



# **50th Anniversary Celebration of North American Aviation in Downey 1947 - 1997**

**Projects Apollo, Skylab and ASTP**

**Compiled by Ken Elchert**

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# Quotations

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***“Now it is time to take longer strides -- time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth.”***

***“For while we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last. We take an additional risk by making it in full view of the world... But this is not merely a race. Space is open to us now; and our eagerness to share its meaning is not governed by the efforts of others. We go into space because whatever mankind must undertake, free men must fully share.”***

***“I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish....”***



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***“We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard, because there is new knowledge to be gained and new rights to be won and they must be won for the progress of all mankind...”***

***We shall send to the Moon more than 240,000 miles from the control center in Houston, a giant rocket more than 300 feet tall, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food, and survival, on an untried mission to an unknown celestial body...***

***And therefore, as we set sail, we ask God’s blessing on the most hazardous and dangerous and greatest adventure on which man has ever embarked...”***

President John F. Kennedy  
September 12, 1962



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***“...I have spoken at length largely in terms of the deterrence and resistance of aggression and attack. But, in today’s world, freedom can be lost without a shot being fired, by ballots as well as bullets. The success of our leadership is dependent upon respect for our mission in the world as well as our missiles -- on a clearer recognition of the virtues of freedom as well as the evils of tyranny.***

***...And that is also why we have regained the initiative in the exploration of outer space, making an annual effort greater than the combined total of all space activities undertaken during the fifties ... and making it clear to all that the United States of America has no intention of finishing second place in space. This effort is expensive -- but it pays its own way, for freedom and for America....***

***There is no longer any fear in the free world that a Communist lead in space will become a permanent assertion of supremacy and the basis of military superiority. There is no longer any doubt about the strength and skill of American science, American industry, American education, and the American free enterprise system. In short, our national space effort represents a great gain in, and a great resource of, our national strength.”***

President John F. Kennedy  
November 22, 1963  
(undelivered)

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***“...the goal of landing a man on the Moon and returning him to Earth has the highly important role of accelerating the development of space science and technology, motivating the scientists and engineers who are engaged in this effort to move forward with urgency, and integrating their efforts in a way that cannot be accomplished by a disconnected series of research investigations in several fields. It is important to realize, however, that the real values and purposes are not in the mere accomplishment of man setting foot on the Moon but rather in the great cooperative national effort in the development of science and technology which is stimulated by this goal.”***

***“... the billions of dollars required in this effort are not spent on the Moon; they are spent in factories, workshops, and laboratories of our people for salaries, for new materials, and supplies, which in turn represent income for others.... The national enterprise involved in the goal of manned lunar landing and return within this decade is an activity of critical impact on the future of this Nation as an industrial and military power, and as a leader of a free world.”***

Dr. Hugh Dryden  
Deputy NASA Administrator  
June 22, 1961

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***“We feel humble that we were the ones to perform this historic feat ... It might show the restless students of the world the benefits ... the triumph of the ‘squares’ who work with computers and slide rules, of engineering and of science, and of men who read from the Bible on Christmas eve.”***

Tom Paine  
Acting NASA Administrator  
December 27, 1968

***“Houston, Tranquillity Base here -- the Eagle has landed.”***  
***“That’s one small step for [a] man -- one giant leap for mankind.”***

Neil Armstrong  
Commander, Apollo 11  
July 20, 1969

**HERE MEN FROM THE PLANET EARTH  
FIRST SET FOOT UPON THE MOON  
JULY 1969 A.D.  
WE CAME IN PEACE FOR ALL MANKIND**

Inscription on a plaque on the *Eagle*  
Tranquillity Base, Moon



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***“As for the Yankees, their sole ambition now was to take possession of that new continent in the sky, to plant on its highest peak the starry flag of the United States of America.”***

***“I have searched, labored, calculated, and I am sure now that we can succeed in an enterprise which in any other country would be regarded as folly.”***

***“No one could deny that it was a beautiful piece of metal, a metallurgical product that was a great credit to the industrial genius of the Americans.”***

***“I do not believe I go too far when I say that in the future we shall have trains of projectiles in which people will be able to travel comfortably from the Earth to the Moon.”***

Excerpts from *From the Earth to the Moon*  
by Jules Verne  
1865



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***“Let me say briefly about the paper ‘On the Possibility of Navigating Interplanetary Space’, that the possibility by your showing is so remote is it worthwhile to publish it? The speculation about it is interesting, but the impossibility of ever doing it is so certain that it is not practically useful... I return the paper with thanks.”***

Professor W. W. Payne  
Responding to Professor Goddard  
1908

***“This foolish idea of shooting at the moon is an example of the absurd lengths to which vicious specialization will carry scientists... For a projectile entirely to escape the gravitation of the earth, it needs a velocity of 7 miles a second. The energy of our most violent explosive - nitroglycerine - is less than 1500 calories per gram. Consequently, even had the explosive nothing to carry, it has only one tenth of the energy to escape the earth... hence the proposition appears to be basically impossible.”***

A. W. Bickerton  
Professor of Physics and Chemistry  
1926

***“Regardless of all future scientific advances, Man will never reach the Moon. Man is inherently an earthly creature.”***

Lee de Forest  
U.S. pioneer of radio  
1957

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***“It must be stated that there is not the slightest possibility of such a journey.***

***There is not in sight any source of energy that would be a fair start toward that which would be necessary to get us beyond the gravitational control of the Earth.***

***There is no theory that would guide us through interplanetary space to another world even if we could control our departure from the Earth.***

***There is no means of carrying the large amount of oxygen, water, and food that would be necessary for such a long journey; and***

***There is no known way of easing our ether ship down onto the surface of another world, if we could get there.”***

Professor Forrest Ray Moulton  
1935

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# Apollo Spacecraft

# Apollo Spacecraft

## Dimensions and Mass

	Length (ft.)	Diameter (ft.)	Mass (lbs.)
CSM	34.0	12.833	66,000
CSM + LES	65.0	12.833	74,000
CSM + LES + LM + SLA	81.854	21.667	115,000

## Rockets

CM	12 RCS jets
SM	16 RCS jets 1 SPS engine
LES	3 solid propellant motors
LM	16 RCS jets 1 Descent engine 1 Ascent engine
Total	50

## CSM

Total Propellant Mass:	40,759 lbs.
Total RCS Impulse:	848,471.3 lb-sec
Total $\Delta v$ :	9200 ft/sec
Total Average Electrical Power:	6.30 kW
Total Electrical Energy:	690.00 kWh
Number of Space Flights:	24
Unit Price:	\$77M

# Launch Escape Subsystem (LES)

	<b>Overall</b>
Length:	33 ft. 5.5 in.
Mass:	8000 lbs. - 8500 lbs.
Max Diam:	4 ft.
	<b>LES motor</b>
Manufacturer:	Lockheed Propulsion Co., Redlands, CA
Nozzles	4
Length:	185.6 inches
Diameter:	26 inches
Propellant Mass:	4700 lbs.
Thrust:	147,000 lbs. (sea level) 155,000 lbs. (vacuum)
Burn Time:	3.2 sec.
	<b>Pitch control motor</b>
Manufacturer:	Lockheed Propulsion Co., Redlands, CA
Length:	22 inches
Diameter:	9 inches
Mass:	50 lbs.
Thrust:	2400 - 3000 lbs.
Burn Time:	>0.5 sec.
	<b>Tower jettison motor</b>
Manufacturer:	Thiokol Chemical Corp., Elkton, MD
Nozzles	2
Length:	55.617 inches
Diameter:	26 inches
Mass:	525 lbs.
Thrust:	31,500 lbs. - 33,000 lbs.
Burn Time:	>1 sec.

# Command Module

Length	12 ft.	[11 ft. 5 in.]
Diameter	12 ft. 10 in.	
Mass	12,277 to 13,200 lbs	[12,250 to 12,874 lbs]
Habitable Volume	210 cubic feet	
RCS jets		
Number	12	
Fuel	Monomethyl Hydrazine	
Oxidizer	Nitrogen Tetroxide	
Propellant Mass	269 lbs.	
Thrust	93.5 lbs. each	
Specific Impulse	290 sec.	
Total Impulse	57,712.5 lb-sec	
Panel display		
Display instruments	24	
Switches	566	
Mechanical event indicators	40	
Lights	12	
Crew controls		
Handgrip controllers	2	
Switches	34	
Knobs	6	
Functional parts	>2,000,000 (not counting wires and skeletal components)	
Wires	15,000 (15 miles) -- enough to wire 50 2-bedroom homes	
Electrical System	Batteries	
Capacity	1000 Amp-hours	
Energy	20.0 kWh	

# Service Module

## Overall

Length	
• Excluding Nozzle	14 ft. 10 in.
• Including Nozzle	24 ft. 7 in.
Diameter	12 ft. 10 in.
Fueled Mass	51,243 to 54,064 lbs.
Dry Mass	11,500 lbs.

## SPS engine

Engine Mass	770 lbs.
Fuel Mass	15,766 lbs. Aerozine 50
Oxidizer Mass	25,208 lbs. Nitrogen Tetroxide
Propellant Capacity	45,000 lbs.
Mixture Ratio	1.60
Thrust	20,500 lbs. - 21,500 lbs.
Flow Rate	54.3 lb/sec
Specific Impulse	314.25 sec.
Chamber Pressure	99 psia
Length	12 ft. 9 in.
Throat Diameter	12.4 in.
Inside Exit Diameter	7 ft. 10.5 in.
Expansion Ratio	62.50
Firing Duration	0.4 to 500 sec.
Operating Lifetime	750 sec.
Restart Capability	36 to 50
Total $\Delta v$	9200 ft/sec

## RCS jets

Number	16
Fuel	Monomethyl Hydrazine
Oxidizer	Nitrogen Tetroxide
Propellant Mass	1360 lbs.
Specific Impulse	290 sec.
Total Impulse	790,758.7 lb-sec
Thrust	100 lbs. ea.

## Electrical System (3 Fuel Cells)

Avg. Power	6.30 kW
Energy	670.0 kWh



# Apollo CSM Mass Breakdown

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<b>Command Module</b>	
Structure	3,455
Heat Shield	1,870
Reaction Control System	882
Recovery Equipment	540
Navigation Equipment	1,113
Telemetry Equipment	441
Electrical Equipment	1,543
Communicatuions System	220
Crew Seats & Provisions	1,213
Crew	476
Miscellaneous Contingency	441
Environmental Control System	441
Propellants	<u>165</u>
Total	12,800
<b>Service Module</b>	
Structure	4,211
Electrical Equipment	2,645
Maneuvering System	6,614
Propellants	<u>40,595</u>
Total	54,065

Note: All masses given in pounds.





# Mockups

Ten wooden mock-ups were built in 1962 for use in providing engineering configuration and systems information as well as for developing manufacturing methods. The first mock-up drawing was received on January 15, 1962, and fabrication effort began February 9. The first mock-up, for cabin exterior equipment, was completed on June 11, 1962. Two additional mock-up requirements were added in 1963 and completed by November 1964.

Number	Module	Utilization	Completion	Site	Comments
<b>BLOCK I</b>					
M-1/E1	CM	CM Evaluator 1.	Early 1962	Downey	Complete CM
M-1/E2	CM	CM Evaluator 2.	March 1962	MSC	Complete CM
M-2/E3	CM	Accepted 9/29/62. Engineering design evaluation studies.	Dec. 1962	KSC	Cabin interior arrangement
M-2/E4	CM	Accepted 9/29/62. Engineering design evaluation studies.	Dec. 1962	KSC	Cabin interior arrangement
M-3	CM	Accepted 9/10/62. Engineering design evaluation studies.	June 1962	KSC	Cabin interior arrangement KSC Visitors Ctr @ end of Crew Access Arm
M-4	Partial SM	Accepted 11/14/62. Evaluate SM /adapter interface.	June 1962	Downey	+ Partial Adapter.
M-5	CM	Accepted 10/12/62. Official config control mockup.	June 1962	Downey	Cabin exterior arrangement
M-6	SM	-----	-----	-----	Req't. deleted 4/62
M-7	SM	Accepted 11/4/62. Dsn eval of SM and its components.	June 1962	MSC	SM only; design studies
M-8	CM	-----	-----	-----	Req't. deleted 4/62
M-9	CSM	Accepted 1/4/63. Size, Wt. & cg evaluation.	Dec. 1962	Tulsa	Handling/transport studies
M-10/E5	Life sys	Structural shell became evaluator 5.-----	-----	-----	Req't. deleted 3/26/62
M-11	CSM	Accepted 1/4/63. Size, Wt. & cg evaluation. Facilities verification vehicle (S/C FVV).	Dec. 1962	KSC	Handling/transport studies KSC Visitors Ctr on S-IB in Rocket Garden
M-12	Partial CM	Accepted 10/12/62. Maintain current config of CSE.*	Dec. 1962	Downey	Crew support studies.

\*CSE: Crew Support Equipment



# Mockups (Continued)

Number	Module	Utilization	Completion	Site	Comments
M-13	Crew sys	-----			Req't deleted 3/26/62.
M-14	Crew sys	-----			Req't deleted 3/26/62.
M-15	CSM	-----			Req't deleted 3/26/62.
M-16	Partial SM	-----			Req't deleted 3/26/62.
M-17	Partial SM	-----			Req't. deleted.
M-18	CSM	Simulation of complete spacecraft.	12/31/62	Downey	+ Adapter.
M-19	CSM	-----			Req't. deleted.
M-20	CM	-----			Req't. deleted.
M-21	Adapter	-----			Req't. deleted.
M-22	CM	Accepted 3/18/64. Evaluate interior & ext. arrangement	8/63	MSC	
M-23	Partial CSM	Accepted 12/1/64. Umbilical tests.	11/64	MSFC	+ Partial LES
<b>BLOCK II</b>					
M-24	CM	Block II mockup review; wiring & tubing mockup.	12/65	Downey	
M-25	SM	Block II mockup review; wiring & tubing mockup.	12/65	Downey	SM only
M-26	CM	Block II tooling mockup.	2/65	Downey	Lower Eqt. Bay
M-27	CM	Block II tooling mockup.	2/65	Downey	Fwd. Deck
M-27A	CM	Block II Used in CDR on 12/6-17/65.	4/30/65	Downey	Docking Mech.
M-28	CM	Block II mockup for astronaut's review.	4/30/65	Downey	Interior
M-29	SM (?)	Block II house test model. House Spacecraft No. 2	6/66	Downey	Same as 2H-1

Note: There is an Apollo command module mock-up located at the Planes of Fame Museum in Chino, CA.

