MIT	Massachusetts Institute of Technology (prime contractor for Apollo Guidance and Navigation)
MILA	Merritt Island Launch Area, Merritt Island, Florida
NAA	North American Aviation, prime contractor for Apollo spacecraft

NAA-Downey	North American Aviation, Inc. at Downey, Calif.
OAT	Overall Test
OSA	Ordnance Storage Area (at MILA)
OTP	Operational Test Procedure
PC	Pitch control (motors in the launch escape system)
PIA	Pre-installation Acceptance
POD	Pre-flight Operations Division
QUAD	Quadrant of four thruster nozzles in the reaction control system of the S/M
Q-BALL	An instrument package in the nose cone of the LET to measure the angle of attack of the Saturn vehicle during the first two minutes of flight, in order to compute the trajectory.
RASPO	Resident Apollo Spacecraft Program Office
RCS	Reaction control system
RF	Radio frequency
RFI	Radio Frequency Interference (an Apollo test)
S-I	First stage of the SA-7 vehicle
S-IV	Second stage of the SA-7 vehicle
SA-7	Seventh in the series of Saturn I, Block II launch vehicles
S/C	Spacecraft, including the LES, C/M, S/M, S/Mi and S/Ma
S/M	Service module
S/Ma	Service module adapter (between S-IV and S/M)
S/Mi	Service module insert (between S/M and S/Ma)
TM	Telemetry
TMS	Telemetry signal
TWX	Teletype message
VSWR	Voltage standing wave ratio

SUMMARY

BP-15 was the second of two boilerplate spacecraft used to demonstrate the compatibility of the Apollo spacecraft configuration with the Saturn I Block II launch vehicle in a launch and exit environment; and using trajectories similar to those anticipated for future Apollo-Saturn V orbital flights with production spacecraft. The first in this series, BP-13, was successfully launched with the SA-6 vehicle on May 29, 1964 (see SP-188).

Objectives for BP-15 in Apollo Mission A-102 were as follows:

(1) To further demonstrate compatibility of the Apollo spacecraft configuration with the Saturn I Block II configuration.

(2) To determine launch and exit environmental parameters to verify design criteria, to verify RCS thruster design, an instrumented dummy "squad" was used to stimulate the reaction control system thrusters to be used on later airframe spacecraft. To determine temperatures, moments, dynamic pressures and other in-flight parameters, various sensing devices were installed in the spacecraft. Both BP-13 and BP-15 had a "Q Ball" in the nose cone of the launch escape system to relay data to the ground stations on the vehicle's angle of attack in the early part of the ascent.

(3) To demonstrate the alternate mode of launch escape subsystem (LES) jettison. This consisted of utilizing the launch escape (LE) motor and pitch-control (PC) motor instead of the tower jettison motor as in the BP-13 flight. This method proved successful by safely removing the LES out of the way of the spacecraft.

All spacecraft objectives were successfully met on Apollo Mission A-102. All strain gauge, pressure, and accelerometer measurements indicated satisfactory performance in the launch environment. BP-15, like BP-13, was not separated from the S-IV stage. No plans or provisions had been made for recovery of the spacecraft, which re-entered over the Indian Ocean on its 59th orbit.

From the time of arrival of the spacecraft modules and the LES at Cape Kennedy on June 8, 1964 until launch of SA-7 on

September 18, 1964, no delays were caused as a result of spacecraft malfunctions or anomalies.

Hurricanes Cleo and Dora resulted in evacuation of personnel from the Eastern Test Range (ETR) for a total of three days, but caused no impact on the schedule and did not result in damage to the ETR, its hardware or installations.

BP-15 preflight operations constituted the first use of the new spacecraft checkout facilities at Merritt Island Launch Area (MILA).

A major difference in the BP-15 prelaunch operations from those of BP-13 was the Launch Countdown Demonstration test (see page 29). This was programmed into the schedule to increase the proficiency of the launch personnel and to insure an on-time launch.

INTRODUCTION

This document presents a chronology of technical progress of Boilerplate Spacecraft BP-15 for Apollo mission A-102, from its arrival at John F. Kennedy Space Center, Florida, Until SA-7 launch and the one-hour flight report.

Information was obtained from the following official NASA sources:

(1) Daily status reports released by the Apollo ETR Field Test Office, Resident Apollo Spacecraft Program Office (RASPO), Manned Spacecraft Center - Florida Operations (MSC-FO).

(2) "Flight Readiness Review (FRR) of Boilerplate 15", a published report of the BP-15 Flight Readiness Review meeting of NASA and NAA responsible engineers, dated September 10, 1964

(3) Daily status notes of the Project Engineer, Apollo Spacecraft Program Office, (ASPO) covering the period of L-1 day activities.

(4) Corrected test flow charts covering the period of BP-15 activity at ETR.

(5) The One-Hour TWX released by NASA-MSC-ASPO and NASA-MSC-FO.

(6) The Boilerplate 15 Postlaunch Report, published by RASPO ETR.

Wherever possible, activity is reported daily. While no attempt is made to describe operations in detail, the glossary of abbreviations, and the brief descriptions of major tests performed, are included for clarification.

MAJOR TESTS PERFORMED

GSE INTEGRATED TEST - to verify correct operation of the test complex prior to connecting the S/C.

POWER DISTRIBUTION TEST - to verify correct operation of the S/C power control system prior to activating other onboard systems.

ECS TEST - to verify the correct operation of the S/C cooling system.

C-BAND SYSTEM TEST - to verify correct operation of both beacons and their associated antenna systems.

T/M SYSTEM TEST - to verify correct operation of all S/C instrumentation and associated RF systems.

S/C INTEGRATED SYSTEM TEST - to verify correct operation of the complete S/C and associated test equipment as an integrated unit. This is accomplished through two simulated flight sequences; one with the S/C in flight configuration (i.e., test equipment disconnected in the correct launch sequence).

S/C-COMPLEX COMPATIBILITY - to verify compatibility between the S/C and its test complex by assuring proper operation of each onboard system with its associated GSE, and to prove readiness for an overall integrated test.

S/C INTEGRATED TEST - to verify S/C readiness to move to the LC by exercising all onboard systems in simulated flight sequences; one sequence, with all equipment connected and one sequence, in flight configuration.

MISSION SIMULATION - to verify S/C readiness for electrical mate with the L/V. This follows mechanical mate with the L/V simulator.

ELECTRICAL MATE TEST - to verify correct operation of all interfacing circuitry.

RFI TEST - to insure against RF interference between the various systems in the mated S/C and L/V.

SWING ARM OAT - overall test to insure compatibility between the S/C - L/V and the launch test complex. Includes simulated flight sequence with umbilical ejection and swing arm actuation.

MAJOR TEST PERFORMED (Continued)

S/C - L/V OAT No. 1, Plugs In - a complete test of all S/C and L/V systems with all test equipment connected, to demonstrate readiness to support the Flight Configuration OAT.

S/C - L/V OAT No. 2, Plugs Out - flight configuration simulated flight sequence including umbilical ejection and firing of live ordnance initiators. To assure S/C - L/V compatibility in a configuration closely approximating actual launch and flight.

