

Apollo BP-1101/1101A

BP-1101/1101A is a NASA-Manned Spacecraft Center (NASA-MSC¹) Landing and Recovery Division in-house designed aluminum boilerplate BP) Apollo Command Module, the crew module of the Apollo Program, Skylab Program and the Apollo Soyuz Test Project (ASTP). BP-1101A is in Apollo Block II configuration (lunar mission configuration²) but was initially delivered as BP-1101 in early 1965 in Apollo Block I configuration (earth orbit mission configuration³) following its fabrication of Aluminum Alloy 5056 at Kelly AFB Air Material Command in San Antonio. The boilerplate was built to test the flotation characteristics of the Apollo Command Module and used a combination of internal ballast and exterior dummy equipment, which approximated equipment displacement and location in the aft and forward compartments (See Photo #1). BP-1101/1101A was configured to float the same as a flight article Command Module as well as simulate its moment of inertia for static and dynamic water tests. NASA used full-scale Apollo Command Module boilerplates, which are essentially shells built to the outer mold line dimensions of the flight article Apollo Command Module, for testing and training in lieu of contractor⁴ delivered vehicles, which were limited.

BP-1101 was outfitted with test hardware and used for early NASA developmental tests of the Block I uprighting system and the flotation collar in a water tank at NASA-MSC for unmanned static testing and in the Gulf of Mexico for unmanned dynamic testing in 1965 (See Photos #2-8). The uprighting system was commanded by a hardwire control box controlled by the test conductor from a life raft. The uprighting system⁵ utilized three flotation bags in the Command Module forward compartment and were inflated after splashdown to upright the Command Module if inverted (Stable II) and/or to insure the Command Module would not invert and would stay upright (Stable I) during postlanding recovery operations. The Apollo Command Module could not be configured to be self-righting and still maintain an acceptable aerodynamic lift-to-drag ratio. The flotation collar⁶ was installed by Navy Underwater Demolition Team (UDT) swimmers following an Apollo Command Module splashdown to stabilize the vehicle for astronaut and vehicle recovery operations.

BP-1101 was returned to Kelly AFB to modify to BP-1101A in late 1965. The modification involved reconfiguring the forward compartment and tunnel from the Block I design for earth orbit missions to the Block II design

for lunar missions. Following its return to NASA-MSC, BP-1101A was re-outfitted with test hardware and used for NASA developmental Block II uprighting system tests in 1966-67, essentially repeating the Block I tests. The final uprighting tests with Block II BP-1101A were performed in the Gulf of Mexico (open water) and tested single bag failure modes (+y, -y, +z) with flight-like uprighting bags (See Photos #9-14). The uprighting system was commanded wirelessly and controlled by the test conductor from the MV Retriever.

The BP-1101/1101A tests aided in improving the final systems designs of both the uprighting system and flotation collar, which both had very successful operational uses throughout Apollo Command Module flight operations during the Apollo Program in 1968-1972, Skylab Program in 1973-1974, and Apollo Soyuz Test Project (ASTP) in 1975. The Apollo Program had five uprightings of inverted Command Modules after splashdown in eleven missions on Apollo's 7, 8, 11, 12, and 16; Skylab had one uprighting on Skylab 4 in three missions; and ASTP had one uprighting in its one mission. Navy UDT swimmers successfully installed flotation collars on all Command Modules in postlanding operations during the Apollo, Skylab, and ASTP programs.

The Block II uprighting bags and flotation collar used on Apollo 11 (See Photo #15) are currently installed on BP-1102/1102A, BP-1101A's sister boilerplate, on display at the Air & Space Steven F. Udvar-Hazy Center at Dulles. After its delivery to NASA from Kelly AFB, BP-1102/1102A's interior was outfitted with hardware to provide a realistic simulation for astronaut water egress training of all Apollo/Skylab/ASTP crews.

Following completion of NASA testing in early 1967, BP-1101A was placed in storage until transferred for permanent display in 1975 at the Disabled American Veterans Club, George Klumker Post No. 22 (See Photo #16) in Wheat Ridge, Colorado from 1975 until 2001 when it was transferred to the Wings Over The Rockies Air & Space Museum (See Photos #17, #18, #19) in Denver, Colorado. BP-1101A is Smithsonian National Air & Space Museum Collection Object No. A19760054000.

(Special thanks to Ed O'Briant and Paul Chaput for their contributions to this report.)

March 8, 2008

Updated: February 18, 2017

Written By:

Coye Mac Jones

NASA-MSC/LRD Vehicle Project Engineer for BP-1101/1101A in 1965-66

Retired NASA-Johnson Space Center/Houston in January 2003

(I wrote this report after I visited the Wings Over the Rockies Air & Space Museum and found BP-1101A painted and not so easy to identify and spoke to the curator who said they had no info on the boilerplate. This incentivized me to write the report for the museum and then I followed up with a presentation to museum volunteers.)

Notes:

1. NASA Manned Spacecraft Center was renamed NASA Lyndon B. Johnson Space Center in 1973.

2. Apollo Block II Command Modules carried rendezvous and docking equipment for manned lunar missions. (The Block II Command Modules were substantially redesigned after the Apollo 1 fire and flew all manned Apollo, Skylab and ASTP missions.)

3. Apollo Block I Command Modules carried no rendezvous and docking equipment and were to be used for manned earth-orbital missions only. (The Apollo 1 fire caused the program to not fly any manned Block I Command Modules.)

4. The contractor for the Apollo Command Module was North American Aviation, which became North American Rockwell in 1967, then Rockwell International in 1973.