# Boilerplate CM's

BP No.	Completion	Utilization	Site	Disposition
BP-1	9/7/62	Accepted 11/14/62. Land and water impact tests.	Downey/MS	Scrapped by JSC 11/71
BP-2	12/62	Accepted 12/11/62. Land and water impact tests starting 3/11/63.	Downey/MS	Scrapped by JSC 11/71
BP-3	9/10/62	Accepted 4/15/63. Parachute recovery test 9/6/63.	El Centro	Not recovered -- destroyed.
BP-4	-----	Water impact tests of earth impact attenuation system.	-----	Requirement deleted
BP-5	-----	-----	-----	Requirement deleted 8/62 -- not built
BP-6	3/8/63	Accepted 7/1/63. Pad abort test of LES 11/7/63 (PA-1).	WSMR	Modified to BP-6A.
BP-6A	9/64	Parachute recovery tests by aircraft drops.	El Centro	Modified to BP-6B.
BP-6B	5/66	Parachute recovery tests (Block II) by aircraft drops.	El Centro	Modified to BP-6C.
BP-6C	?	Parachute recovery tests.	El Centro?	Scrapped by Rockwell 5/75
BP-7	-----	-----	-----	Requirement deleted -- not built
BP-8	-----	Water egress flotation, recovery aids, logistics equipment.	-----	Requirement deleted
BP-9	3/6/63	Accepted 3/11/63. Dynamic tests.	MSFC	Modified to BP-9A.
BP-9A	?	Launched on SA-10 (A-105/Pegasus III), 7/30/65.	KSC	Not recovered.
BP-10	-----	-----	-----	Requirement deleted -- not built
BP-11	-----	-----	-----	Requirement deleted -- not built
BP-12	12/63	Accepted 2/16/64. Transonic abort test of LES 5/13/64 (A-001).	WSMR	Modified to BP-12A.
BP-12A	7/65	Water impact tests.	Downey	?
BP-13	Acc. 2/17/64	Booster compatibility. Launched on SA-6 (A-101), 5/28/64.	KSC	Not recovered (re-entered 6/1/64)
BP-14	9/64	North American house Block I s/c # 1. Tests started 8/14/64	Downey	?
BP-15	6/64	Accepted 6/14/64. Booster compatibility. Launched (A-102), 9/18/64.	KSC	Not recovered.
BP-16	8/64	Accepted 8/17/64. " " Launched (A-103/Pegasus I), 2/16/65.	KSC	Not recovered.
BP-17	-----	-----	-----	Requirement deleted -- not built
BP-18	-----	Structure qualification.-----	-----	Requirement deleted -- transferred to BP-30
BP-19	2/63	Accepted 2/19/63. Parachute recovery tests starting 5/3/63.	El Centro	Modified to BP-19A.
BP-19A	?	Parachute tests. Backup for BP-6C.	El Centro?	On display, LA Co. Museum of Nat'l History
BP-20	-----	-----	-----	Requirement deleted -- not built
BP-21	-----	-----	-----	Requirement deleted 8/62 -- not built
BP-22	3/17/65	High altitude abort test 5/19/65 (A-003) on Little Joe II.	WSMR	On display atop a Little Joe II at NASA/JSC
BP-23	9/64	Accepted 9/17/64. Max Q abort test 12/8/64 (A-002) on Little Joe II.	WSMR	Modified to BP-23A
BP-23A	5/65	Pad abort test of LES 6/29/65 (PA-2).	WSMR	On display, Marshall Space Flight Center

# Boilerplate CM's (Continued)

BP No.	Completion	Description	Site	Disposition
BP-24				Requirement deleted -- not built
BP-25	8/62	Accepted 10/2/62. 1st completed CM boilerplate began testing 8/7/62. Water recovery & handling equipment tests.	MSC	Pate Museum of Transportation, Fort Worth, TX
BP-26	8/64	Accepted 8/10/64. Launched (A-104/Pegasus II), 5/25/65. Micrometeoroid mission.	KSC	Not recovered.
BP-27	9/64	Accepted 9/25/64. Dynamic tests.	MSFC	On display at MSFC with LES
BP-28	7/64	Water and land impact test 74 during 4/65 in S&ID Impact Test Facility.	Downey	Modified to BP-28A.
BP-28A	?	Earth landing tests.	Downey?	Scrapped 11/71
BP-29	4/65	Flotation tests.	MSC	Modified to BP-29A.
BP-29A	?	Flotation tests.	MSC?	On display, Meteor Crater, AZ
BP-30	9/30/66	Originally BP-18. Backup for CM-020.	KSC	On display, ASVC, KSC
BP-213	?	Practice capsule used in helicopter drop tests.	?	Cernan Earth & Space Ctr., Triton College, River Grove, IL
BP-1101A	?	?	?	On display, Disabled American Veterans Club, Wheat Ridge, CO
BP-1102A	?	Contained original interior of CM-109	?	Museum of Natural History & Science, Louisville, KY
BP-1150	?	?	?	MSFC, Huntsville, AL
BP-1201	?	?	?	Space Center, Alamogordo, NM
BP-1202	?	?	?	AF Space Museum, CCAS, FL
BP-1203	?	?	?	Salvaged
BP-1204	?	?	?	Garber Facility, Suitland, MD
BP-1205	?	?	?	Space Center, Alamogordo, NM
BP-1206	?	?	?	RAF Woodbridge, Suffolk, UK
BP-1207	?	?	?	Discovery Center, Ocala, FL
BP-1208	?	?	?	Salvaged
BP-1209	?	?	?	Salvaged
BP-1210	?	?	?	Museum of the Cherokee Strip, Enid, OK
BP-1213	?	?	?	Salvaged
BP-1214	?	?	?	Salvaged
BP-1216	?	?	?	Salvaged

# Boilerplate CM's (Continued)

BP No.	Completion	Description	Site	Disposition
BP-1217	?	?	?	Salvaged
BP-1220	?	?	?	N. Carolina Museum of Life & Sciences, Durham, NC
BP-1222	?	?	?	Salvaged
BP-1223	?	?	?	Salvaged
BP-1224-1	?	Flammability tests.	MSC	Harris Co. Youth Village, Webster, TX
BP-1226	?	?	?	Salvaged
BP-1227	?	?	?	Grand Rapids Time Capsule, Grand Rapids, MI
BP-1228	?	?	?	Salvaged
BP-1229	?	?	?	Salvaged
BP-1250-C	?	Flammability tests. Cabin vent valve tests.	?	?
BP-1302	?	?	?	Salvaged
KSC-E	?	Apollo emergency egress trainer	KSC?	Detroit Science Center, Detroit, MI
JSC#2	?	ASTP astronaut trainer now part of ASTP display -- CSM	JSC?	KS Cosmosphere & Space Center
JSC#4	?	?	JSC?	US Space & Rocket Center, AL
BP-K	?	Formerly at NASA/JSC and restored in 1994	JSC?	Astrodome, Houston, TX

# Locations of Unidentified Boilerplates

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Location	Comments	
Apollo County Park	Lancaster, CA	Parachute drop tests? BP-12?
Apollo Middle School	Hollywood, FL	Apollo practice capsule
Florence Air & Space Museum	Florence, SC	
Goddard Space Flight Center	Greenbelt, MD	
Kirkpatrick Science and Air Space Museum	Oklahoma City, OK	
Patrick AFB	Florida	
Space Center Houston	Houston, TX	Skylab trainer
UDT-Seal Museum	Fort Pierce, FL	Naval training capsule
University of Oklahoma	Norman, OK	

# Block I CM's

CM No.	Utilization	Site	Disposition
001	Service Module only--propulsion tests	WSMR	N/A
002	Completed 10/65. Pwr-on tumbling abort test on LJ II (A-004) 1/20/66	WSMR	Modified to CM-002A
002A	Scheduled land drop mission canceled.	Downey	Modified to CM-002B
002B	Land drop tests. Assigned to pogo tests.	?	Soon to be on display, Cradle of Aviation, Garden City, NY
003	-----	-----	Requirement deleted -- not built
004	Completed 7/65. Static & thermal structural load tests.	Downey	Modified to CM-004A
004A	Completed 11/26/65. Static & thermal structural tests	Downey	Modified to CM-004B
004B	Unified hatch qualification model.	?	Scrapped
005	-----	-----	Requirement deleted -- not built
006	System compatibility, Block II ECS tests. House spacecraft No. 2.	Downey	Scrapped
007	Acoustic (Sept/Oct 65), water impact & post landing tests.	Downey/MSC	Modified to CM-007A
007A	Post landing tests. Unified hatch qualification. ASTP tests.	MSC	On display, Museum of Flight, Seattle, WA
008	Thermal vacuum tests; environmental proof test.	MSC	Modified to CM-008A
008A	Land tests. Assigned to Skylab program.	?	Scrapped
009	1st Apollo s/c -- ass'y start 10/63; accepted 10/20/65; shipped 10/24/65; mate to booster 12/26/65; launched on SA-201 ("Apollo 1A") 2/26/66	KSC	1st Apollo s/c recovered from flight -- modified to CM-009A
009A	Land impact - structural test.	?	On display, Strategic Air Command Museum, Ashland, NE
010	Backup for CM-002/004A. Pad abort test canceled.	WSMR	On display, US Space & Rocket Center, Huntsville, AL (On S-V)
011	Launched on SA-202 ("Apollo 2") 8/25/66.	KSC	Modified to CM-011A
011A	Land impact test.	?	On display, Dulles International Airport, Washington, DC
012.	Damaged in SA-204 (Apollo 1) fire 1/27/67	KSC	Langley Research Center, Hampton, VA (not on public display)
013	-----	-----	Requirement deleted -- not built
014	Originally scheduled for manned flight (Apollo 2) on SA-205.	KSC	Disassembled in parallel w/ CM-012 then modified to CM-014A
014A	Land test.	?	Scrapped
015	Operational tests of LM. CM consisted of BP-18?	KSC	N/A
016	-----	-----	Requirement deleted -- not built
017	Evaluate launch countdn ops-launched on SA-501 (Apollo 4) 11/9/67.	KSC	On display, Stennis Space Center, Port Saint Louis, MS
018	-----	-----	Requirement deleted -- not built
019	-----	-----	Requirement deleted -- not built
020	Reentry tests - launched on SA-502 (Apollo 6). Post recovery tests.	KSC	On display, Fernbank Science Center, Atlanta, GA

# Block II CM's

CM No.	Utilization	Site	Disposition
098 (2TV-1 & 2)	Thermal-vac, docked mode; pogo tests; Skylab tests.	MSC	On display, Academy of Science, Moscow, Russia
099 (aka 2S-1)	Ground & water test 104 12/16/66; Skylab tests.	Downey	Scrapped
100 (aka 2S-2)	Structural tests for modified Block II; Skylab tests.	Downey	National Air and Space Museum, Washington, D. C.?
101 "Phoenix"	Launched on SA-205 ( <b>Apollo 7</b> ). DCR on 3/6-7/68	KSC	On display National Museum of Science & Technology, Ottawa, Ontario, Canada
102	Pad 34 checkout & static structural tests.	KSC	Structure refurbished -- scrapped
103	Launched on SA-503 ( <b>Apollo 8</b> ).	KSC	On display, Chicago Museum of Science & Industry, Chicago, IL
104 Gumdrops	Launched on SA-504 ( <b>Apollo 9</b> ).	KSC	On display, Michigan Space & Science Center, Jackson, MI
105	ASTP demonstration.	?	Modified to CM-105AV (?)
105AV	Acoustic and vibration tests.	?	On display (ASTP display), National Air & Space Museum, Washington, DC
106 Charlie Brown	Launched on SA-505 ( <b>Apollo 10</b> ).	KSC	On display, Science Museum, London, U.K. (hatch is @ MI Space & Sci Ctr)
107 Columbia	Launched on SA-506 ( <b>Apollo 11</b> ).	KSC	On display, National Air and Space Museum, Washington, D. C.
108 Yankee Clipper	Launched on SA-507 ( <b>Apollo 12</b> ).	KSC	On display, Virginia Air and Space Center (NASA LaRC), Hampton, VA
109 Odyssey	Launched on SA-508 ( <b>Apollo 13</b> ).	KSC	On display, Kansas Cosmosphere and Space Center, Hutchinson, KS
110 Kitty Hawk	Launched on SA-509 ( <b>Apollo 14</b> ).	KSC	On display, US Astronaut Hall of Fame, Titusville, FL
111	Launched on SA-210 (" <b>Apollo 18</b> "-ASTP).	KSC	On display, NASA KSC Visitors Center, FL
112 Endeavor	Launched on SA-510 ( <b>Apollo 15</b> ).	KSC	On display, USAF Museum, Wright-Patterson AFB, Dayton, OH
113 Casper	Launched on SA-511 ( <b>Apollo 16</b> ).	KSC	On display, U. S. Space and Rocket Center, Huntsville, AL
114 America	Launched on SA-512 ( <b>Apollo 17</b> ).	KSC	On display, Space Center Houston, Houston, TX
115	Requirement deleted.	----	On display (on Saturn-V), NASA Johnson Space Center, Houston, TX
115A	Requirement deleted.	----	?
116	Launched on SA-206 ( <b>Skylab 2</b> ).	KSC	On display, National Museum of Naval Aviation, Pensacola, FL
117	Launched on SA-207 ( <b>Skylab 3</b> ).	KSC	On display, NASA Lewis Research Center, Cleveland, OH
118	Launched on SA-208 ( <b>Skylab 4</b> ).	KSC	On display, National Air and Space Museum, Washington, D.C.
119	On SA-209 as SA-210 b/u & SA-208 b/u & rescue.	KSC	On display, Apollo/Saturn V Center, Kennedy Space Center, FL

Note: There are two unidentified Apollo CM's at the Paul E. Garber Preservation, Restoration, and Storage Facility in Maryland (NASM)



# Lunar Module

<b>Overall</b>	
Length	21.0 ft.
Diameter	14.1 ft.
Habitable Volume	235 ft <sup>3</sup>
Gross Mass	32,034 to 36,262 lbs.
Crew	317.5 lbs.
Total $\Delta v$	15,420 ft/sec
Unit Price	\$50M

	<b>Ascent Stage</b>	<b>Descent Stage</b>
Length	11.5 ft.	9.2 ft.
Diameter	14.1 ft.	30.8 ft. (max.)
Mass	10,025 lbs.	22,375 lbs
Propellant		
• Type	N <sub>2</sub> O <sub>4</sub> /UDMH	N <sub>2</sub> O <sub>4</sub> /UDMH
• Mass	5,225 - 5,262 lbs.	18,040 - 19,564 lbs.
RCS		
• Thrust	16 x 99 lbs.	-----
• I <sub>SP</sub>	290 sec.	-----
Primary Engine		
• Thrust	3,500 lbs.	1,000 - 9,900 lbs.
• I <sub>SP</sub>	311 sec.	311 sec.
• $\Delta v$	7,285 ft/sec	8100 ft/sec
Electrical Power		
• Source	Batteries	Batteries
• Energy	17.0 KWh	33.0 KWh
• Capacity	800.0 Ah	1600 Ah