S/C - L/V SIMULATED FLIGHT TEST - the final test to assure readiness of all S/C - L/V systems, the LC, and all supporting range functions.

CHRONOLOGY OF EVENTS

June 7, 1964 ARRIVAL OF SERVICE MODULE AND ADAPTER

The service module (S/M), adapter (S/Ma) and ancillary equipment arrived at the Cape Kennedy Skid Strip at 1304 hours EST from Long Beach Municipal Airport, California, aboard a C-133 airplane. Unloading and movement to Hangar AF was completed at 1600 hours EST.[1,3]

June 8, 1964

The fit check of the S/Ma with the launch vehicle instrument unit (IU) was performed, and the launch escape motor was undergoing preparations for grain inspection, scheduled for June 16. Receiving Inspection of the S/Ma was initiated.[1,3]

June 9, 1964

The following operations were completed: Receiving Inspection of the S/M, Connector Plug Verification of S/M and S/Ma, checkout of the launch escape subsystem substitute unit, and installation of three of the four S/M reaction control system (RCS) dummy thruster quadrants. The dummy quadrants (quads) were designed to test aerodynamic and thermal characteristics in flight. A fourth quad, with prototype steel nozzles and instrumentation transducers, was being assembled in North American Aviation (NAA) at Downey, Calif. and was to be installed near the -Z axis of the S/M.

Ground support equipment (GSE) for the launch escape subsystem was in process of being assembled. Buildup of the launch escape system (LES) motors was scheduled to be started June 16.[2,3]

June 10, 1964

The following items were completed: cleaning of the water/glycol flex lines; verification of the data distribution and recording console amplifiers; and correction of excessive voltage drop between the data distribution and recording console and the junction (J) box near the service structure swing arm. The latter was accomplished by adding copper wiring.

Modification of the S/M umbilical connection was initiated to correct a misalignment problem occurring on installation of the umbilical disconnect set. (Continued)

June 10, 1964 (Continued)

Assembly of the LES GSE was in progress.[4]

June 11, 1964

The following items were completed: Engineering Order (EO) rework on H14-016, LES weight and balance fixture, consisting of grinding off excess welding; levelling of the LES weight and balance fixture and fabrication of its supports; and checkout of the LES substitute unit.

In process were the S/M Umbilical Disconnect Fit Check, S/Ma air barrier installation, and fabrication of the two cradle support pallets for the launch escape motor for use during assembly and borescope operations.

Cable up at the launch complex (LC) was in progress for GSE Integrated Checkout scheduled to begin June 16.[5]

June 12, 1964

The following items were completed: the fit check of the A14-024 S/M umbilical disconnect set; set up of the A14-021 launch vehicle substitute unit at the pad; pad cable-up for the GSE Integrated Checkout; continuity check of the J-Box on the umbilical tower; and Receiving Inspection of two tower jettison motors.

The S/Ma air barrier installation was 75 percent complete as required. Installation was scheduled to be completed after S/C stacking in Hangar AF.

In progress were the fabrication of the two cradle supports for the launch escape motor and the Receiving Inspection of the pitch control motor.[6,3]

June 13, 1964

No work performed. (Saturday)

June 14, 1964

No work performed. (Sunday)

June 15, 1964 ARRIVAL OF COMMAND MODULE, LES TOWER

Work completed included: Receiving Inspection of the pitch control motor; addition of a name plate to the umbilical tower J-Box; and change of panel designation to the signal conditioner at the pad.

The BP-15 command module (C/M), LES tower structure, A14-011 ground cooling cart, and miscellaneous GSE arrived by C-133 aircraft at the Cape Kennedy Skid Strip at 1530 hours EST. Offloading was completed by 1810 hours EST, and the hardware moved to Hangar AF. The C/M was placed in Receiving Inspection.

Assembly of LES GSE in the Ordnance Storage Building at Merritt Island Launch Area (MILA), Florida, was 75 percent complete.[7,3]

June 16, 1964

The following operations were completed: GSE Integrated Checkout at Launch Complex (LC) 37, Cape Kennedy; Receiving Inspection of the C/M, LES tower structure and GSE; and fabrication of the two cradle support pallets for the launch escape motor.

In progress were the assembly of the LES GSE at MILA, and the plug verification on the C/M.[8,3]

June 17, 1964

These MILA checkout facility operations were completed: check of power facility receptacles at the Ordnance Storage Area; verification of cable continuity on the C14-029 LES bench maintenance equipment unit.

At Hangar AF on Cape Kennedy, the fit check of the C/M dummy umbilical fairing was completed.

At Launch Complex 37 (LC-37) on Cape Kennedy, Swing Arm Test preparation was completed.

Preparation was in progress for movement of the LES motors to the MILA Ordnance Storage Area (OSA) scheduled for June 19.

The instrumented RCS quad referred to under date of June 9 was scheduled to arrive June 20 from NAA - Downey. To provide required telemetry system channelization for two vibration transducers on the S/M RCS quad, two fluctuating pressure transducers and their amplifiers were removed from C/M.[9,3]

June 18, 1964

A damaged seal around the C/M hatch door was replaced.

The LES motors were moved into the MILA OSA.

LES GSE in the MILA OSA was 90 percent assembled.

Leveling pads for the H14-016 LES weight and balance fixture were in fabrication.[10]

June 19, 1964

The following items were completed: Voltage Standing Wave Ratio (VSWR) Check of the Very High Frequency (VHF) Omni Antenna; installation of the vibration system in the S/Ma and the acoustic system in the S/M.

The launch escape motor was moved to MILA for grain inspection on June 23.[11,3]

June 20, 1964

No work performed. (Saturday)

June 21, 1964

No work performed. (Sunday)

June 22, 1964 C/M MATED WITH S/M

The C/M was mated with the S/M in Hangar AF.

OTP-C-9036, Checkout of S14-052 Water/Glycol Cooling Unit was begun.

Modification of C14-029 LES bench maintenance equipment was 85 percent completed.

The tower sequencers were received from NAA-Downey.

Personnel from Lockheed Missiles and Space Corporation, contractor for the launch escape motor, arrived at ETR to perform grain inspection. (Continued)

June 22, 1964 (Continued)

Delivery of the instrumented RCS quad was slipped two days, to June 24.[12]

June 23, 1964 FIRST MILA CHECKOUT INITIATED

Grain inspection of the launch escape motor in the new Ordnance Storage Building was started, the first checkout of a flight item to be performed at the new MILA facility.

Modification of the LES sequencer bench maintenance equipment was completed and checkout initiated, using spare tower sequencers loaned from NAA-Downey.

OTP-C-9036, Water Glycol Cooling Unit Checkout, was completed.

Tower sequencer Pre-installation Acceptance (PIA) was initiated.

An open item review was held in preparation for S/C movement to LC-37, to ascertain that no open items existed which would constrain the mating with the launch vehicle.[13]

June 24, 1964 INSTRUMENTED RCS QUAD ARRIVAL

The following operations were accomplished: installation of the air conditioning barrier in the S/Ma; C/M-S/M stacked on the S/Ma; and the launch escape motor grain inspection.