5. The final design for the Apollo Block II Command Module uprighting system consisted of three inflatable bags (two 42" bags in the $\pm Y$ bays and one 34" bag located in the +Z bay) located on the upper deck underneath the main parachutes in the forward compartment, two air compressors in the aft bay, and the associated plumbing and wiring. When use of the system was required, a crewman initiated inflation of the bags by turning on the air compressors, which caused ambient air to be pumped through plumbing and valves to each of the bags. The flotation bags were manufactured by Goodyear Aerospace.

6. The design of the Apollo flotation collar evolved from successful Mercury Program and Gemini Program designs and consisted of a circular inflatable tube with an internal backup tube both made of rubberized life raft material and inflated with CO₂. The flotation collars were manufactured by the Naval Air Rework Facility at the Naval Air Station in Pensacola.

Photos



Photo #1: Test setup for initial Block I BP-1101 weight & CG measurement in April 1965. NASA test conductor Ed O'Briant on left, NASA project engineer Coye Mac Jones on right. (Photo Credit: NASA S-65-35838).



Photo #2: Block I BP-1101 being deployed for early Apollo flotation collar test in April 1965 in Gulf of Mexico from NASA MV Retriever, a converted Army LCU (Photo Credit: Paul T. Chaput).



Photo #3: Block I BP-1101 Apollo boilerplate being deployed for early Apollo flotation collar test in April 1965 in Gulf of Mexico (Photo Credit: Paul T. Chaput).



Photo #4: Block I BP-1101 Apollo boilerplate deployed for early Apollo flotation collar test in April 1965 in Gulf of Mexico with Galveston, Texas on horizon (Photo Credit: Coye Mac Jones).



Photo #5: Block I BP-1101 during early Apollo flotation collar test with NASA divers swimming uninflated flotation collar package to BP in April 1965 in Gulf of Mexico (Photo Credit: Paul T. Chaput)



Photo #6: Block I BP-1101 with flotation collar installed/inflated during early Apollo flotation collar test in April 1965 in Gulf of Mexico (Photo Credit: Coye Mac Jones).



Photo #7: Mid-1965 (est.) photo is Block I BP-1101 in inverted Stable II position with uprighting bag inflating during unmanned Apollo Block I uprighting system test in Gulf of Mexico (Photo Credit: Paul T. Chaput)



Photo #8: Block I BP-1101 in upright Stable I position with uprighting bags inflated during unmanned Apollo Block I uprighting system test in mid-1965 (est.) in Gulf of Mexico (Photo Credit: Paul T. Chaput).



Photo #9: Block II BP-1101A during unmanned Apollo Block II uprighting system test in 1967 onboard MV Retriever in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #10: Block II BP-1101A being deployed during unmanned Apollo Block II uprighting system test in 1967 from MV Retriever in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #11: Block II BP-1101A inverted Stable II during unmanned Apollo Block II uprighting system +y bag failure test test in 1967 in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #12: Block II BP-1101A inverted Stable II during unmanned Apollo Block II uprighting system +y bag failure test test in 1967 in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #13: Block II BP-1101A uprighted Stable I during unmanned Apollo Block II uprighting system + y bag failure test in 1967 in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #14: Block II BP-1101A being recovered after unmanned Apollo Block II uprighting system test in 1967 to MV Retriever in Gulf of Mexico (Photo Credit: Still from NASA FR-S67-008 DVD).



Photo #15: Apollo 11 Block II Command Module post-splashdown with uprighting bags inflated and flotation collar installed. Apollo 11 crewmen Armstrong, Aldrin, and Collins and a Navy UDT swimmer in raft in their biological isolation garments are awaiting helicopter pickup for transport to U.S.S. Hornet, prime recovery ship for the historic Apollo 11 lunar landing mission on July 24, 1969 (Photo Credit: NASA S-69-21698).



Photo #16: Block II BP-1101A was displayed at the Disabled American Veterans Club, George Klumker Post No. 22, in Wheat Ridge, Colorado from 1975 to 2001. Paint scheme is of unknown origin. (Photo Credit: John Charles from *A Field Guide to American Spacecraft* website).



Photo #17: Block II BP-1101A has been displayed at the Wings Over The Rockies Air & Space Museum in Denver, Colorado since 2001 to current. BP-1101A was repainted in 2007 to resemble the paint scheme of early Apollo Command Module boilerplates (Photo Credit: Jurg Bolli from *A Field Guide to American Spacecraft* website).



Photo #18: Former NASA BP-1101A Project Engineer Coye Mac Jones (NASA Ret.) during inspection on April 18, 2008 at Wings Museum (Photo Credit: Coye Mac Jones).



Photo #19: Block II BP-1101A interior showing ballast configuration around circumference during inspection on April 18, 2008 at Wings Museum (Photo Credit: Coye Mac Jones).

References

1. "Apollo Postlanding Suitability Program – Block II", dated December 19, 1966; BP-1101A referenced on page 10A.
2. "Apollo Experience Report - Command Module Uprighting System", NASA TN D-7081, dated March 1973; BP-1101 referenced on pages 16-18 (URL: http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19730010171_1973010171.pdf).
3. "Apollo Program Summary Report", JSC-09423, dated April 1975; Para. 4.4.4.4 Uprighting System, Para. 7.4.3 Recovery Operations Equipment and Procedures (URL: <http://history.nasa.gov/apsr/apsr.htm>).
4. "Apollo/Skylab/ASTP and Shuttle Orbiter Major End Items", JSC-03600 dated March 1978; BP-1101A referenced on page 17 (URL: http://klabs.org/history/history_docs/mit_docs/1690.pdf).