# Flown Lunar Modules

Serial No.	Mission	Code Name	Time	Event	Location	
LTA-2R	Apollo 6	test article	April 4, 1968	Launch	Burned up during re-entry	
LTA-10R	Apollo 4	test article	Nov. 9, 1967	Launch	Burned up during re-entry	
LTA-B	Apollo 8	test article	Dec. 21, 1968	Launch	Heliocentric orbit (attached to S-IVB)	
LM-1	Apollo 5	unmanned	Jan. 22, 1968	Launch	Burned up during re-entry	
LM-3	Apollo 9	Spider	March 3, 1969	Launch	Burned up during re-entry	
LM-4	Apollo 10	Snoopy	May 23, 1969	Jettison	Heliocentric orbit (ascent stg)/descent stg crashed	
LM-5	Apollo 11	Eagle				
		Descent stg.	20:17:40 UT July 20, 1969	Landing	0.6875N, 23.433E	Tranquility Base
		Ascent stg.	23:41 UT July 21, 1969	Jettison	Unknown	
LM-6	Apollo 12	Intrepid				
		Descent stg.	06:54:36 UT Nov. 19, 1969	Landing	3.1975S, 23.3855W	Ocean of Storms
		Ascent stg.	22:17:18 UT Nov. 20, 1969	Impact	3.94S, 21.21W	
LM-7	Apollo 13	Aquarius	April 17, 1970	Re-entry	Burned up during re-entry Pacific Ocean	
LM-8	Apollo 14	Antares				
		Descent stg.	09:18:13 UT Feb. 5, 1971	Landing	3.6733S, 17.4653W	Fra Mauro
		Ascent stg.	00:45:26 UT Feb. 7, 1971	Impact	3.42S, 19.67W	
LM-10	Apollo 15	Falcon				
		Descent stg.	22:16:29 UT July 30, 1971	Landing	26.1008N, 3.6528E	Hadley-Apennine
		Ascent stg.	03:03:37 UT Aug. 3, 1971	Impact	26.35583N, 0.25E	
LM-11	Apollo 16	Orion				
		Descent stg.	02:23:36 UT April 21, 1972	Landing	8.9914S, 15.5144E	Descartes Highlands
		Ascent stg.	20:54:12 UT April 24, 1972	Jettison	Unknown	
LM-12	Apollo 17	Challenger				
		Descent stg.	19:54:57 UT Dec. 11, 1972	Landing	20.1653N, 30.7658E	Taurus-Littrow
		Ascent stg.	06:50:21 UT Dec. 15, 1972	Impact	19.96611N, 30.48972E	

# Unflown Lunar Modules

ID	Assignment	Disposition
Mockup	Grumman	Kansas Cosmosphere and Space Center, Huthinson, KS
Mockup	?	Hall of Science, Queens, NY
MSFC 76545	High fidelity mockup	U. S. Space and Rocket Center, Huntsville, AL
“LM-7 1/2”	Grumman model built for Japanese in 1976	Museum in Tokyo, Japan
LTA-1	Systems integration tests. Crew storage tests	Cradle of Aviation Museum, Mitchell Field, Garden City, NY
LTA-3A	Ascent stage only -- structural and drop tests	Franklin Institute Science Museum, Philadelphia, PA
LTA-3DR	Descent stage only	Franklin Institute Science Museum, Philadelphia, PA
LTA-5D	Descent stage only (?) -- propulsion tests at WSTF	?
LTA-8A	Thermal vacuum tests & astronaut training	Space Center Houston, Houston, TX
TM-3	Ascent stage for astronaut training (?)	Junkyard near Kennedy Space Center, FL
TM-5	?	North Carolina Museum of Life & Science, Durham, NC
PA-1	Propulsion tests	In storage at WSTF.
LM-2	Structural test	Nat'l Air and Space Museum, Washington, DC (Lunar Diorama)
LM-9	Not used -- cannibalized	Apollo/Saturn V Center, Kennedy Space Center, FL
LM-13	Requirement deleted (Apollo 18 - Copernicus)	Cradle of Aviation Museum, Mitchell Field, Garden City, NY*
LM-14	Requirement deleted (Apollo 19 - near Tycho)	Franklin Institute?
LM-15	Requirement deleted (Apollo 20)	Scrapped
MSC-16	Astronaut training at KSC	Museum of Science and Industry, Chicago, IL

\*used by Disney-MGM Studios, FL, in filming of HBO series “From the Earth to the Moon”

# Apollo Spacecraft Weights

## Manned Missions

Mission	S/C Wt.	CSM Wt.	LM Wt.	Earth Orb	LOI Cutoff
Apollo 7	36,419	32,566	-----	87,382	-----
Apollo 8	63,717	63,717	-----	282,198	46,743
Apollo 9	80,599	48,563	32,022	289,971	-----
Apollo 10	94,512	63,647	30,849	294,949	69,429
Apollo 11	96,715	63,642	33,073	297,850	72,037.6
Apollo 12	96,812	63,470	33,325	300,057	72,335.6
Apollo 13	96,964	63,470	33,477	296,466	-----
Apollo 14	98,137	64,440	33,680	302,628	71,823.0
Apollo 15	103,311	66,894	36,230	309,332	76,329
Apollo 16	103,165	66,927	36,219	308,737	77,647
Apollo 17	103,187	66,892	36,275	311,153	76,540
Skylab 2	36,007	30,384	-----	-----	-----
Skylab 3	36,073	30,561	-----	-----	-----
Skylab 4	34,291	30,100	-----	-----	-----
“Apollo 18”	32,563	28,054	-----	-----	-----

## Unmanned Missions

Mission	S/C Wt.
A-101	37,258
A-102	36,817
A-103	22,928
A-104	23,069
A-105	23,148
Apollo 4	80,812
Apollo 5	31,658
Apollo 6	81,142

NOTE: All weights given in pounds

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# Launch Vehicles

# Little Joe II Vehicles

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Vehicle	Launch Time	Date	Test	CM No.	Description
12-50-1 (QTV)	9:00 a.m. MST	08/28/63	Qual	-----	Little Joe II vehicle qualification test with dummy CSM.
12-50-2	6:00 a.m. MST	05/13/64	A-001	BP-12	Demonstrate Apollo s/c atmospheric abort system capabilities -- transonic abort.
12-51-1	8:00 a.m. MST	12/08/64	A-002	BP-23	First test of Apollo emergency detection system at abort altitude -- max Q abort.
12-51-2	6:01 a.m. MST	05/19/65	A-003	BP-22	Demonstration of abort capability of Apollo spacecraft -- high altitude abort.
12-51-3	8:17 a.m. MST	01/20/66	A-004	CM-002	Demonstrate launch escape vehicle performance -- intermediate altitude abort.

Notes:

1. All tests were ballistic and were performed at White Sands Missile Range Launch Complex 36
2. Little Joe II's are on display at the Space Center in Alamagordo, NM, and in Rocket Park at Johnson Space Center

# Saturn I Vehicles

Vehicle	Launch	Pad	Payload	Mission	Type	Altitude (miles)	Result
<b>Block I (inert 2nd stage)</b>							
SA-1	10/27/61	LC-34	Inert upper stages	Saturn propulsion test	Suborbital	85	Success
SA-2	04/25/62	LC-34	Inert upper stgs w/ H <sub>2</sub> O	Project Highwater I	Suborbital	93	Success
SA-3	11/16/62	LC-34	Inert upper stgs w/ H <sub>2</sub> O	Project Highwater II	Suborbital	104	Success
SA-4	03/28/63	LC-34	Inert upper stages	Engine-out test (R&D)	Suborbital	77	Success
<b>Block II (w/ live S-IV 2nd stage)</b>							
SA-5	01/29/64	LC-37B	Jupiter nose cone w/ sand	First Saturn orbital flight	Orbital	164 x 471	Success
SA-6	05/28/64	LC-37B	BP-13	A-101 First BP in orbit	Orbital	124 x 140	Success
SA-7	09/18/64	LC-37B	BP-15	A-102 Escape tower jettison	Orbital	114 x 141	Success
SA-8	05/25/65	LC-37B	BP-26/Pegasus 2	A-104	Orbital	308 x 462	Success
SA-9	02/16/65	LC-37B	BP-16/Pegasus 1	A-103 1st Pegasus launch	Orbital	314 x 466	Success
SA-10	07/30/65	LC-37B	BP-9A/Pegasus 3	A-105	Orbital	323 x 336	Success
<b>Unflown</b>							
SA-0	Block I static test stack now on display at Marshall Space Flight Center, Huntsville, AL						
SA-?	Block II static test stack now on display at U.S. Space and Rocket Center, Huntsville, AL						

## Re-entry Dates

SA-5	4/30/66
SA-6	6/1/64
SA-7	9/22/64



# Saturn IB Vehicles

Vehicle	Launch	Pad	Payload	Mission	Type	Result
SA-201	02/26/66	LC-34	CSM-009	“Apollo 1A”	Unmanned Suborbital	Success
SA-202	08/25/66	LC-34	CSM-011	“Apollo 2”	Unmanned Suborbital	Success
SA-203	07/05/66	LC-37B	nose cone	AS-203	Unmanned Orbital	Success
SA-204	01/22/68	LC-37B	LM-1	Apollo 5	Unmanned Orbital	Success
SA-205	10/11/68	LC-34	CSM-101	Apollo 7	Manned Orbital	Success
SA-206	05/25/73	LC-39B	CSM-116	Skylab 2	Manned Orbital	Success
SA-207	07/28/73	LC-39B	CSM-117	Skylab 3	Manned Orbital	Success
SA-208	11/16/73	LC-39B	CSM-118	Skylab 4	Manned Orbital	Success
SA-209	unflown -- see next chart					
SA-210	7/15/75	LC-39B	CSM-111	ASTP	Manned Orbital	Success
SA-211	unflown -- see next chart					
SA-212	unflown -- see next chart					
SA-213	unflown -- see next chart					
SA-214	unflown -- see next chart					



# Unflown Saturn IB Vehicles

Vehicle	Stage	Status
SA-209		Skylab 4 contingency rescue and ASTP backup
	S-IB-9	on display at <b>Alabama Welcome Center, Interstate 65 South</b> or <b>KSC Visitor Complex</b>
	S-IVB-209	on display at KSC Visitors Center, FL
SA-211		
	S-IB-11	on display at <b>Michoud Assembly Facility, New Orleans, LA</b> or <b>AL Welcome Center</b>
	S-IVB-211	on display at Alabama Welcome Center, Interstate 65 South
SA-212		
	S-IB-12	on display at Kennedy Space Center, FL (?)
	[S-IVB-212	converted to <b>Skylab Orbital Workshop</b> ; destroyed on re-entry]
SA-213		was tentatively assigned to Apollo Applications (Skylab)
	S-IB-13	scrapped
	S-IVB-213	status unknown -- probably scrapped -- <b>not built?</b>
SA-214		was tentatively assigned to Apollo Applications (Skylab)
	S-IB-14	scrapped
	S-IVB-214	status unknown -- probably scrapped -- <b>not built?</b>

# Saturn V Vehicles

Vehicle	Mission	Type	Date	Pad	CM	Ign. Wt (lb)	GLOW (lb)	Result	
SA-501	Apollo 4	Unmanned	Orbital	11/09/67	LC-39A	017	6,220,025	6,134,248	Success
SA-502	Apollo 6	Unmanned	Orbital	04/04/68	LC-39A	020	6,208,949	6,123,172	Partial
SA-503	Apollo 8	Manned	Lunar	12/21/68	LC-39A	103	6,219,760	6,133,983	Success
SA-504	Apollo 9	Manned	Orbital	03/03/69	LC-39A	104	6,486,915	6,397,162	Success
SA-505	Apollo 10	Manned	Lunar	05/18/69	LC-39B	106	6,499,016	6,412,359	Success
SA-506	Apollo 11	Manned	Lunar	07/16/69	LC-39A	107	6,484,280	6,398,432	Success
SA-507	Apollo 12	Manned	Lunar	11/14/69	LC-39A	108	6,484,620	6,398,974	Success
SA-508	Apollo 13	Manned	Lunar	04/11/70	LC-39A	109	6,505,857	6,421,367	Success
SA-509	Apollo 14	Manned	Lunar	01/31/71	LC-39A	110	6,508,510	6,420,600	Success
SA-510	Apollo 15	Manned	Lunar	07/26/71	LC-39A	112	6,509,800	6,407,865	Success
SA-511	Apollo 16	Manned	Lunar	04/16/72	LC-39A	113	6,525,969	6,439,713	Success
SA-512	Apollo 17	Manned	Lunar	12/07/72	LC-39A	114	6,530,885	6,444,965	Success
SA-513**	Skylab 1	Unmanned	Orbital	05/14/73	LC-39A	----	6,211,063	6,125,222	Success

## Unflown (see next chart)

All Systems Test Stages

Structural Test Stages

SA-500D

Dynamic Test Vehicle

SA-500F

Facilities Integration Vehicle (rollout on MLP-1 on May 25, 1966)

SA-514

Assigned to Apollo 19 which was canceled

SA-515

Assigned to Apollo 20 which was canceled

\*\*2-stage version -- S-IC-13 and S-II-13; Skylab was S-IVB-212

Skylab 1 re-entered the atmosphere on 7/11/79



# Unflown Saturn V Vehicles

Vehicle	Stage	Comments
<b>All Systems Test Stages</b>		
	S-IC-T	“T-Bird”--1st S-IC built. On display at the Apollo/Saturn V Center, Kennedy Space Center, FL Underwent 15 static test firings (3 full-duration) for total of 867 seconds completed by mid December 1965.
<b>Structural Test Stages</b>		
	S-II-T	Destroyed on test stand May 28, 1966 Known as “Battleship” Test Stages (?)
	S-IC-S	Disposition unknown--probably scrapped
	S-II-S/D	Destroyed on test stand September 29, 1965
	S-IVB-S	Not built?
<b>SA-500D</b>		
	S-IC-D*	Dynamic Test Vehicle First unit built by Boeing. On display at U.S. Space and Rocket Center, Huntsville, AL
	S-II-D	Canceled -- not built; S-IIF/D used instead
	S-IVB-D*	On display at U.S. Space and Rocket Center, Huntsville, AL
	S-IU-D	Disposition unknown
<b>SA-500F</b>		
	S-IC-F	Facilities Integration Vehicle; rolled out May 25, 1966 Disposition unknown--scrapped
	S-II-F/D*	On display at the U.S. Space and Rocket Center, Huntsville, AL
	S-IVB-500F	Skylab Workshop Dynamic Test Stage. Unknown
	S-IU-500F	Disposition unknown--probably scrapped
<b>SA-513</b>		
	S-IVB-513	Assigned to Apollo 18 which was canceled; SA-513 then assigned to Skylab (S-IC and S-II only) On display at Johnson Space Center, Houston, TX
<b>SA-514</b>		
	S-IC-14	Assigned to Apollo 19 which was canceled On display at Johnson Space Center, Houston, TX
	S-II-14	On display at the Apollo/Saturn V Center, Kennedy Space Center, FL
	S-IVB-514	On display at the Apollo/Saturn V Center, Kennedy Space Center, FL
	S-IU-514	Disposition unknown--probably scrapped
<b>SA-515</b>		
	S-IC-15	Assigned to Apollo 20 which was canceled; SA-515 then designated as launch vehicle for the backup Skylab On display at Michoud Assembly Facility, New Orleans, LA
	S-II-15	On display at Johnson Space Center, Houston, TX
	S-IVB-515	Rebuilt as <b>backup Skylab Workshop</b> --on display at NASM, Washington, DC
	S-IU-515	Disposition unknown--probably scrapped