The instrumented RCS quad arrived from NAA-Downey.

The mission sequencer for BP-15 arrived.

The environmental control system (ECS) pump for BP-15 was under modification by the vendor to avoid a pump binding problem encountered in BP-13.

A 3-phase inverter was under modification by the vendor to correct a problem of a loose capacitor. This problem had also occurred on BP-13.[14,3]

June 25, 1964

The S/C was weighed using a single load cell. No problems were encountered. (Continued)

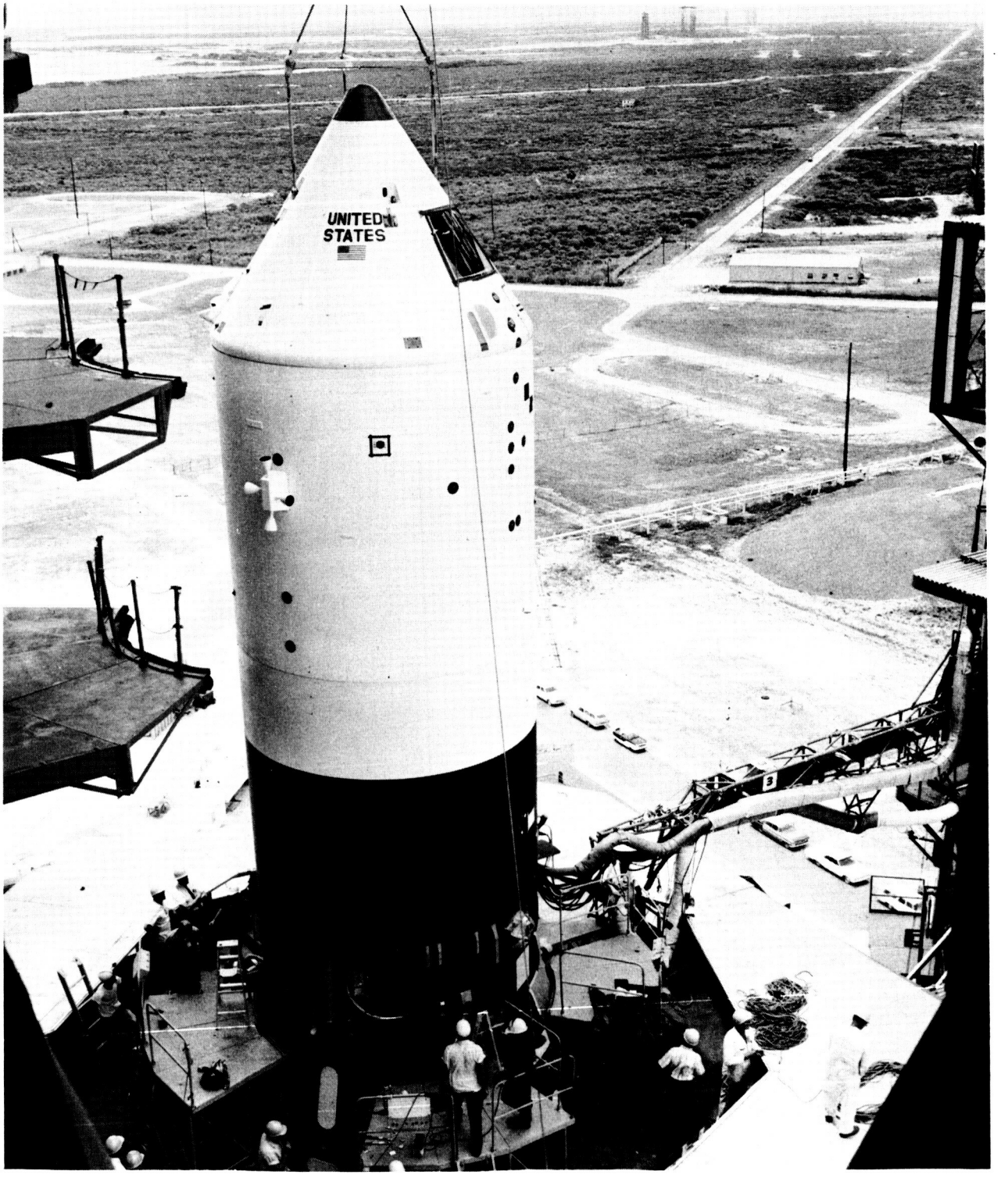

Figure 1. BP-15 being erected at launch complex 37B for hard mate with the SA-7 launch vehicle. Command module is conical shape at top, service module (S/M) and adapter insert (S/Mi) are cylindrical portion painted white. Adapter and instrument unit (IU) are painted black.

June 25, 1964 (Continued)

Preparations were completed for moving the S/C to LC-37, including placement on the transportation dolly. S/C alignment was checked.

During the pressure leak check of the launch escape motor a blowout disc (environmental barrier) in a nozzle blew out at 38 psig. Normal test pressure is 50 psig. It was decided to remove the aft closure, to clean the nozzle, and install a new disc before re-running the leak test.

Mechanical installation of the instrumented RCS quad was completed. Electrical installation was in work.[15,3]

June 26, 1964 TRANSPORTATION TO PAD - MECHANICAL MATE

The S/C was transported to LC-37 and the mechanical mate with the L/V was accomplished without difficulty.

Checkout of the LES sequencer bench maintenance equipment was completed and PIA of the flight tower sequencers was initiated.

The Antenna VSWR Test, OTP-C-8114, was completed.

PIA of the "test only" mission sequencer, using the C14-029 LES sequencer bench maintenance equipment (BME) was completed.

Bonding of the new blowout disc in the LE motor reported June 25 was completed.[16,3]

June 27, 1964

No work performed. (Saturday)

June 28, 1964

No work performed. (Sunday)

June 29, 1964

Launch date was rescheduled a week earlier. A new schedule was being drawn up to reflect the earlier launch.

Installation of the instrumented RCS quad was completed. (Continued)

June 29, 1965 (Continued)

Installation of the umbilical disconnect was 75 percent complete.[17,3]

June 30, 1964

The pressure test of the launch escape motor was successfully completed, and the LES Buildup initiated.

T/M Hardline Tests were completed.

In response to a request by the Manned Spacecraft Center (MSC) Mechanical Structures Branch, the data range of the strain measurements was changed to ± 500 micro inches per inch.[18]

July 1, 1964 FIRST POWER APPLICATION

BP-15 operations were on schedule. Cable Hookup for T/M Systems Test, OTP-C-3131, was completed, and the T/M Systems Test 60 percent completed. This constituted the first time of power application to BP-15 since its arrival at ETR.

PIA of the flight mission sequencer was completed.

PIA of the modified ECS pump was 50 percent complete. The modification was the result of high starting current surge encountered in BP-13 testing.

The airlock portion of the tent to be installed around the C/M was completed and ready for installation.[19,3]

July 2, 1964

The following items were satisfactorily completed: T/M Systems Test, OTP-C-3131; mission sequencer installation in the C/M; drain and fill of the S14-052 water/glycol cooling unit; PIA of the modified ECS pump; and installation of the tent around the C/M hatch.

Installation of the ECS pump in the C/M was 60 percent complete, and the LES Buildup was 35 percent complete. LES harness bonding was in work.

Due to an engine problem in the S-I stage, a minimum one-week slip in the SA-7 launch was announced. Three engines were scheduled for removal.[20,3]

July 3, 1964

No work performed. (Holiday)

July 4, 1964

No work performed. (Saturday)

July 5, 1964

No work performed. (Sunday)

July 6, 1964

The ECS pump installation in the C/M, and cabling-up for ECS servicing, were completed. Items in progress included the dummy umbilical and air vent installation, LES Buildup and Harness Installation; and battery charging in support of POD-C-0005, Integrated Systems Test with the Launch Vehicle Substitute Unit.

A new C/M interior temperature probe was installed to replace one found defective during the T/M Systems Test July 2.[21,3]

July 7, 1964

The following items were successfully completed: dummy umbilical and air vent installations; and ECS Fill and Bleed, POD-C-5024. The latter was performed with a modified pump, which operated without any current surges.

LES Buildup and Harness Installation and battery preparation to support Simulated Flight Test using the launch vehicle simulator, were in progress.

Gain adjustment of the strain gage amplifiers was completed.[22,3]

July 8, 1964

It was decided to remove the remaining five S-1 stage engines and return them to Marshall Space Flight Center (MSFC) for corrective action and static firing. Three had been previously removed on July 2.

Open Item Review and Pre-briefing for Test POD-C-0005, (Continued)

July 8, 1964 (Continued)

Integrated Systems Checkout with the Booster Simulator, was completed, along with related battery preparation and cableup.

PIA of the adjusted strain gage amplifiers was performed, and installation in the C/M completed.[23]

July 9, 1964 SIMULATED MISSION CONDUCTED

Simulated Mission with the Launch Vehicle Simulator POD-C-0005, was successfully completed. As a result of this test, the 5-ampere fuses in the NASA power control box were permanently replaced with 10-ampere fuses by NASA Engineering Order (EO). Prematurely blown fuses were also encountered at this same stage in BP-13 testing.

The H14-016 weight and balance fixture was readied for LES Weight and Balance.[24,3]

July 10, 1964

LES Buildup and Harness Installation was 65 percent complete. 48 hours of curing were required between bonding coats.

The environmental tent to be placed around the C/M was completed.

Two strain gage amplifiers in the S/C were found to be unbalanced following the Simulated Mission performed July 9. Balancing was scheduled.[25]

July 11, 1964

No work performed. (Saturday)

July 12, 1964

No work performed. (Sunday)

July 13, 1964

The schedule slippage due to the S-I motor troubleshooting was set at approximately two weeks. The S/C-L/V Electrical Interface Test was rescheduled to begin on August 7 and the S/C-L/V Simulated Flight on September 9. (Continued)

July 13, 1964 (Continued)

The environmental tent was installed over the C/M.

LES Buildup and Harness Installation was 70 percent complete.

Twenty-four igniter cartridges arrived, but were rejected because their spring-type shorting devices were not acceptable to NASA. The cartridges were returned to the contractor for corrective action.[26]

July 14, 1964 LES WIRE BONDING COMPLETED

At Hangar AF, the H14-016 LES weight and balance fixture preparation was completed. This included recalibration of the index pointer and leveling pad rework items. Preparation of the ground cooling cart also completed.

In the Ordnance Storage Building at MILA, curing of the bonding material on the harnesses and the placing of polyurethane foam in the LES tower legs was completed, in readiness for mating to the launch escape motor.[27,3]

July 15, 1964

The LES tower was mated to the launch escape motor, and was ready for painting.

Balancing of the strain gauge amplifiers was initiated. A fuse was blown in the signal conditioner box and one amplifier was seen to have a defective calibration circuit. Investigation was being continued.[28]

July 16, 1964

The signal conditioner box was sent to the Malfunction Analysis Laboratory for investigation.[29]

July 17, 1964

The LES pitch control motor was successfully installed and painting started.

Checkout of recorders to be used in pad testing was completed. (Continued)

July 17, 1964 (Continued)

Troubleshooting continued on problems encountered in balancing of the strain gage amplifiers.[30,3]

July 18, 1964

No work performed. (Saturday)

July 19, 1964

No work performed. (Sunday)

July 20, 1964

The LES nose cone was installed, and painting continued.

Investigation of the strain gage amplifier balancing problem continued.[31]

July 21, 1964

LES painting was completed. Weight and Balance was scheduled for July 23 and 24.

Both BP-15 operations and L/V operations were on schedule.[32]

July 22, 1964

Troubleshooting continued on strain gage amplifier problems.

Setup for Weight and Balance was completed.

The LES Buildup was completed.

A joint communications check of all headsets in LC-37 blockbouse, service tower, and Hangars AF and S revealed crosstalk traceable to the plug-in boxes.

Removable equipment was installed in the C/M and on the service tower for MIT to check S/C and tower sway and vibration.[33,3]

July 24, - 26, 1964 LES WEIGHT AND BALANCE STARTED

LES Weight and Balance was initiated.

Strain gage amplifier trouble was isolated to a defective rack. PIA of the spare rack was completed preparatory to installation in the S/M.

The three-phase inverter was checked out in the C/M and performance was satisfactory.

Pressure transducer was installed. The water/glycol lines from the S14-052 water/glycol cooling unit to the C/M were filled and the fluid circulated through the ECS plumbing. Operations were satisfactory.[34,3]

July 27, 1964 LES WEIGHT AND BALANCE COMPLETED

LES Weight and Balance was successfully completed, and preparations were made for removal of the LES to a storage area.

The replacement strain gage amplifier rack was brought to LC-37 for installation in the S/M. The defective rack was sent to Hangar S for further checkout in the instrumentation laboratory.[35]

July 30, 1964

The two strain gage amplifiers were installed in the S/M and were balanced. No problems were encountered.

The spare tower and mission sequencers were still at NAA-Downey awaiting resolution of a motor switch problem.[36]

July 31, 1964

Relocation of the C/M temperature sensor to the inlet side of the heat exchanger was initiated.

The LES doors were sealed.