\*National Engineering Historic Landmark



# Saturn V

World's largest launch vehicle to become operational. From Nov. 9, 1967 to May 5, 1973, 13 Saturn V's took 12 astronauts to 6 Moon landing sites and sent Skylab into orbit

Pieces	> 3,000,000
Parts	700,000
Length	363.013 ft. with Apollo spacecraft; 344 ft with Skylab 281 ft. without spacecraft
Diameter	33 ft.
GLOW	6,221,823 to 6,537,238 lbs.
Propellant mass	5,973,067 lbs.
Dry mass	430,000 lbs.
Orbital payload	253,000 lbs.
Escape payload	105,600 lbs.
First Stage (S-IC)	
Propellant	
LOX	3,133,000 lbs. - 3,306,630 lbs. (331,000 gal. - 345,000 gal.)
RP-1	1,359,000 lbs. - 1,431,540 lbs. (203,000 gal.)
Mass flow rate	28,814 lb/sec (through SA-509) 29,588 lb/sec (after SA-509)
Thrust (5 F-1 engines)	
Sea Level	7,680,982 lbs. (through SA-509) [7,648,000] 7,809,138 lbs. (after SA-509)
Vacuum	9,088,420 lbs. (through SA-509) 9,155,147 lbs. (after SA-509)
Power	180,000,000 horsepower -- equivalent to 85 Hoover dams [160,000,000]



# S-II Stage

Largest, most powerful, most advanced high-energy rocket system in the world  
 Built in world's largest clean room using world's largest pressure cooker and lathe  
 Shipped through the Panama Canal on *USNS Point Barrow* and *SS Steel Structure*

Length	81 ft. 7 in. (including interstage section)
Diameter	33 ft. 0 in.
Propellant Mass	
LH <sub>2</sub>	152,638 lbs. to 159,774 lbs. (259,385 to 271,512 gal.)
LOX	792,714 lbs. to 836,120 lbs. (83,391 to 87,957 gal.)
Total	945,350 to 995,895 lbs.
Dry Mass	88,500 lbs. to 77,947 lbs.
Total Mass	1,038,628 to 1,088,061 lbs
Structural Mass Fraction	0.0856 to 0.0727 [0.031]
Solid Propellant Ullage Rockets	
Number	8
Length	7 ft.
t <sub>b</sub>	4 sec.
Rocketdyne J-2 engines	
Number	5 (1 fixed, 4 gimbaled)
T <sub>total</sub>	1,120,216 to 1,163,854 lbs. @ MR = 5.5 868,000 lbs. @ MR = 4.2
P <sub>C</sub>	632 psia
I <sub>SP</sub>	421 sec.
t <sub>b</sub>	165 sec. (center engine) 367.85 to 395.06 sec. (outer engines)
Power	95.4 Billion Watts (72 Hoover dams; >21M horsepower)



# S-II Stage Initial and Burnout Conditions

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	<b>MET</b>	<b>Altitude</b>		<b>Earth-Fixed Velocity</b>		<b>Range</b>
	sec.	nmi	ft.	mph	fps	nmi
Initial Conditions	163.2 - 170.6	33 - 36	200,000 - 222,000	5037 - 5375	7387.6 - 7882.9	51.3
Burnout Conditions	552.2 - 563.1	99.5 - 102.5	604,330 - 623,000	14,535 - 14,728	21,318 - 21,601	888

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# Crews

# Prime Crews

<b>Apollo</b>			
<u>Mission</u>	<u>Commander</u>	<u>CM Pilot</u>	<u>LM Pilot</u>
Apollo 1	<i>Virgil I. "Gus" Grissom</i>	<i>Edward White</i>	<i>Roger Chaffee</i>
Apollo 7	Walter M. Schirra, Jr.	<i>Donn F. Eisele</i>	R. Walter Cunningham
Apollo 8	Frank Borman	James A. Lovell, Jr.	William A. Anders
Apollo 9	James A. McDivitt	David R. Scott	Russell L. Schweickart
Apollo 10	Thomas P. Stafford	John W. Young	Eugene A. Cernan
Apollo 11	<b>Neil A. Armstrong</b>	Michael Collins	<b>Edwin E. "Buzz" Aldrin, Jr.</b>
Apollo 12	<i>Charles "Pete" Conrad, Jr.</i>	Richard F. Gordon, Jr.	<b>Alan L. Bean</b>
Apollo 13	James A. Lovell, Jr.	<i>John L. Swigert, Jr.*</i>	Fred W. Haise, Jr.
Apollo 14	<i>Alan B. Shepard, Jr.</i>	<i>Stuart A. Roosa</i>	<b>Edgar D. Mitchell</b>
Apollo 15	<b>David R. Scott</b>	Alfred M. Worden	<i>James B. Irwin</i>
Apollo 16	<b>John W. Young</b>	Thomas K. Mattingly II	<b>Charles M. Duke, Jr.</b>
Apollo 17	<b>Eugene A. Cernan</b>	<i>Ronald E. Evans</i>	<b>Harrison "Jack" H. Schmitt</b>
<b>Skylab</b>			
<u>Mission</u>	<u>Commander</u>	<u>Pilot</u>	<u>Science Pilot</u>
Skylab 2	<i>Charles "Pete" Conrad, Jr.</i>	Paul J. Weitz	Joseph P. Kerwin
Skylab 3	<b>Alan L. Bean</b>	Jack R. Lousma	Owen K. Garriott
Skylab 4	Gerald P. Carr	William R. Pogue	Edward G. Gibson
<b>ASTP</b>			
<u>Mission</u>	<u>Commander</u>	<u>CM Pilot</u>	<u>Docking Module Pilot</u>
"Apollo 18"	Thomas P. Stafford	Vance D. Brand	<i>Donald K. "Deke" Slayton</i>

\*replaced Thomas K. Mattingly II due to exposure to German measles  
 Names of moonwalkers are shown in **bold** letters.  
 Names of deceased astronauts as of 9/00 are in *italics*.





# Back-up Crews

<b>Apollo</b>			
<u>Mission</u>	<u>Commander</u>	<u>CM Pilot</u>	<u>LM Pilot</u>
Apollo 1	Walter M. Schirra, Jr.	<i>Donn F. Eisele</i>	R. Walter Cunningham
Apollo 7	Thomas P. Stafford	John W. Young	Eugene A. Cernan
Apollo 8	Neil A. Armstrong	Edwin E. “Buzz” Aldrin, Jr.	Fred W. Haise, Jr.
Apollo 9	<i>Charles “Pete” Conrad, Jr.</i>	Richard F. Gordon, Jr.	Alan L. Bean
Apollo 10	L. Gordon Cooper, Jr.	<i>Donn F. Eisele</i>	Edgar D. Mitchell
Apollo 11	James A. Lovell, Jr.	William A. Anders	Fred W. Haise, Jr.
Apollo 12	David R. Scott	Alfred M. Worden	<i>James B. Irwin</i>
Apollo 13	John W. Young	<i>John L. Swigert, Jr.</i>	Charles M. Duke, Jr.
Apollo 14	Eugene A. Cernan	<i>Ronald E. Evans</i>	Joe H. Engle
Apollo 15	Richard F. Gordon, Jr.	Vance D. Brand	Harrison “Jack” H. Schmitt
Apollo 16	Fred W. Haise, Jr.	<i>Stuart A. Roosa</i>	Edgar D. Mitchell
Apollo 17	John W. Young	<i>Stuart A. Roosa</i>	Charles M. Duke, Jr.
<b>Skylab</b>			
<u>Mission</u>	<u>Commander</u>	<u>Pilot</u>	<u>Science Pilot</u>
Skylab 2	Russell L. Schweickart	Bruce McCandless II	F. Story Musgrave
Skylab 3	Vance D. Brand	Don L. Lind	William B. Lenoir
Skylab 4	Vance D. Brand	Don L. Lind	William B. Lenoir
<b>ASTP</b>			
<u>Mission</u>	<u>Commander</u>	<u>CM Pilot</u>	<u>Docking Module Pilot</u>
“Apollo 18”	Alan L. Bean	<i>Ronald E. Evans</i>	Jack R. Lousma

Names of deceased astronauts as of 9/97 are in *italics*.

# Support Crews

Mission	Support Crew			
<b>Apollo</b>				
Apollo 1	<i>Ronald E. Evans</i>	<i>Edward G. Givens, Jr.</i>	<i>John L. Swigert, Jr.</i>	
Apollo 7	<i>Ronald E. Evans</i>	William R. Pogue	<i>John L. Swigert, Jr.</i>	
Apollo 8	Vance D. Brand*	Gerald P. Carr	Thomas K. Mattingly II	
Apollo 9	Jack R. Lousma [Haise]	Edgar D. Mitchell	Alfred M. Worden	
Apollo 10	Charles M. Duke, Jr.	Joe H. Engle	<i>James B. Irwin</i>	
Apollo 11	<i>Ronald E. Evans</i>	Thomas K. Mattingly II	William R. Pogue	<i>John L. Swigert</i>
Apollo 12	Gerald P. Carr	Edward G. Gibson	Paul J. Weitz	
Apollo 13	Vance D. Brand	Jack R. Lousma	William R. Pogue	
Apollo 14	[Philip K. Chapman]	Charles G. Fullerton	Bruce McCandless II	William R. Pogue
Apollo 15	Joseph P. Allen IV	<i>Karl G. Henize</i>	Robert A. R. Parker	
Apollo 16	Philip K. Chapman	Anthony W. England	Henry W. Hartsfield, Jr.	[Donald H. Peterson]
Apollo 17	Charles G. Fullerton	<i>Robert F. Overmyer</i>	Robert A. R. Parker	
<b>Skylab</b>				
Skylab 2	Robert L. Crippen	Henry W. Hartsfield, Jr.	William E. Thornton	Richard H. Truly
Skylab 3	Robert L. Crippen	Henry W. Hartsfield, Jr.	William E. Thornton	Richard H. Truly
Skylab 4	Robert L. Crippen	Henry W. Hartsfield, Jr.	William E. Thornton	Richard H. Truly
<b>ASTP</b>				
“Apollo 18”	Karol J. Bobko	Robert L. Crippen	<i>Robert F. Overmyer</i>	Richard H. Truly

\*John S. Bull was on the Apollo 8 support crew but resigned in 1968 and was replaced by Brand

Names of deceased astronauts as of 9/00 are in *italics*.

# Cancelled Apollo Missions

<b>Mission</b>	<b>Apollo 18*</b>	<b>Apollo 19</b>	<b>Apollo 20</b>
<u>Prime Crew</u>			
Commander	Richard F. Gordon, Jr.	Fred W. Haise, Jr.	Charles "Pete" Conrad
CM Pilot	Vance D. Brand	William R. Pogue	Paul J. Weitz
LM Pilot	Dr. Harrison H. Schmitt	Gerald P. Carr	Jack R. Lousma
<u>Support Crew</u>			
Commander	Dr. Joseph P. Allen	Dr. Anthony W. England	
CM Pilot	Karl G. Henize	Henry W. Hartsfield, Jr.	
LM Pilot	Dr. Robert A. R. Parker	Dr. Donald H. Peterson	
Destination	Schroter's Valley/Gassendi	Copernicus/Hyginus Rille	Copernicus/Marius Hills
Planned Mission Date	February 1972	July 1972 - November 1972	Dec. 1972 - May 1973
Cancellation Date	September 2, 1970	September 2, 1970	January 4, 1970

\*The Apollo spacecraft used on the Apollo-Soyuz Test Project is sometimes referred to as Apollo 18

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# Mission Data

# Boilerplate CM Flights

<b>Date</b>	<b>Test</b>	<b>Vehicle</b>	<b>BP No.</b>	<b>Location/Pad</b>	<b>Type</b>	<b>Description</b>
11/07/63	PA-1	LES	BP-6	White Sands LC-36	Ballistic	First pad abort test of LES
05/13/64	A-001	LJII-2	BP-12	White Sands LC-36	Ballistic	Transonic abort test of LES
05/28/64	A-101	SA-6	BP-13	KSC LC-37B	Orbital	First Apollo orbital flight test
09/18/64	A-102	SA-7	BP-15	KSC LC-37B	Orbital	Successful Saturn I launch
12/08/64	A-002	LJII-3	BP-23	White Sands LC-36	Ballistic	High Q test of LES
02/16/65	A-103	SA-9	BP-16	KSC LC-37B	Orbital	Successful Saturn I launch
05/19/65	A-003	LJII-4	BP-22	White Sands LC-36	Ballistic	LV destroyed but LES worked
05/25/65	A-104	SA-8	BP-26	KSC LC-37B	Orbital	Successful Saturn I launch
06/29/65	PA-2	LES	BP-23A	White Sands LC-36	Ballistic	Pad abort test of LES
07/30/65	A-105	SA-10	BP-9A	KSC LC-37B	Orbital	Successful Saturn I launch