Leak testing of the umbilical tower water/glycol line was completed.[37,3]

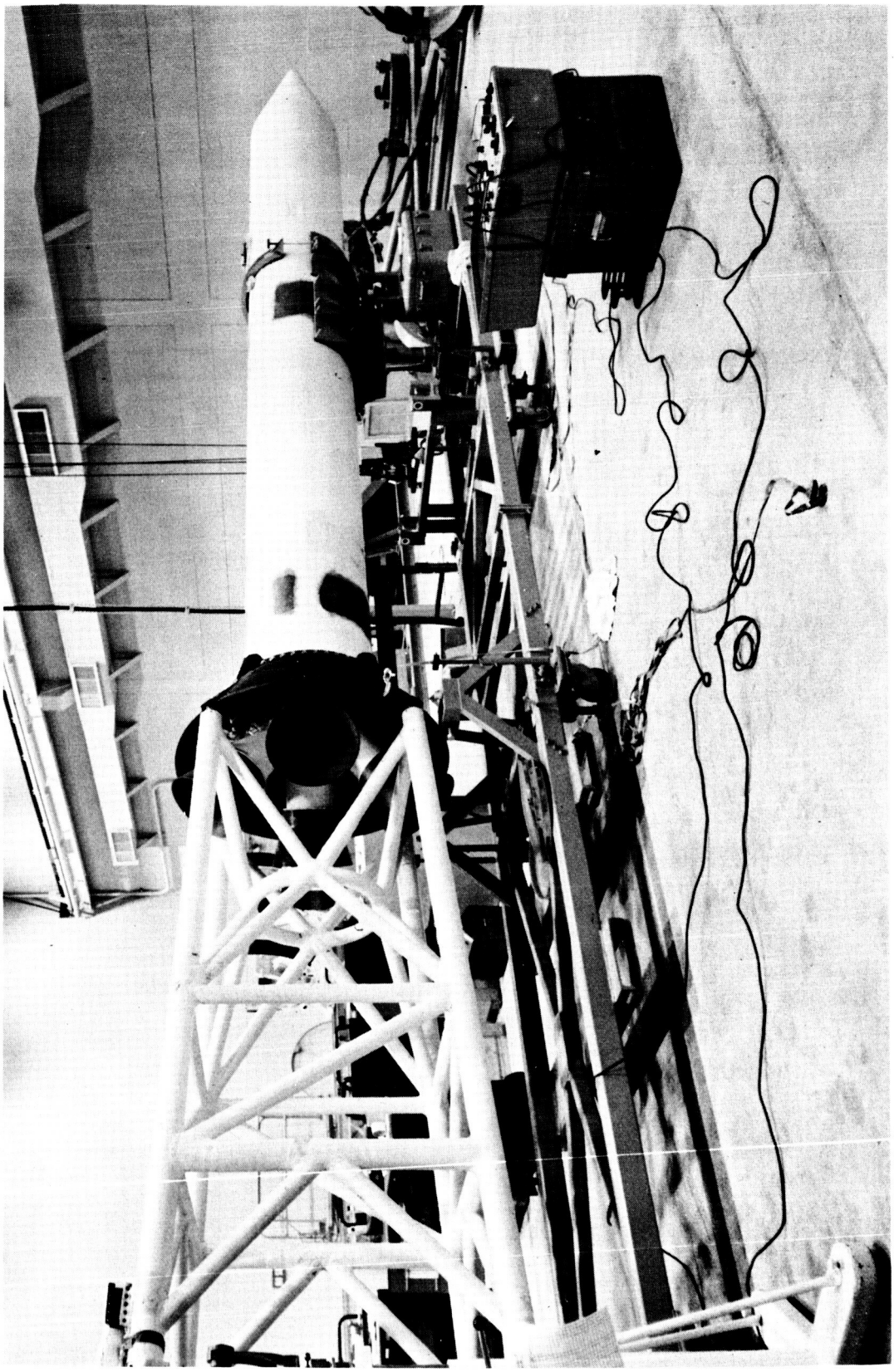

Figure 2. Launch Escape System (LES) for BP-15 in weight and balance fixture in the Pyrotechnic Installation Building at Merritt Island Launch Area (MILA), Florida on July 24, 1964. The LES was the first flight item to be checked out at MILA.

August 1, 1964

No work performed. (Saturday)

August 2, 1964

No work performed. (Sunday)

August 3, 1964

All BP-15 and launch vehicle operations were on schedule.

Work was in progress for securing the RCS accelerometer, using Q_3 cables in the RCS nozzle.

Meters for the C14-414 launch control group were being calibrated.[38]

August 4, 1964 RCS ACCELEROMETER INSTALLED

The RCS accelerometer was installed and cable was successfully sealed to the RCS nozzle with sealing compound.[39]

August 5, 1964

The C/M interior air temperature probe was relocated from the outlet to the inlet side of the heat exchanger in order to obtain better temperature data during flight.

The 12 igniter cartridges previously rejected because of incorrect shorting devices were received and PIA begun.

Cable-up for S/C-L/V Electrical Interface Test scheduled for August 7 was completed with exception of the umbilical disconnect rigging. Batteries were also undergoing preparation for the test.

As a result of a mis-wired amplifier rack recently discovered, all eight racks in the S/C and the spares were being checked for this condition.[40,3]

August 6, 1964

An open-item review and pre-test briefing disclosed that there were no constraints to running the S/C-L/V Electrical Interface Test. Objective of the test was to demonstrate and (Continued)

August 6, 1964

verify compatibility of the S/C-L/V interface and the MSC-MSFC GSE interface.

PIA of the 12 igniter cartridges received from WSWR was successfully completed.

The mission sequencer test unit arrived. This was the same unit used on BP-13.

Cable from the low-level commutator to the TMS 1090 box was wrapped with metallic mesh to attenuate radio frequency interference (RFI).[41]

August 7, 1964 ELECTRICAL INTERFACE CHECK COMPLETED

The S/C-L/V Electrical Interface Check was successfully completed at 1222 hours EST. Interface connections were first made with power off, then power was applied to the S/C and L/V at the interface for circuit protection. A L/V Electrical Bridge Wire (EBW) Functional Test was performed as a part of the Electrical Interface Check.

Ring-out and Functional Check of all instrumentation amplifier racks was completed satisfactorily.

The Q-Ball Fit Check was also completed.[42,3]

August 8, 1964

No work performed. (Saturday)

August 9, 1964

No work performed. (Sunday)

August 10, 1964

PIA of the backup "test only" mission sequencer was successfully completed.

Cable-up for the L/V Sequencer Malfunction S/C Monitor Test was completed, and preparation of batteries was 75 percent completed.[43]

August 11, 1964

A pre-test briefing and open item review for the L/V Sequencer Malfunction - S/C Monitor Test revealed that there were no constraints to conducting the test. Objective of the test was to demonstrate and verify compatibility of the L/V-S/C interface during a L/V Sequencer Malfunction Test. S/C participation would consist essentially of a passive monitoring of GSE panels, with the S/C powered and the LES armed to ensure that no abnormal indications are received. LES Substitute Unit A14-001 was to be used for the test.

It was planned to operate the ECS during the subject test in order to circulate the water/glycol as part of an activation program requiring occasional exercise of the system.[44,3]

August 12, 1964

L/V Sequencer Malfunction - S/C Monitor Test, POD-C-0031, was successfully completed at 1530 hours. No abnormal indications were received during any of the L/V Sequencer Malfunction Checks.

The ECS run was completed without problems; the modified ECS pump operated satisfactorily. The differential pressure between the tank inlet and pump outlet was 4.5 psi greater than encountered on BP-13.