# CM Block I and II Flights

Spacecraft	CM Code Name	Mission	Mission Type	Date of Mission	Launch Veh	Pad
<b>Block I (Unmanned)</b>						
CM-002	-----	A-004	Ballistic	01/20/66	LJ II-5	WSMR
CSM-009	-----	AS-201 "Apollo 1A"	A (suborb)	02/26/66	SA-201	LC 34
CSM-011	-----	AS-202 "Apollo 2"	A (suborb)	08/25/66	SA-202	LC 34
CSM-012	-----	Apollo 1	C	02/21/67*	SA-204	LC 34
CM-017/SM-020	-----	Apollo 4	A (orbital)	11/09/67	SA-501	LC 39A
CM-020/SM-014	-----	Apollo 6	A (orbital)	04/04/68	SA-502	LC 39A
<b>Block II (Manned)</b>						
CSM-101	"Phoenix" **	Apollo 7	C	10/11/68 - 10/22/68	SA-205	LC 34
CSM-103	-----	Apollo 8	C-Prime	12/21/68 - 12/27/68	SA-503	LC 39A
CSM-104	"Gumdrop"	Apollo 9	D	03/03/69 - 03/13/69	SA-504	LC 39A
CSM-106	"Charlie Brown"	Apollo 10	F	05/18/69 - 05/26/69	SA-505	LC 39B
CSM-107	"Columbia"	Apollo 11	G	07/16/69 - 07/24/69	SA-506	LC 39A
CSM-108	"Yankee Clipper"	Apollo 12	H	11/14/69 - 11/21/69	SA-507	LC 39A
CSM-109	"Odyssey"	Apollo 13	H	04/11/70 - 04/17/70	SA-508	LC 39A
CSM-110	"Kitty Hawk"	Apollo 14	H	01/31/71 - 02/09/71	SA-509	LC 39A
CSM-112	"Endeavor"	Apollo 15	J	07/26/71 - 08/07/71	SA-510	LC 39A
CSM-113	"Casper"	Apollo 16	J	04/16/72 - 04/27/72	SA-511	LC 39A
CSM-114	"America"	Apollo 17	J	12/07/72 - 12/19/72	SA-512	LC 39A
CSM-116	-----	Skylab 2	-----	05/25/73 - 06/22/73	SA-206	LC 39B
CSM-117	-----	Skylab 3	-----	07/28/73 - 09/25/73	SA-207	LC 39B
CSM-118	-----	Skylab 4	-----	11/16/73 - 02/08/74	SA-208	LC 39B
CSM-111	-----	ASTP	-----	07/15/75 - 07/24/75	SA-210	LC 39B

\*planned launch date--CSM-012 not launched

\*\*unofficial



# All CM Flights

CM	Mission	Vehicle	Date	Type	Recovered?
<b>Boilerplates (Unmanned)</b>					
BP-6	PA-1	LES	11/7/63	Ballistic	Y
BP-9A	A-105	SA-10	7/30/65	Orbital	N
BP-12	A-001	LJII (12-50-2)	5/13/64	Ballistic	Y
BP-13	A-101	SA-6	5/28/64	Orbital	N
BP-15	A-102	SA-7	9/18/64	Orbital	N
BP-16	A-103	SA-9	2/16/65	Orbital	N
BP-22	A-003	LJII (12-51-2)	5/19/65	Ballistic	Y
BP-23	A-002	LJII (12-51-1)	12/8/64	Ballistic	Y
BP-23A	PA-2	LES	6/29/65	Ballistic	Y
BP-26	A-104	SA-8	5/25/65	Orbital	N
<b>Block I (Unmanned)</b>					
CM-002	A-004	LJII (12-51-3)	1/20/66	Ballistic	Y
CM-009	“Apollo 1A”	SA-201	2/26/66	Suborbital	Y
CM-011	“Apollo 2”	SA-202	8/25/66	Suborbital	Y
CM-017	Apollo 4	SA-501	11/9/67	Orbital	Y
CM-020	Apollo 6	SA-502	4/4/68	Orbital	Y
<b>Block II (Manned)</b>					
CM-101	Apollo 7	SA-205	10/11/68	Orbital	Y
CM-103	Apollo 8	SA-503	12/21/68	Lunar	Y
CM-104	Apollo 9	SA-504	3/3/69	Orbital	Y
CM-106	Apollo 10	SA-505	5/18/69	Lunar	Y
CM-107	Apollo 11	SA-506	7/16/69	Lunar	Y
CM-108	Apollo 12	SA-507	11/14/69	Lunar	Y
CM-109	Apollo 13	SA-508	4/11/70	Lunar	Y
CM-110	Apollo 14	SA-509	1/31/71	Lunar	Y
CM-111	ASTP	SA-210	7/15/75	Orbital	Y
CM-112	Apollo 15	SA-510	7/26/71	Lunar	Y
CM-113	Apollo 16	SA-511	4/16/72	Lunar	Y
CM-114	Apollo 17	SA-512	12/7/72	Lunar	Y
CM-116	Skylab 2	SA-206	5/25/73	Orbital	Y
CM-117	Skylab 3	SA-207	7/28/73	Orbital	Y
CM-118	Skylab 4	SA-208	11/16/73	Orbital	Y

Ballistic	6
Suborbital	2
Orbital	13
<u>Lunar</u>	<u>9</u>
Total	30



# Unmanned Saturn Launch Data

<b>Mission</b>	<b>Launch Time</b>	<b>Launch Date</b>	<b>Vehicle</b>	<b>Launch Pad</b>
<u>Saturn C-1</u>				
AS-1	10:00:06 EST	Oct. 27, 1961	SA-1	LC-34
AS-2	09:00:34 EST	April 25, 1962	SA-2	LC-34
AS-3	12:45:02 EST	Nov. 16, 1962	SA-3	LC-34
AS-4	15:11:55 EST	March 28, 1963	SA-4	LC-34
<u>Saturn S-I</u>				
AS-5	11:25:01 EST	Jan. 29, 1964	SA-5	LC-37B
A-101	13:07:00 EDT	May 28, 1964	SA-6	LC-37B
A-102	11:22:43 EDT	Sept. 18, 1964	SA-7	LC-37B
A-103	09:37:03 EST	Feb. 16, 1965	SA-9	LC-37B
A-104	02:35:01 EDT	May 25, 1965	SA-8	LC-37B
A-105	09:00:00 EDT	July 30, 1965	SA-10	LC-37B
<u>Saturn S-IB</u>				
AS-201	11:12:01 EST	Feb. 26, 1966	SA-201	LC-34
AS-203	10:53:17 EDT	July 5, 1966	SA-203	LC-37B
AS-202	13:15:32 EDT	Aug. 25, 1966	SA-202	LC-34
Apollo 5	17:48:08 EST	Jan. 22, 1968	SA-204	LC-37B
<u>Saturn S-V</u>				
Apollo 4	07:00:01 EST	Nov. 9, 1967	SA-501	LC-39A
Apollo 6	07:00:01 EST	April 4, 1968	SA-502	LC-39A
Skylab 1	13:30:00 EDT	May 14, 1973	SA-513	LC-39A



# Manned Saturn Launch Data

<b>Mission</b>	<b>Liftoff Time</b>	<b>Launch Date</b>	<b>Vehicle</b>	<b>Launch Pad</b>
Apollo 7	11:02:45.36 EDT	Oct. 11, 1968	SA-205	ETR LC-34
Apollo 8	07:51:00.67 EST	Dec. 21, 1968	SA-503	KSC LC-39A
Apollo 9	11:00:00.67 EST	March 3, 1969	SA-504	KSC LC-39A
Apollo 10	12:49:00.58 EDT	May 18, 1969	SA-505	KSC LC-39B
Apollo 11	09:32:00.63 EDT	July 16, 1969	SA-506	KSC LC-39A
Apollo 12	11:22:00.68 EST	Nov. 14, 1969	SA-507	KSC LC-39A
Apollo 13	14:13:00.61 EST	April 11, 1970	SA-508	KSC LC-39A
Apollo 14	16:03:02.57 EST	Jan. 31, 1971	SA-509	KSC LC-39A
Apollo 15	09:34:00.58 EDT	July 26, 1971	SA-510	KSC LC-39A
Apollo 16	12:54:00.59 EST	April 16, 1972	SA-511	KSC LC-39A
Apollo 17	00:33:00.63 EST	Dec. 7, 1972	SA-512	KSC LC-39A
Skylab 2	09:00:00 EDT	May 25, 1973	SA-206	KSC LC-39B
Skylab 3	07:10:50 EDT	July 28, 1973	SA-207	KSC LC-39B
Skylab 4	09:01:23 EST	Nov. 16, 1973	SA-208	KSC LC-39B
ASTP	15:50:01 EDT	July 15, 1975	SA-210	KSC LC-39B

# Additional Apollo Developmental Test Flights

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<b>Mission</b>	<b>Launch Date</b>	<b>Vehicle</b>	<b>Launch Site</b>	<b>Test Subject*</b>	<b>Results</b>
R-3	July 20, 1963	SCOUT	Wallops	heatshield materials	Unsuccessful
FIRE 1	April 14, 1964	Atlas-Antares	ETR	Apollo-shaped reentry vehicle	Successful
R-4	Aug. 18, 1964	SCOUT	Wallops	heatshield materials	Successful
FIRE 2	May 22, 1965	Atlas	ETR	Apollo-shaped reentry vehicle	Successful
R-5	Feb. 9, 1966	SCOUT	ETR	heatshield materials	Successful

\*all flights were suborbital reentry tests

# Lunar Orbits

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<b>Mission</b>	<b>Orbits</b>	<b>Duration</b>	<b>Duration*</b>
Apollo 8	10	00d 20h 06m 49s	020h 10m 13.0s
Apollo 10	31	02d 13h 31m	061h 43m 23.6s
Apollo 11	30	02d 11h 30m	059h 30m 25.79s
Apollo 12	45	03d 16h 56m 01s	088h 58m 11.52s
Apollo 14	34	02d 18h 39m	066h 35m 39.99s
Apollo 15	74	06d 01h 18m	145h 12m 41.68s
Apollo 16	64	05d 05h 46m 50s	125h 49m 32.59s
Apollo 17	75	06d 03h 41m 13s	147h 43m 37.11s
Total	363	29d 19h 28m 53s	29d 19h 43m 45.28s

\*according to “*Apollo by the Numbers*,” by Richard Orloff

# Lunar Landing Data

Mission	Lunar Module	Landing Location	Latitude	Longitude	Landing Time
Apollo 11	LM-5	Eagle	Sea of Tranquillity	00.67408N 23.47297E	4:17:39 pm EDT 07/20/69
Apollo 12	LM-6	Intrepid	Ocean of Storms	03.01239S 23.42157W	1:54:36 am EST 11/19/69
Apollo 14	LM-8	Antares	Fra Mauro	03.64530S 17.47136W	4:18:13 am EST 02/05/71
Apollo 15	LM-10	Falcon	Hadley-Apennines	26.13222N 03.63386E	6:16:29 pm EDT 07/30/71
Apollo 16	LM-11	Orion	Descartes Highlands	08.97301S 15.50019E	9:23:35 pm EST 04/20/72
Apollo 17	LM-12	Challenger	Taurus-Littrow	20.19080N 30.77168E	2:54:58 pm EST 12/11/72

Mission	Surface Stay Time	EVA Time	Liftoff Time	Samples	Impact Date and Location
Apollo 11	00d 21h 36m 21s	02:31:40	1:54:01 pm EDT 07/21/69	47.52 lbs	? Unknown
Apollo 12	01d 07h 31m 12s	07:45:18	9:25:48 am EST 11/20/69	75.73 lbs	11/20/69 3.94S, 21.21W
Apollo 14	01d 09h 30m 31s	09:22:31	1:48:42 pm EST 02/06/71	93.22 lbs	02/07/71 3.42S, 19.67W
Apollo 15	02d 18h 54m 53s	19:07:53*	1:11:22 pm EDT 08/02/71	170.44 lbs	08/03/71 26.36N, 0.25E
Apollo 16	02d 23h 02m 13s	20:14:16	8:25:48 pm EST 04/23/72	211.01 lbs	05/29/72 Unknown
Apollo 17	03d 02h 59m 40s	22:03:57	5:54:37 pm EST 12/14/72	243.65 lbs	12/15/72 19.96N, 30.50E
Total	12d 11h 34m 50s	81:05:35		841.58 lbs	

\*includes stand-up EVA

Note: landing coordinates are Mean-Earth/Polar Axis (M.E.) coordinates



# Splashdown and Recovery

Mission	Date	Mission Duration	Ocean	Recovery Ship
<b>Apollo</b>				
“Apollo 1A”*	02/26/66	00d 00h 36m 59s	Atlantic	USS Boxer LPH-4
“Apollo 2”*	08/25/66	00d 01h 33m 28s	Pacific	USS Hornet CVS-12
Apollo 4*	11/09/67	00d 08h 37m 09s	Pacific	USS Bennington CVS-20
Apollo 6*	04/04/68	00d 10h 22m 59s	Pacific	USS Okinawa LPH-3
Apollo 7	10/22/68	10d 20h 09m 03s	Atlantic	USS Essex CVS-9
Apollo 8	12/27/68	06d 03h 00m 42s	Pacific	USS Yorktown CVS-10
Apollo 9	03/13/69	10d 01h 00m 54s	Atlantic	USS Guadalcanal LPH-7
Apollo 10	05/26/69	08d 00h 03m 23s	Pacific	USS Princeton LPH-5
Apollo 11	07/24/69	08d 03h 18m 35s	Pacific	USS Hornet CVS-12
Apollo 12	11/24/69	10d 04h 36m 24s	Pacific	USS Hornet CVS-12
Apollo 13	04/17/70	05d 22h 54m 41s	Pacific	USS Iwo Jima LPH-2
Apollo 14	02/09/71	09d 00h 01m 58.1s	Pacific	USS New Orleans LPH-11
Apollo 15	08/07/71	12d 07h 11m 53s	Pacific	USS Okinawa LPH-3
Apollo 16	04/27/72	11d 01h 51m 05s	Pacific	USS Ticonderoga CVA-14
Apollo 17	12/19/72	12d 13h 51m 59s	Pacific	USS Ticonderoga CVA-14
<b>Skylab</b>				
Skylab 2	06/22/73	28d 00h 49m 49s	Pacific	USS Ticonderoga CVA-14
Skylab 3	09/25/73	59d 11h 09m 04s	Pacific	USS New Orleans LPH-11
Skylab 4	02/08/74	84d 11h 15m 31s	Pacific	USS New Orleans LPH-11
<b>ASTP</b>				
“Apollo 18”	07/24/75	09d 01h 28m 23s	Pacific	USS New Orleans LPH-11

\*Unmanned



# Splashdown Time and Location

<b>Mission</b>	<b>Splashdown Time</b>	<b>Date</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Miss Distance (nmi)</b>
“Apollo 1A”	11:49:21 am EST	02/26/66	08.18S	011.15W	39
“Apollo 2”	02:49:00 pm EDT	08/25/66	16.12N	168.97E	200
Apollo 4	03:37:10 am EST	11/10/67	30.10N	172.53W	8.6
Apollo 6	05:00:00 pm EST	04/04/68	27.67N	157.98W	?
Apollo 7	07:11:48 am EDT	10/22/68	27.53N	064.07W	1.9
Apollo 8	10:51:42 am EST	12/27/68	08.12N	165.02W	1.4
Apollo 9	12:00:53 pm EST	03/13/69	23.22N	067.98W	2.7
Apollo 10	12:52:23 pm EDT	05/26/69	15.07S	164.65W	1.3
Apollo 11	12:50:35 pm EDT	07/24/69	13.31N	169.25W	1.7
Apollo 12	03:58:25 pm EST	11/24/69	15.78S	165.15W	2.0
Apollo 13	01:07:41 pm EST	04/17/70	21.63S	165.37W	1.0
Apollo 14	04:05:00 pm EST	02/09/71	27.02S	172.67W	0.6
Apollo 15	04:45:53 pm EDT	08/07/71	26.13N	158.13W	1.0
Apollo 16	02:45:05 pm EST	04/27/72	00.71S	156.22W	3.0
Apollo 17	02:24:59 pm EST	12/19/72	17.88S	166.12W	1.0
Skylab 2	09:49:49 am EDT	06/22/73	24.75N	127.03W	?
Skylab 3	06:19:54 pm EDT	09/25/73	30.78N	120.48W	2.8
Skylab 4	11:16:54 am EDT	02/08/74	31.30N	119.80W	?
ASTP	05:18:24 pm EDT	07/24/75	22.0N	163.0W	4.0

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# Miscellaneous

# Some Key NAA Personnel During Apollo

Personnell	Position
<a href="#">J. Leland “Lee” Atwood</a>	NAA President, Chairman of the Board
D. K. Bailey	Ground Support Equipment
Bud Benner	Assistant Chief Engineer
Bill D. Bergen	President of Space Division
Mac Blair	In charge of Advanced Plans
Bob Carroll	Assistant Program Mgrr/Business Mgt.
<a href="#">Frank Compton</a>	?
<a href="#">Scott Crossfield</a>	Test Pilot
Gerald R. Fagan	Assistant CM Project Mgr.
<a href="#">Charlie H. Feltz</a>	Assistant Program Manager
<a href="#">Toby Freedman</a>	In charge of Life Sciences
Bob Greer	Ass’t to President, VP & S-II Pgm Mgr
John P. Healy	Block II CM Mgr.
Bastian “Buz” Hello	VP for Launch Operations
<a href="#">Francis Hung</a>	Structures specialist
George Jeffs	Chief Engineer, CSM
Alan Kehlet	Block II CM Project Mgr.
Dutch Kindelberger	NAA President, Chairman of the Board
<a href="#">Bob Laidlaw</a>	Design
<a href="#">Dave Levine</a>	Electronics

Personnell	Position
Bud Mahurin	?
<a href="#">John McCarthy</a>	VP of Engineering at S&ID
C. V. Mills	Planning and Operations
Dale D. Myers	VP of S&ID, Apollo Program Mgr.
H. Gary Osbon	Chief Engineer, CSM
Bill Parker	Chief Engineer at S&ID
<a href="#">John W. Paup</a>	VP, Apollo Pgm Mgr, CM Mgr., Assistant to the President
Ray W. Pyle	Project Engineering
Harold Raynor	“No. 2 man” at S&ID
Ralph Ruud	Executive VP of S&ID
<a href="#">Norm J. Ryker</a>	Director, Systems Engineering
<a href="#">Milt Sherman</a>	Assistant Program Mgr/Pgm Control
<a href="#">Harrison Storms</a>	President of S&ID
S. M. Treman	Control Systems
Paul Vogt	VP at Space Division
Louis W. Walkover	Assistant CM Project Mgr.
J. J. Williams	Vehicle Systems
Norm Wilson	Manufacturing Engineering Mgr., SB

Underlined names are of the personnel who participated in the Apollo proposal at Langley.



# Apollo Responsibilities of North American Aviation

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Item	Division
Command Module (CM)	<b>S&amp;ID-Downey</b>
LES with tower	<b>S&amp;ID-Downey</b>
Service Module (SM)	
• Systems	<b>S&amp;ID-Downey</b>
• Basic structure	Tulsa Div.
Spacecraft LM Adapter (SLA)	Tulsa Div.
Saturn 5 Instrument Unit ring	?
S-II stage	<b>S&amp;ID-Seal Beach</b>
F-1 engines	Rocketdyne
J-2 engines	Rocketdyne
Stage separation motors	Rocketdyne
LM ascent stage engine	Rocketdyne
LM descent stage engine	Rocketdyne

Note: more than half the value of the total Apollo/Saturn 5 vehicle was produced by NAA

# S-II Proposals

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	<b>Phase I</b>	<b>Phase II</b>
Aerojet General Corporation	X	X
Chrysler Corporation, Missile Division	X	
Convair Astronautics Division of General Dynamics Corp.	X	X
Douglas Aircraft Corporation	X	X
Lockheed Aircraft Corporation, Georgia Division	X	
Martin Company	X	
North American Aviation, Inc.	X	X

# Apollo Spacecraft Proposals

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## Companies the RFP Was Issued To

- Boeing
- Chance Vought
- Douglas
- General Dynamics Astronautics Division
- General Electric
- Goodyear Aircraft
- Grumman
- Lockheed Missiles & Space Company
- Martin
- McDonnell Aircraft
- North American Aviation
- Radio Corporation of America
- Republic Aviation
- Space Technology Laboratories

## Companies Responding\*

- General Dynamics Astronautics with AVCO
- General Electric with Douglas, Grumman & STL
- McDonnell Aircraft with Lockheed Aircraft, Hughes Aircraft & Chance Vought
- Martin
- North American Aviation

\*Chamberlain Hotel, Old Point Comfort, VA

# Source Evaluation Board Ratings of Apollo Spacecraft Proposals

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	Weighting Factor	Martin		GD		NAA		GE		McDonnell	
		Raw	Wtd.	Raw	Wtd.	Raw	Wtd.	Raw	Wtd.	Raw	Wtd.
Technical Approach	0.30	5.58	1.67	5.27	1.58	5.09	1.53	5.16	1.55	5.53	1.66
Technical Qualifications	0.30	6.63	1.99	5.35	1.60	6.66	2.00	5.60	1.68	5.67	1.70
Bussiness Plan	0.40	8.09	3.24	8.52	3.41	7.59	3.04	7.99	3.20	7.62	3.05
Total Weighted Score:			6.90		6.59		6.56		6.42		6.41

# Apollo CSM Contract

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## **Development and fabrication**

Manned or test CM and SM	49
Boilerplate (engineering test) vehicles	30
Full-scale mockups	23
Test fixtures	5
Trainers	5
Apollo mission simulators	4
Evaluators	3
Miscellaneous SLA	2
+ accompanying Spacecraft/LM Adapters (SLA)	
+ tracking and ground support equipment	

## **Tests performed**

Escape motor tests	7
Parachute drop tests	40
CM land-impact tests	48
CM water-impact tests	52
CSM acoustic/vibration tests	15.5 hrs.
CSM modal survey testing	277.6 hrs.
CSM thermal vacuum tests	773 hrs.
SM propulsion-systems tests	1474.5 min.

# Boilerplate CM Test Summary

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Test	Capsules Involved
Parachute recovery	BP-3, 6A, 6B, 6C, 19, 19A
Abort flight	BP-6, 12, 22, 23, 23A
Orbital flight	BP-9A, 13, 15, 16, 26
Land/water impact	BP-1, 2, 4, 12A, 28
Flotation/water recovery	BP-8, 25, 29, 29A
Flammability	BP-1224-1, 1250-C
Dynamic	BP-9, 27
Earth landing	BP-28A
Other	BP-14, 30, 1101A, 1102A, 1206, 1207, 1210, 1220, 1227

# Block I and II CSM Utilization

Utilization	Capsules Involved
<b>Block I</b>	
Tested in unmanned flights	
Ballistic	002, 009
Orbital	011, 017, 020
Destroyed in fire	012
Other	002A, 002B, 004, 004A, 004B, 006, 007, 007A, 008, 008A, 009A, 010, 011A, 014, 014A, 098, 099
<b>Block II</b>	
In manned flights	
Earth-orbital flights before lunar missions	101, 104, 111, 116, 117, 118
Lunar missions	
Landing	107, 108, 110, 112, 113, 114
Non-landing	103, 106, 109
In unmanned ground tests	2S-1, 2S-2, 2TV-1, 2TV-2, 105AV
Pad checkout, ASTP demo, backup, etc	100, 102, 105, 115, 119

# All Launches

Vehicle	Mission Type	Flights			Dates
		Apollo	Skylab	ASTP	
<b>Little Joe II</b>	Unmanned ballistic	5			8/28/63 to 1/20/66
<b>Saturn I</b>	Unmanned				
	Block I suborbital	4			10/27/61 to 3/28/63
	Block II orbital	6			1/29/64 to 7/30/65
<b>Saturn IB</b>	Unmanned				
	suborbital	2			2/26/66 and 8/25/66
	orbital	2			7/5/66 and 1/22/68
	Manned orbital	1	3	1	10/11/68 to 7/15/75
<b>Saturn V</b>	Unmanned orbital	2	1		11/9/67 to 5/14/73
	Manned				
	orbital	1			3/3/69
	lunar	9			12/21/68 to 12/7/72



# Apollo Mission Classification

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Type	Description	Flight
A	unmanned CSM/Saturn test	Apollo 1A, 2, 4, 6
B	unmanned Lunar Module test	Apollo 5
C	first manned Apollo flight	Apollo 1, 7
C-Prime	first manned circumlunar mission	Apollo 8
D	first manned Saturn V flight with CSM and LM in low earth orbit	Apollo 9
E	manned flight with CSM and LM in high earth orbit	-----
F	first manned lunar orbit mission with CSM and LM	Apollo 10
G	first manned lunar landing	Apollo 11
H	longer duration manned lunar expedition	Apollo 12, 13, 14
J	scientific manned lunar mission with lunar rover	Apollo 15, 16, 17

# Apollo Translunar Flight Data

## -Masses-

<b>Element Masses</b>			
	<u>Dry</u>	<u>Loaded</u>	<u>Propellant</u>
CM	11,700	12,277 - 13,200	-----
(CM RCS)	-----	-----	(270)
SM	11,500 - 11,800	52,800 - 54,044	41,000 - 42,250
(SM RCS)	-----	-----	(1,360)
Total CSM	23,200 - 23,500	63,470 - 66,927	41,600 - 43,750
LM Descent Stg	4,100 - 6,085	22,000 - 25,600	18,050 - 19,500
LM Ascent Stg	4,500 - 4,700	10,300 - 10,950	5,190 - 5,230
Total LM	8,600 - 10,785	33,073 - 36,275	23,250 - 24,750
SLA	4,200		
<b>Initial Earth Orbit Masses</b>			
CM + SM + LM + SLA		100,750 - 107,400	
S-IVB + IU		195,700 - 203,750	
CM + SM + LM + SLA + S-IVB + IU		296,466 - 311,153	
<b>Initial Lunar Orbit Mass</b>			
CM + SM + LM		71,700 - 77,600	
<b>Mass On The Moon</b>			
LM		16,153.2 - 18,208	

Note: all masses given in pounds



# Apollo Translunar Flight Data

## -Propulsion & Performance-

<b>Propulsion</b>		
	<u>Thrust (lbs)</u>	<u>Isp (sec)</u>
S-IVB	220,000	418
CM RCS	12 x 93.5	290
SM SPS	20,500	314
SM RCS	16 x 100	290
LM Descnt	1,000 - 10,000	304
LM Ascent	3,500	309
LM RCS	16 x 100	290
<b>Performance</b>		
	<u>Delta v (fps)</u>	<u>Duration (sec.)</u>
ETO	31,680	720
TLI	10,420 [10,825]	320 - 350
MCC	75 [35]	
LOI	3,100 [3,525]	350 - 375
Descent	6,900 [6,300*]	730 - 765
Ascent	6,070 [5,980]	440
TEI	3,250 [3,525]	150 - 200
MCC	75 [60]	
Total	61,600 [62,125]	
<b>Velocities</b>		
Earth Orbit Velocity	25,500 fps	
TLI Velocity	36,225 fps	
Lunar Orbit Velocity	5,350 fps	
TEI Velocity	8,975 fps	

$$C_3 = -14,084,265 \text{ to } -19,745,586 \text{ ft}^2/\text{s}^2$$

### Earth Orbit

h (mi)	v <sub>orb</sub> (ft/sec)	P <sub>orb</sub> (min)
124.27	25,553	88.35
155.34	25,456	89.36
186.41	25,360	90.37
217.48	25,266	91.39

### Lunar Orbit

h (mi)	v <sub>orb</sub> (ft/sec)	P <sub>orb</sub> (min)
31.07	5,433	113.07
62.14	5,359	117.87
93.21	5,287	122.64
124.27	5,219	127.56

\*Does not include deorbit Δv of 195 fps



# S-1C Impact Locations

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<b>Mission</b>	<b>Latitude (deg)</b>	<b>Longitude (deg)</b>	<b>Downrange (nmi)</b>
Apollo 8	30.24	74.109	353.462
Apollo 9	30.183	74.238	346.635
Apollo 10	30.188	74.207	348.8
Apollo 11	30.212	74.038	357.1
Apollo 12	30.273	73.895	365.2
Apollo 13	30.177	74.065	355.3
Apollo 14	29.835	74.042	351.7
Apollo 15	29.42	73.653	368.8
Apollo 16	30.207	74.147	351.6
Apollo 17	28.219	73.878	356.6

# SIVB Impact Data

<b>Mission</b>	<b>Impact Time (UT)</b>	<b>Latitude (deg)</b>	<b>Longitude (deg)</b>	<b>Impact Speed (km/s)</b>	<b>Impact Energy (10<sup>10</sup> Joules)</b>	<b>Angle from Horizontal (deg)</b>
Apollo 13	01:09:41.0 04/14/70	2.75 S	27.86 W	2.58	4.63	76
Apollo 14	07:40:55.4 02/04/71	8.09 S	26.02 W	2.54	4.52	69
Apollo 15	20:58:42.9 07/29/71	1.51 S	11.81 W	2.58	4.61	62
Apollo 16	21:02:04 04/19/72	1.3 N 2.24 N*	23.8 W 24.49 S*	2.5 - 2.6	4.59	79
Apollo 17	20:32:42.3 12/10/72	4.21 S	12.31 W	2.55	4.71	55

\*estimate from tracking prior to LOS

Notes:

Apollo 11 SIVB was injected into heliocentric orbit

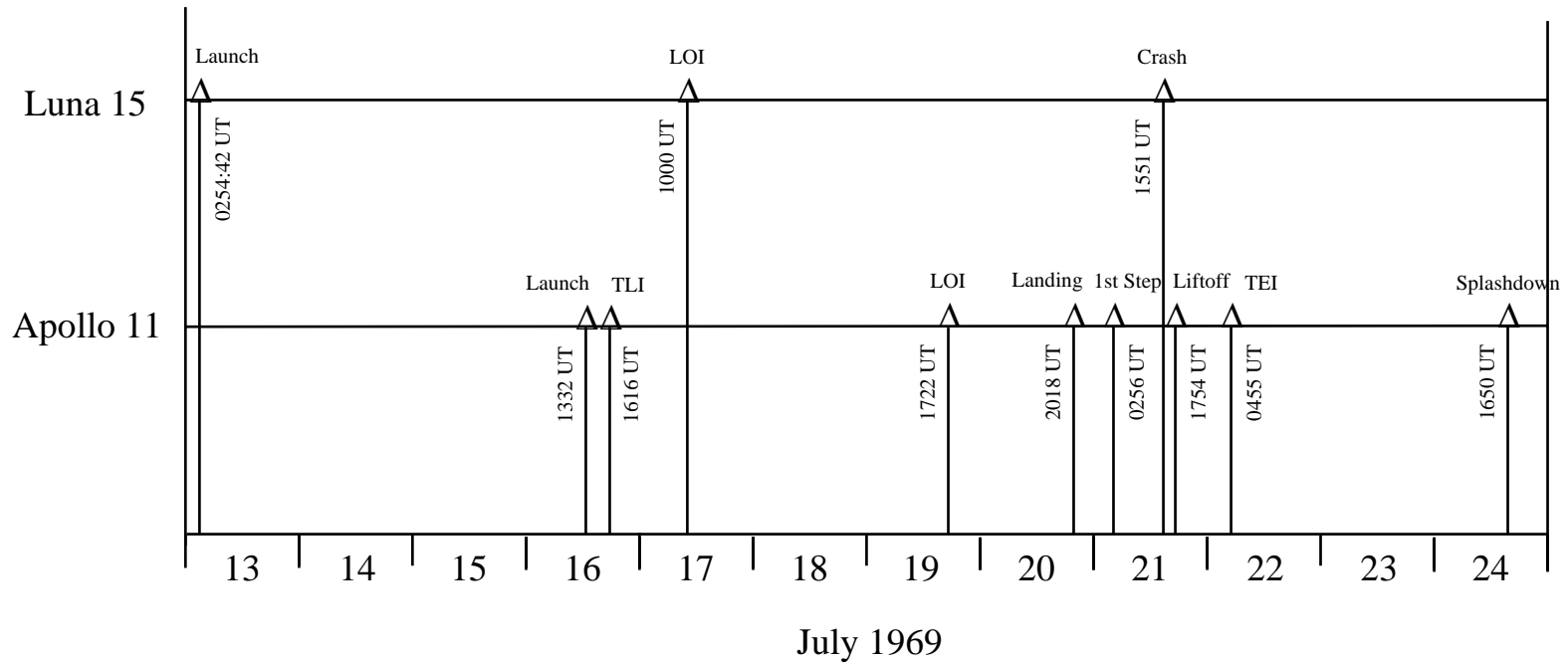
Apollo 12 SIVB was injected into Earth Orbit

# Total Manned Mission Durations

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<b>Project</b>	<b>Days</b>	<b>Hrs</b>	<b>Min</b>	<b>Sec</b>
Apollo	104	06	00	37
Skylab	171	23	14	24
ASTP	009	01	28	23
Total	285	06	43	24

# Luna 15 and Apollo 11 Timelines



# Items Left Behind at Tranquility Base

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LM Descent Stage  
TV Camera  
2 Still Cameras  
Tools  
Portable Life Support Systems  
Boots  
American Flag  
Rod Support for Solar Wind Experiment  
Laser Beam Reflector (Lunar Laser Ranging Experiment)  
Seismic Detector  
Gnomon



# Apollo Astronauts

## Prime and Backup Crew Members

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**Buzz Aldrin**

Bill Anders

**Neil Armstrong**

**Alan Bean**

Frank Borman

Vance Brand

**Gene Cernan**

*Roger Chaffee\**

Mike Collins

*Pete Conrad*

Gordon Cooper\*

Walt Cunningham

**Charlie Duke**

*Donn Eisele*

Joe Engle\*

*Ron Evans*

Dick Gordon

*Gus Grissom\**

Fred Haise

*Jim Irwin*

Jim Lovell

Ken Mattingly

Jim McDivitt

**Ed Mitchell**

*Stu Roosa*

Wally Schirra

**Jack Schmitt**

Rusty Schweickart

**Dave Scott**

*Alan Shepard*

Tom Stafford

*Jack Swigert*

*Ed White\**

Al Worden

**John Young**

\*Did not fly on Apollo spacecraft.

Names of moonwalkers are shown in **bold** letters.

Names of deceased astronauts as of 9/98 are in *italics*.

# Apollo Support, Skylab & ASTP Astronauts

## Not On Apollo Prime or Backup Crews

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<u><b>Apollo Support</b></u>	<u><b>Skylab and ASTP (and not on Apollo Support)</b></u>
Joe Allen*	Karol Bobko*
John Bull*	Bob Crippen*
Gerry Carr	Owen Garriott
Philip Chapman*	Joe Kerwin
Anthony England*	Bill Lenoir*
Gordon Fullerton*	Don Lind*
Ed Gibson	Story Musgrave*
<i>Edward Givens*</i>	<i>Deke Slayton</i>
Hank Hartsfield*	Bill Thornton*
<i>Karl Henize*</i>	Dick Truly*
Jack Lousma	
Bruce McCandless*	
<i>Bob Overmyer*</i>	
Robert Parker*	
Donald H. Peterson*	
Bill Pogue	
Paul Weitz	

\*Did not fly aboard Apollo spacecraft

Names of deceased astronauts as of 9/97 are in *italics*.

# Astronauts Who Flew Apollo Spacecraft

Astronaut	Mission(s)	Astronaut	Mission(s)
<b>Buzz Aldrin</b>	Apollo 11	Joe Kerwin	Skylab 2
Bill Anders	Apollo 8	Jack Lousma	Skylab 3
<b>Neil Armstrong</b>	Apollo 11	Jim Lovell	Apollo 8, 13
<b>Alan Bean</b>	Apollo 12, Skylab 3	Ken Mattingly	Apollo 16
Frank Borman	Apollo 8	Jim McDivitt	Apollo 9
Vance Brand	ASTP	<b>Ed Mitchell</b>	Apollo 14
Gerry Carr	Skylab 4	Bill Pogue	Skylab 4
<b>Gene Cernan</b>	Apollo 10, 17	<i>Stu Roosa</i>	Apollo 14
Mike Collins	Apollo 11	Wally Schirra	Apollo 7
<i>Pete Conrad</i>	Apollo 12, Skylab 2	<b>Jack Schmitt</b>	Apollo 17
Walt Cunningham	Apollo 7	Rusty Schweickart	Apollo 9
<b>Charlie Duke</b>	Apollo 16	<b>Dave Scott</b>	Apollo 9, 15
<i>Donn Eisele</i>	Apollo 7	<i>Alan Shepard</i>	Apollo 14
<i>Ron Evans</i>	Apollo 17	<i>Deke Slayton</i>	ASTP
Owen Garriott	Skylab 3	Tom Stafford	Apollo 10, ASTP
Ed Gibson	Skylab 4	<i>Jack Swigert</i>	Apollo 13
Dick Gordon	Apollo 12	Paul Weitz	Skylab 2
Fred Haise	Apollo 13	Al Worden	Apollo 15
<i>Jim Irwin</i>	Apollo 15	<b>John Young</b>	Apollo 10, 16

Names of moonwalkers are shown in **bold** letters.

Names of deceased astronauts as of 9/00 are in *italics*.

# Former Astronauts Now Living in California

Name*	Missions	Location	Business
<b>Buzz Aldrin</b>	G-12, A-11	Laguna Beach	Starcraft Enterprises
Vance Brand	ASTP, STS-5, 41B, 35	Edwards	Dryden Flight Research Center
Gordon Cooper	M-9, G-5	Van Nuys	Galaxy Group, Inc.
Gordon Fullerton	STS-3, 51F	Edwards	Dryden Flight Research Center
Ed Gibson	SL- 4	Carlsbad	Gibson International Corp.
Dick Gordon	G-11, A-12	Los Angeles	Astro Science Corp.
Sally Ride	STS-7, 41G	San Diego	University of California
<b>Dave Scott</b>	G-8, A-9, 15	Los Angeles	Scott Science & Technology, Inc.

\*Names of Moon walkers are in **bold** letters.

# Costs

## Apollo Project Cost

Apollo spacecraft	\$7,945,000,000
Saturn launch vehicle development	\$9,300,000,000
Saturn I	\$767,100,000
Saturn IB	\$1,131,200,000
Saturn V	\$6,871,100,000
Engines	\$854,200,000
Mission support	\$1,432,300,000
Tracking/data acquisition	\$664,100,000
Ground facilities	\$1,830,300,000
Operation of installations	<u>\$2,420,600,000</u>
Total	\$23,915,900,000*

## NAA S&ID Apollo contracts value

Apollo CSM	\$4,068,025,000
S-II	\$581,000,000

## Cost per lunar mission

Saturn V	\$185,000,000
Apollo	55,000,000
Launch ops	<u>70,000,000</u>
Total	\$310,000,000

**Skylab Project Cost:** \$2,460,000,000

**ASTP Project Cost (U.S. portion):** \$218,000,000

## CSM Funding History

Year	Funding
1962	\$52,000,000*
1963	345,000,000
1964	545,874,000
1965	577,834,000
1966	615,000,000
1967	560,400,000
1968	455,300,000
1969	282,821,000
1970	282,821,000
1971	245,542,000
1972	55,033,000
1973	<u>50,400,000</u>
Total:	\$4,068,025,000

\* "spacecraft development"

\*\$95B in 1990 dollars

# Miscellaneous Apollo Facts

## Employment

NASA employees who worked on Apollo	12,000 (30% of personnel)
American firms	17,000 to 20,000
Engineers and scientists	300,000
Contractor employees in 1965	376,700
NASA & contractor personnel at peak effort	420,000

## Saturn launches (10/27/61 to 12/19/72)

Unmanned development missions	16
Manned flights	11
Earth orbital missions	2
Lunar missions	9
Circumlunar	3
Lunar landings	6
Total number of launches	27

## Lunar exploration

Men on the moon	12
Man-hours of surface exploration	166
Miles traversed on the Moon	~60
Specimens of rock and soil samples returned	2196 (841.58 lbs.)
Major scientific experiments left on the Moon	60
Scientific experiments conducted in lunar orbit	34

# Moon Race Chronology

<u>Launch Date</u>	<u>Mission</u>	<u>Country</u>	<u>Outcome</u>	<u>Description</u>
08/17/58	Pioneer 0	USA	Failure	Attempted lunar orbit.
09/23/58	Luna 1958A	USSR	Failure	Attempted lunar impact.
10/11/58	Pioneer 1	USA	Failure	Attempted lunar orbit.
10/12/58	Luna 1958B	USSR	Failure	Attempted lunar impact.
11/08/58	Pioneer 2	USA	Failure	Attempted lunar orbit.
12/04/58	Luna 1958C	USSR	Failure	Attempted lunar impact.
12/06/58	Pioneer 3	USA	Failure	Attempted lunar flyby.
01/02/59	Luna 1	USSR	Success	Flyby. (first)
03/03/59	Pioneer 4	USA	Partial	Flyby. (59,983 km)
07/18/59	Luna 1959A	USSR	Failure	Attempted lunar impact.
09/12/59	Luna 2	USSR	Success	Lunar impact. (first)
10/04/59	Luna 3	USSR	Success	Probe.
11/26/59	Pioneer P-3 (Atlas-Able 4)	USA	Failure	Attempted lunar orbiter.
04/15/60	Luna 1960A	USSR	Failure	Attempted lunar flyby.
04/18/60	Luna 1960B	USSR	Failure	Attempted lunar flyby.
09/25/60	Pioneer P-30 (Atlas-Able 5A)	USA	Failure	Attempted lunar orbiter.
12/15/60	Pioneer P-31 (Atlas-Able 5B)	USA	Failure	Attempted lunar orbiter.
08/23/61	Ranger 1	USA	Failure	Attempted lunar test flight.
11/18/61	Ranger 2	USA	Failure	Attempted lunar flight test.
01/26/62	Ranger 3	USA	Failure	Attempted lunar impact.
04/23/62	Ranger 4	USA	Failure	First U.S. lunar impact.
10/18/62	Ranger 5	USA	Failure	Attempted lunar impact.
01/04/63	Sputnik 33 (Luna 1963A)	USSR	Failure	Attempted lunar lander.
02/02/63	Luna 1963B	USSR	Failure	Attempted lunar lander.
04/02/63	Luna 4	USSR	Failure	Attempted lunar lander.
1/30/64	Ranger 6	USA	Failure	Lunar impact.
03/21/64	Luna 1964A	USSR	Failure	Attempted lunar lander

# Moon Race Chronology (Continued)

<u>Launch Date</u>	<u>Mission</u>	<u>Country</u>	<u>Outcome</u>	<u>Description</u>
04/20/64	Luna 1964B	USSR	Failure	Attempted lunar lander.
06/04/64	Zond 1964A	USSR	Failure	Attempted lunar flyby.
07/28/64	Ranger 7	USA	Success	Lunar impact..
02/17/65	Ranger 8	USA	Success	Lunar impact..
03/12/65	Cosmos 60	USSR	Failure	Attempted lunar lander.
03/21/65	Ranger 9	USA	Success	Lunar impact.
04/10/65	Luna 1965A	USSR	Failure	Attempted lunar lander.
05/09/65	Luna 5	USSR	Failure	Attempted soft landing.
06/08/65	Luna 6	USSR	Failure	Attempted lunar lander.
07/18/65	Zond 3	USSR	Success	Lunar flyby.
10/04/65	Luna 7	USSR	Failure	Attempted soft landing.
12/03/65	Luna 8	USSR	Failure	Attempted soft landing.
01/31/66	Luna 9	USSR	Success	Lunar lander (semi-soft). (First)
03/01/66	Cosmos 111	USSR	Failure	Attempted lunar orbiter?
03/31/66	Luna 10	USSR	Success	Lunar orbiter. (First)
04/30/66	Luna 1966A	USSR	Failure	Attempted lunar orbiter.
05/30/66	Surveyor 1	USA	Success	Soft lunar lander. (First)
07/01/66	Explorer 33	USA	Failure	Attempted lunar orbiter.
08/10/66	Lunar Orbiter 1	USA	Success	2nd lunar orbiter.
08/24/66	Luna 11	USSR	Success	3rd lunar orbiter.
09/20/66	Surveyor 2	USA	Failure	Attempted lunar lander.
10/22/66	Luna 12	USSR	Success	4th lunar orbiter.
11/06/66	Lunar Orbiter 2	USA	Success	5th lunar orbiter.
12/21/66	Luna 13	USSR	Success	3rd lunar lander.
02/05/67	Lunar Orbiter 3	USA	Success	6th lunar orbiter.
03/10/67	Cosmos 146	USSR	Failure	7K L-1P test.
04/08/67	Cosmos 154	USSR	Failure	7K L-1P test.