Samples of the water/glycol were sent to the laboratory for analysis.[45,3]

August 13, 1964

Mating of the LES and L/V-S/C Overall Test (OAT) No. 1 were rescheduled one day earlier due to non-availability of range RF clearance. All L/V operations remained on schedule.

A decision was made to check the contact resistance of the motor switches in the BP-15 tower and mission sequencers. This would include removing the tower sequencers from the LES for checkout in the bench maintenance area on August 14; and making the check three times on each sequencer.

The mission sequencer check was scheduled for August 17.[46]

August 14, 1964

The tower sequencer motor was resistance-checked and the

(Continued)

August 14, 1964 (Continued)

tower sequencer was checked out.

The amplifiers in Recording Console C14-420 in the LC-37 blockhouse were checked out.[47]

August 15, 1964

No work performed. (Saturday)

August 16, 1964 LES MECHANICAL MATE

The mechanical mating of the LES to the C/M was performed on Sunday in order to have a cleared pad for safety, but without causing an impact in the L/V schedule.

Water/glycol samples taken during the ECS run August 12 were found by the laboratory to be clean.[48]

August 17, 1964

The contact resistance of the motor switches in the tower sequencers were found to be within limits. The tower sequencers were found to be within limits. The tower sequencers were satisfactory and scheduled for reinstallation in the LES. The mission sequencer was removed from the S/C for checkout.

Battery preparation to support the S/C-L/V OAT No. 1 was initiated.

The Q-Ball was installed on the LES and checkout of the Installation by KSC was initiated.[49]

August 18, 1964

Pre-test briefing for the S/C-L/V OAT No. 1 scheduled for August 19 was held. S/C objectives for this test were to verify and demonstrate compatibility of the S/C and L/V systems during a simulated mission; to verify that no transients exist on the pyro lines during a S/C-L/V simulated mission; and to monitor sequencer command signals at the booster interface. Also incorporated in this test were simulated hold-down release, simulated umbilical ejection, and simulated lift-off.

Cable-up was completed for OAT No. 1 and battery preparation continued.[50]

August 19, 1964 OAT No. 1 COMPLETED

The S/C-L/V OAT No. 1 (Plugs In) was completed. Analysis of pyrotechnic data was in progress. Considerable noise was experienced on the S/C telemetry (T/M) Link B. This noise was believed to be due to the L/V T/M. A problem with T/M hardline transmission was also encountered, and ascertained to be a line amplifier problem.[51,3]

August 20, 1964

Analysis of the pyrotechnic data from OAT No. 1 indicated that the launch escape motor squibs did not fire, though the squib simulators in the line were blown. Investigation revealed that two oscilloscopes in the lines were providing a ground path through facility ground to the S/C. A new test run with the oscilloscopes disconnected revealed no problems; the recorders showed that the squibs fired and the fuses blew. Thus, the problem was one of test setup.

Investigation of noise on T/M Link B during OAT No. 1 indicated the launch vehicle to be the source, however, an electrical storm interrupted testing and caused the pad to be cleared because of the live launch escape motors. Continued L/V testing was planned prior to the RFI Test in an effort to eliminate this problem.[52]

August 21, 1964

The T/M interference problem encountered during OAT No. 1 was resolved by relocating the L/V F Link antenna which had been mounted on the service structure.

Pre-test briefing for the S/C-L/V RFI Test was held and no constraints to the test were found. Objective of the test was to check-out certain flight instrumentation of the space vehicle to insure proper operation and no interference between RF and associated systems; and to further verify compatibility with the range and NASA ground instrumentation. On-station time for the test was scheduled for 0400 EST August 24, and operations included checkout of all RF systems with the service structure around the vehicle as well as in its launch location.

SA-7 testing was revamped to incorporate a countdown demonstration test in order to perform a complete launch simulation. L minus 1 day for the countdown demonstration was set for September 11. (Continued)

August 21, 1964 (Continued)

This week, a total of 12 hours working time was lost due to electrical storms prevalent at this time of year. Range safety requires that when the LES is mated and all live motors installed, the pad area must be cleared of personnel whenever there is lightning within a five-mile radius of the pad.[53]

August 22, and 23, 1964

No work performed. (Saturday and Sunday)

August 24, 1964 S/C-L/V RFI TEST COMPLETED

The S/C-L/V RFI Test was completed at 1230 hours EST. It was run both with and without the service structure around the vehicle. No fuses were blown and no RFI problems were encountered. Booster interference previously encountered during OAT No. 1 was eliminated through removal of the external antenna on the service structure. All S/C channels were free of interference with the L/V T/M systems operating.[54,3]

August 25, 1964

A broken wire in one of the tower legs found during the RFI Test was repaired and satisfactorily continuity tested.

The tower sequencers completed PIA and were installed on BP-15.

Battery charging and cable-up for the space vehicle systems plug drop test (OAT No. 2) was in progress. The primary objective of this test was to verify compatibility and proper operation of all space vehicle and GSE systems during a normal automatic firing and flight sequence with actual hold down release and live ordnance items in explosive test chamber. The test, scheduled for August 28, was postponed due to inclement weather forecasted for the date.[55]

August 26, and 27, 1964 HURRICANE CLEO

Due to Hurricane Cleo there was no activity at ETR. The base was cleared of all but essential personnel.[56]

August 29, 1964 OAT NO. 2 COMPLETED

Work was resumed following Hurricane Cleo; however, launch date was advanced two days in order to provide added analysis time between the countdown demonstration test and actual launch. No hurricane damage was sustained by the S/C or the L/V.

The S/C-L/V OAT No. 2 was successfully completed. All pyrotechnics fired cleanly. Two plugs were found to be reversed on the calorimeter in the C/M hatch, and this was corrected following the test. A further anomaly was shown in the ECS system when fuses F3 and F7 in the fan circuit blew out, drawing excessive current. Troubleshooting revealed that the oscillator in an inverter was failing to start, causing the high current surge. The inverter was returned to NAA-Downey and a spare installed in the S/C.

Spare tower and mission sequencers arrived and PIA was performed. A spare inverter was also received from NAA-Downey.

Battery preparation to support the S/C-L/V Simulated Flight Test was in progress.[57]

August 30, 1964

No work performed. (Sunday)

September 1, 1964

Both S/C and L/V operations were on schedule. The launch date remained unchanged.

Battery preparation in support of the Simulated Flight Test scheduled for September 3 was in progress.[58]

September 2, 1964

Pre-test briefing and open item review for the S/C-L/V Simulated Flight Test was held, and no constraints to holding the test on September 3 were revealed. The objectives of the test were to demonstrate and verify compatibility of the S/C and L/V systems during a simulated mission; and to verify the LES capability of providing adequate electrical power to reliably fire the tower separation and motor igniter initiators. This was to be demonstrated by blowing 0.75 ampere fuses at each squib location in less than 30 milliseconds after receipt of jettison signal. (Continued)

September 2, 1964 (Continued)

The mission sequencer, which had BP-13 type motor switches, was installed in the S/C following PIA. The unit was checked out satisfactorily after installation.

Eight pyro and logic batteries, and six main batteries were received to support further BP-14 testing.

The shroud installation on the LES tower legs was completed.[59]

September 3, 1964 SIMULATED FLIGHT TEST COMPLETED

The S/C-L/V Simulated Flight Test was successfully completed at 1300 hours EST with all fuses blown. During the fuse check, the explosive bolt body in the -Z+Y leg of the LES tower was found to be broken. Since all explosive bolts in the LES were from the same lot (Lot No. 5), it was decided to replace all explosive tower bolts, including the four spares at ETR. The LES was demated from the C/M and moved to the Ordnance Storage Area at MILA. The broken explosive bolt was sent to the Malfunction Analysis Laboratory.[60]

September 4 (0800 hours EST) through September 5, (2400 hours)1964

The replacement set of explosive bolts arrived from NAA-Downey and were installed in the LES tower. The LES was then mated with the C/M. Analysis of the broken bolt was initiated, with indications of a tensile or tension-and-bending failure and a crystalline area.

A re-verification test was scheduled for the LES on September 8, requiring a jettison signal from the L/V.

It was decided to structurally reinforce the instrumented RCS quad against possible buckling during the "high Q" (high aerodynamic pressure) portion of the ascent.[61]

September 5, 1964

No work performed. (Saturday)

September 6, 1964

No work performed. (Sunday)

September 7, 1964

No work performed. (Labor Day)

September 8, 1964 EVACUATION FOR HURRICANE DORA

Revalidation of all electrical connections between the C/M and the LES subsystem was successfully completed.

Due to the approach of Hurricane Dora, the ETR was cleared of all personnel by 1400 hours EST. (Except for "ride-out" crew)

September 9, 1964 HURRICANE DORA NEAR AREA

Due to the continuing threat of Hurricane Dora, the ETR remained evacuated.[62]

September 10, (0800 hours EST) to September 13, (2400 hours), 1964

Hurricane Dora, which had appeared certain to pass through the ETR area, turned north along the Atlantic coast without causing damage to Cape or MILA installations.

All operations remained on schedule.

During a qualification firing of tower jettison motors by Thiokol Chemical Corporation at Elkton, Md., a structural failure occurred in the interstage between the tower jettison motor and LE motor. The failure was due to faulty spotwelding. To provide adequate strength, $\frac{1}{4}$-inch bolts were added every two inches around the circumference and between the spot welds on the upper and lower rings of the interstage. Work was completed on Sunday, September 13.[63]

September 14, 1964 LAUNCH COUNTDOWN DEMONSTRATION FOR L-1 DAY

During ordnance installation it was discovered that the pyrotechnic devices in the bunker had become wet during Hurricane Dora. This was remedied by using pyros in storage for BP-16 (the Pegasus A micrometeroid boilerplate S/C to be flown with the SA-9 mission).

The S/C portion of the LCD proceeded successfully with no problems.[64]

September 15, 1964 L-1 DAY LAUNCH COUNTDOWN DEMONSTRATION

The L-1 LCD began at 2350 hours EST (September 14) and was completed at 1645 EST. The countdown progressed normally until T-90 minutes when a hold was called due to L/V (Continued)

September 15, 1964 (Continued)

difficulty during LOX tanking of the S-I stage.

During testing the 50 percent reference voltage read 5 to 7 millivolts high, but the 0 and 100 percent reference voltages were on parameter. The problem appeared to be in the reference voltage card in the TMS 1090 box, and the 50 percent reference would have no effect on data reduction nor would it affect the 0 and 100 percent levels. The Instrumentation and Electronic Systems Divison, MSC-Houston, with the concurrence of MSC-Florida Operations, recommended making no changes to the TMS 1090 box.

No S/C problems were encountered. L/V holds totaled $7\frac{1}{2}$ hours.[65,66]

September 16, 1964

No S/C checkout operations were performed because booster tanking was in progress.

During this period briefings were conducted for engineers contributing to BP-15 postlaunch reports and post-test debriefing for LCD.[65]

September 17, 1964 L-1 DAY COUNTDOWN

L-1 day countdown began at 0730 hours EST, at T-875 minutes. The S/C portion of the countdown, consisting of tower-bolt ordnance electrical connection closeout and electrical verification, began at 0940 hours EST. The usual L-1 day S/C activities had been performed on the L-1 day of the LCD September 14 and thus were not repeated at this time.

Final countdown began at 1125 hours EST, at T-545 minutes. S/C testing proceeded normally without any holds or equipment malfunctions. Two significant events occurred: one was multipath interference with C-band beacon responses, and the other, an inadvertent actuation of the service structure's 4-level Firex system at T-360 minutes causing wetting of approximately 50 percent of the S/M exterior, and the umbilicals.

September 18, 1964 LAUNCH DAY COUNTDOWN

The count was continued until T-245 minutes when a hold was called because of the wet umbilicals. (Continued)

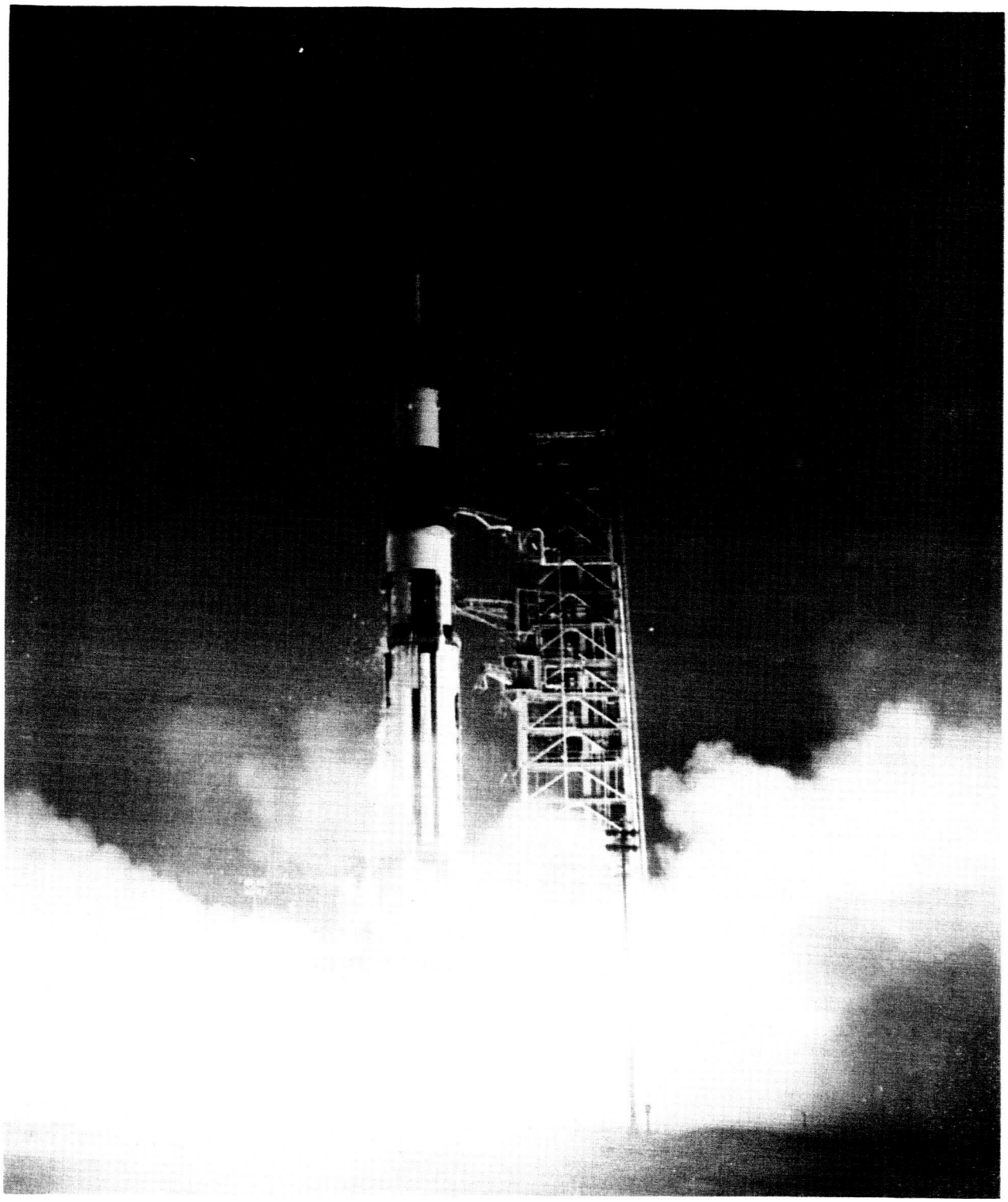

Figure 3. SA-7 at moment of liftoff from Complex 37B at Cape Kennedy. The launch escape system (LES) is visible at the extreme top, mated to the conical shaped command module of the BP-15 Boilerplate Spacecraft.

September 18, 1964 (Continued)

Water had entered one S-IV umbilical connector, producing erroneous indications of S-IV engine exciter firing. After drying operations, the count was resumed at T-176 minutes. The count continued until a scheduled 21-minute hold at T-30 minutes. This hold was extended four minutes due to a problem in the S-IV. The count progressed to T-12 minutes, when a 20-minute hold was called to resolve a problem in the hydraulic pump interlock of the S-I.

The count was resumed until a hold was called at T-5 minutes because of intermittent operation of the Grand Turk Island radar. The count was recycled to T-13 minutes because of S-IV lox bubbling and spacecraft battery lifetime constraints. The S/C was transferred to external power. During the hold, difficulty was encountered with the swing arm hydraulic test. This was corrected by a jumper in the blockhouse distributer without lengthening the range hold. After 50 minutes the radar problem was corrected and the count proceeded continuously through lift-off.

September 19, 1964 ONE HOUR REPORT

SA-7, Mission A-102, utilizing Apollo BP-15, was successfully launched from ETR, LC-37B, Cape Kennedy, Fla., at 11:22:43 hours EST. The LET was successfully jettisoned by the planned alternate method (LE and PC motors) at the approximate planned time after S-I/S-IV separation. Preliminary Cape Kennedy range data indicated satisfactory T/M and C-Band radar operation from the 3 S/C T/M links and 2, C-band beacon subsystems. Loss of signal occurred at approximately T+500 seconds when the BP-15/S-IV went over the horizon. No S/C subsystem problems were indicated during the real-time analysis of T/M data.[67,68]

SOURCES

Daily Status Reports (DSR) by Resident Apollo Spacecraft Program Office (RASPO), Eastern Test Range (ETR) are referenced here as DSR, with date of report.

[1]Daily Status Report (DSR) 6/9/64
[2]DSR 6/10/64
[3]Flight Readiness Review (FRR)
[4]DSR 6/11/64
[5]DSR 6/12/64
[6]DSR 6/15/64
[7]DSR 6/16/64
[8]DSR 6/17/64
[9]DSR 6/18/64
[10]DSR 6/19/64
[11]DSR 6/22/64
[12]DSR 6/23/64
[13]DSR 6/24/64
[14]DSR 6/25/64
[15]DSR 6/26/64
[16]DSR 6/29/64
[17]DSR 6/30/64
[18]DSR 7/1/64
[19]DSR 7/2/64
[20]DSR 7/6/64
[21]DSR 7/7/64
[22]DSR 7/8/64
[23]DSR 7/9/64
[24]DSR 7/10/64
[25]DSR 7/13/64
[26]DSR 7/14/64
[27]DSR 7/15/64
[28]DSR 7/16/64
[29]DSR 7/17/64
[30]DSR 7/20/64
[31]DSR 7/21/64
[32]DSR 7/22/64
[33]DSR 7/23/64
[34]DSR 7/27/64
[35]DSR 7/28/64
[36]DSR 7/31/64
[37]DSR 8/1/64
[38]DSR 8/4/64
[39]DSR 8/5/64

SOURCES (Continued)

[40]DSR 8/6/64
[41]DSR 8/7/64
[42]DSR 8/10/64
[43]DSR 8/11/64
[44]DSR 8/12/64
[45]DSR 8/13/64
[46]DSR 8/14/64
[47]DSR 8/15/64
[48]DSR 8/17/64
[49]DSR 8/17/64
[50]DSR 8/18/64
[51]DSR 8/20/64
[52]DSR 8/21/64
[53]DSR 8/24/64
[54]DSR 8/25/64
[55]DSR 8/26/64
[56]DSR 8/28/64
[57]DSR 9/1/64
[58]DSR 9/2/64
[59]DSR 9/3/64
[60]DSR 9/4/64
[61]DSR 9/8/64
[62]DSR 9/10/64
[63]DSR 9/14/64
[64]Apollo Spacecraft Program Office (ASPO) Project Engineer's daily status notes.
[65]ASPO Project Engineer's daily status notes
[66]Postlaunch Report for Apollo Mission A-102, published by RASPO
[67]Postlaunch Report for Apollo Mission A-102, 7.2 Launch Operations unclassified pages 7-10 and 7-11
[68]BP-15 One-Hour TWX, DTG 191730Z NASA-MSC-ASPO

A P P R O V A L

APOLLO SPACECRAFT BP-15

A Chronology of

Technical Progress

at Kennedy Space Center

APPROVALS:

George T. Sasseen
Manager, Apollo C/SM Operations

Floyd D. Brandon
Chief, Planning & Technical Support Office

DISTRIBUTION

KSC

-ASO-3 (5)
-DLO
-HU
-HW
-HY
-SCO-1
-SCO-2
-SCO-3
-SCO-4
-SCO-5
-SCO-6
-SCO-7
-SCO-8
-SCO-31
-SCO-32
-SCO-33
-SCO-42
-SCO-43
-SCO-44
-SCO-45
-SCO-61
-SCO-622
-HT

Manned Spacecraft Center,
Houston, Texas

Attn: AP6 (5)

Scientific and Technical Information Facility
P. O. Box 5700
Bathesda, Md.
Attn: S-AK/RKT
NASA Representative (2)