# Moon Race Chronology (Continued)

<u>Launch Date</u>	<u>Mission</u>	<u>Country</u>	<u>Outcome</u>	<u>Description</u>
04/17/67	Surveyor 3	USA	Success	4th lunar lander.
05/04/67	Lunar Orbiter 4	USA	Success	7th lunar orbiter.
07/14/67	Surveyor 4	USA	Failure	Attempted lunar lander.
07/19/67	Explorer 35	USA	Success	8th lunar orbiter
08/01/67	Lunar Orbiter 5	USA	Success	9th lunar orbiter.
09/08/67	Surveyor 5	USA	Success	5th lunar lander.
09/28/67	Zond-1967A	USSR	Failure	Zond 4-type mission - lunar test flight.
11/07/67	Surveyor 6	USA	Success	6th lunar lander.
11/09/67	<b>Apollo 4</b>	USA	Success	<b>First Saturn V launch.</b>
11/22/67	Zond-1967B	USSR	Failure	Zond 4-type mission - lunar test flight.
01/07/68	Surveyor 7	USA	Success	7th lunar lander.
01/22/68	<b>Apollo 5</b>	USA	Success	<b>First LM flight test.</b>
02/07/68	Luna 1968A	USSR	Failure	Attempted lunar orbiter.
03/02/68	Zond 4	USSR	Failure	7K-L1 s/c destroyed during entry.
04/04/68	<b>Apollo 6</b>	USA	Success	<b>Unmanned suborbital test of manned craft.</b>
04/07/68	Luna 14	USSR	Partial	10th lunar orbiter.
04/23/68	Zond 1968A	USSR	Failure	Attempted lunar test flight of 7K L-1.
09/15/68	Zond 5	USSR	Success	Lunar flyby/Earth return. First L1 to fly around Moon.
10/11/68	<b>Apollo 7</b>	USA	Success	<b>First manned flight test of CSM.</b>
11/10/68	Zond 6	USSR	Success	Lunar flyby/Earth return. Crashed on Soviet soil.
12/21/68	<b>Apollo 8</b>	USA	Success	<b>First manned circumlunar mission.</b>
01/20/69	Zond 1969A	USSR	Failure	Attempted lunar flyby and return.
02/19/69	Luna 1969A	USSR	Failure	Attempted lunar rover (Lunokhod).
02/21/69	Zond L1S-1	USSR	Failure	First N-1 launch. Exploded at T + 70 sec.
03/03/69	<b>Apollo 9</b>	USA	Success	<b>First manned test of complete lunar spacecraft.</b>
04/14/69	Luna 1969B	USSR	Failure	Attempted lunar sample return?
05/18/69	<b>Apollo 10</b>	USA	Success	<b>First manned circumlunar test of complete lunar spacecraft.</b>

# Moon Race Chronology (Continued)

<u>Launch Date</u>	<u>Mission</u>	<u>Country</u>	<u>Outcome</u>	<u>Description</u>
06/14/69	Luna 1969C	USSR	Failure	Attempted lunar sample return?
07/03/69	Zond L1S-2	USSR	Failure	Circumlunar -- exploded at T + 5 sec.
07/13/69	Luna 15	USSR	Failure	11th unmanned lunar sampler/orbital -- crashed.
<b>07/16/69</b>	<b>Apollo 11</b>	<b>USA</b>	<b>Success</b>	<b>First manned lunar landing. (8th in all)</b>
08/07/69	Zond 7	USSR	Success	Lunar flyby/Earth return. Only completely successful L1 mission.
09/23/69	Cosmos 300	USSR	Failure	Attempted lunar sample return.
10/22/69	Cosmos 305	USSR	Failure	Attempted lunar sample return.
<b>11/14/69</b>	<b>Apollo 12</b>	<b>USA</b>	<b>Success</b>	<b>2nd manned lunar landing. (9th in all)</b>
11/28/69	Cosmos	USSR	Failure	7K L-1E test.
02/06/70	Luna 1970A	USSR	Failure	Attempted lunar sample return?
02/19/70	Luna 1970B	USSR	Failure	Attempted lunar orbiter?
<b>04/11/70</b>	<b>Apollo 13</b>	<b>USA</b>	<b>Partial</b>	<b>5th manned translunar flight.</b>
09/12/70	Luna 16	USSR	Success	Lander/sample return. First sample return.
10/20/70	Zond 8	USSR	Success	Lunar flyby/Earth return. Test for manned craft.
11/10/70	Luna 17	USSR	Success	Lander/rover -- Lunokhod 1. First rover.
12/02/70	Cosmos 382	USSR	?	7K L-1E test.
<b>01/31/71</b>	<b>Apollo 14</b>	<b>USA</b>	<b>Success</b>	<b>Third manned lunar landing. (12th in all)</b>
<b>07/26/71</b>	<b>Apollo 15</b>	<b>USA</b>	<b>Success</b>	<b>Fourth manned lunar landing. (13th in all)</b>
09/02/71	Luna 18	USSR	Failure	Attempted lunar sample return.
09/28/71	Luna 19	USSR	Success	Lunar orbiter.
02/14/72	Luna 20	USSR	Success	Lander/sample return. (14th landing in all)
<b>04/16/72</b>	<b>Apollo 16</b>	<b>USA</b>	<b>Success</b>	<b>Fifth manned lunar landing. (15th in all)</b>
11/23/72	Soyuz L3	USSR	Failure	Lunar distance -- exploded at T + 107 sec.
<b>12/07/72</b>	<b>Apollo 17</b>	<b>USA</b>	<b>Success</b>	<b>Sixth manned lunar landing. (16th in all)</b>
01/08/73	Luna 21	USSR	Success	Lander/rover -- Lunokhod 2 (17th lunar landing)
06/10/73	Explorer 49	USA	Success	Lunar orbiter.
05/29/74	Luna 22	USSR	Success	Lunar orbiter.

# Moon Race Chronology (Continued)

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<u>Launch Date</u>	<u>Mission</u>	<u>Country</u>	<u>Outcome</u>	<u>Description</u>
10/28/74	Luna 23	USSR	Failure	Attempted lunar sample return. (18th landing)
10/16/75	Luna 1975A	USSR	Failure	Attempted lunar sample return.
08/09/76	Luna 24	USSR	Success	Lunar sample return. (19th landing)

# Acronyms and Abbreviations

AFB	Air Force Base	GD	General Dynamics
AL	Alabama	GE	General Electric
AS	Apollo Saturn	GLOW	Gross Liftoff Weight
ASTP	Apollo Soyuz Test Project	h	hours
ASVC	Apollo Saturn V Center	IL	Illinois
AZ	Arizona	in.	inch
BP	boilerplate	Inc.	Incorporated
b/u	backup	I <sub>SP</sub>	specific impulse
CA	California	IU	Instrumentation Unit
CDR	Critical Design Review	JSC	Johnson Space Center
cg	center of gravity	KS	Kansas
CM	Command Module	KSC	Kennedy Space Center
Co.	company, county	kW	kilowatts
CO	Colorado	KY	Kentucky
Corp.	corporation	LaRC	Langley Research Center
CSM	Command/Service Module	LA	Louisiana
Ctr.	center	lb., lbs.	pounds
d	days	LC	Launch Complex
DCR	Design Certification Review	LES	Launch Escape System
Div.	division	LH2	Liquid Hydrogen
E	East	LM	Lunar Module
ECS	Environmental Control System	LOI	Lunar Orbit Insertion
EDT	Eastern Daylight Time	LOS	Loss Of Signal
EST	Eastern Standard Time	LOX	Liquid Oxygen
ETO	Earth To Orbit	M	million
FL	Florida	m	minutes
fps	feet per second	MCC	Midcourse Correction
ft.	feet	MD	Maryland
FVV	Facilities Verification Vehicle	MET	Mission Elapsed Time
fwd.	forward	Mgr.	Manager
GA	Georgia	MI	Michigan
gal.	gallons	mph	miles per hour

# Acronyms and Abbreviations (Cont'd.)

MS	Mississippi	SA	Saturn Apollo
MSC	Manned Spaceflight Center	SB	Seal Beach
MSFC	Marshall Space Flight Center	SC	South Carolina, spacecraft
N	North	s/c	spacecraft
N/A	Not Applicable	sec.	second
NAA	North American Aviation	SLA	Spacecraft LM Adapter
NASA	National Aeronautics and Space Administration	SM	Service Module
NASM	National Air and Space Museum	SPS	Service Propulsion System
NC	North Carolina	stg.	stage
NE	Nebraska	T	thrust
NM	New Mexico	$t_b$	burn time
nmi	nautical mile	TEI	Trans Earth Injection
NY	New York	TLI	Trans Lunar Injection
OH	Ohio	TX	Texas
OK	Oklahoma	UDT	Underwater Demolition Team
PA	Pennsylvania, Pad Abort	UK	United Kingdom
$P_c$	chamber pressure	U.S.	United States
Pgm.	program	USAF	United States Air Force
psia	pounds per square inch, absolute	USNS	United States Navy Ship
$P_{orb}$	orbital period	UT	Utah
Q	dynamic pressure	$v_{orb}$	orbital velocity
R&D	Research and Development	VP	Vice President
RAF	Royal Air Force	W	West
RCS	reaction control system	WA	Washington
S	South	WSMR	White Sands Missile Range
s	seconds	WSTF	White Sands Test Facility
S&ID	Space and Information Systems	Wt.	weight

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# 50th Anniversary Celebration Info

# Photos and Drawings

No.	Ref.	Page	Color/B&W	Photo/Drawing	Subject
1	1	132	color	illustration	mission profile
2	1	132	color	illustration	mission profile
3	1	224	color	painting/photo	Apollo/Soyuz
4	1	225	color	painting/photo	Apollo/Soyuz
5	2	153	B&W	drawing	spacecraft evolution
6	2	253	B&W	photos	CM (DNY)
7	2	254	B&W	photo	SPS engine
8	2	267	color	photo	structure sim (DNY)
9	2	271	color	photo	s/c assembly (DNY)
10	2	272	color	drawing	Block I s/c
11	2	417	B&W	photo	CSM (A-15 @ Moon)
12	2	425	B&W	painting	CSM (A-15 @ Moon)
13	2	427	B&W	drawing	Block II s/c
14	2	449	B&W	painting	CSM @ Moon
15	2	465	color	painting	CSM @ Moon
16	2	466	color	painting	Skylab
17*	2	472	color	painting	Apollo/Soyuz
18	2	513	B&W	photo	ASTP (DNY)
19	2	518	B&W	painting	Apollo/Soyuz
20	3	159	B&W	photo	S-II

# Photos and Drawings (Continued)

No.	Ref.	Page	Color/B&W	Photo/Drawing	Subject
21	4	26	color	illustration	Saturn V & CSM
22	5	28	color	illustration	Saturn V
23	5	119	color	illustration	Saturn V
24*	5	121	color	illustration	CSM
25*	5	167	color	illustration	Skylab
26*	5	176-7	color	illustration	Apollo/Soyuz
27	6	101	B&W	photo	Kindelberger (DNY)
28	6	157	B&W	photo	CSM (DNY)
29	6	158-9	B&W	drawing + photo	CSM
30	6	163	color	photo	CSM (DNY)
31*	6	167	color	photo	CSM (DNY)
32	6	170	color	painting	Apollo/Soyuz
33	7	129	color	photos	CM ass'y & test (DNY)
34	8	48	color	photo	S-II arm farm
35	8	72	color	photos	CSM testing (DNY)
36	8	108	color	photo	S-II
37	-----DELETED-----				
38	9	184-5	color	illustration	Skylab
39	9	208-9	color	illustration	Apollo-Soyuz
40	9	172-3	color	illustration	Saturn V + CSM + mission



# Photos and Drawings (Continued)

<u>No.</u>	<u>Ref.</u>	<u>Page</u>	<u>Color/B&amp;W</u>	<u>Photo/Drawing</u>	<u>Subject</u>
41	10	173	B&W	illustration	S-II
42	10	221	B&W	photos	CM manufacturing (DNY)
43	11	212	B&W	photo	Apollo 7 CM (DNY)
44	12	51	color	painting	Moon ship
45	13	31	B&W	drawing	Apollo parking orbit
46	13	87	B&W	drawing	CSM + LM
47	13	89	B&W	drawing	CM + LM
48	13	109	B&W	drawing	Saturn V
49	14	76	B&W	photo	CSM in VAB
50	14	124	B&W	photo	CSM in test stand (DNY)
51	15	123	B&W	drawing	Saturn V & CSM
52	15	195	B&W	drawing	Apollo/Soyuz
53	16	163	color	photos	CM ass'y & test (DNY)
54	19	64-5	color	illustration	Saturn I & V & CSM
55	19	66	color	illustration	CSM + LES
56	19	68-9	color	illustration	CM + LES
57*	19	88-9	color	illustration	CSM
58	18	72	color	photo	S-II stage
59	17	viii	B&W	photo	Apollo CM ass'y (DNY)
60	17	42-3	B&W	photos	CM interior & CSM

# Photos and Drawings (Continued)

No.	Ref.	Page	Color/B&W	Photo/Drawing	Subject
61	17	44	B&W	illustration	CSM w/ LES
62	17	47	color	photo	Apollo 1 crew
63	17	49	color	photo	Apollo 7 crew
64	17	53	color	photo	Apollo 8 crew
65	17	57	color	photo	Apollo 9 crew
66	17	61	color	photo	Apollo 10 crew
67	17	65	color	photo	Apollo 11 crew
68	17	73	color	photo	Apollo 12 crew
69	17	77	color	photo	Apollo 13 crew
70	17	81	color	photo	Apollo 14 crew
71	17	85	color	photo	Apollo 15 crew
72	17	89	color	photo	Apollo 16 crew
73	17	93	color	photo	Apollo 17 crew
74	17	103	color	photo	Skylab 2 crew
75	17	107	color	photo	Skylab 3 crew
76	17	111	color	photo	Skylab 4 crew
77	17	115	color	photo	Apollo/Soyuz crew
78	20	4	B&W	drawing	Sat V & Apollo s/c
79	20	5	B&W	drawing	CM & SM
80	20	7	B&W	illustration	CSM w/ LES

# Photos and Drawings (Continued)

No.	Ref.	Page	Color/B&W	Photo/Drawing	Subject
81	20	11	B&W	drawing	Saturn V & IB
82	20	39	B&W	drawing	CM
83*	20	40	B&W	photo	CM (DNY)
84	20	53	B&W	drawing	SM
85*	20	54	B&W	photo	CSM (DNY)
86	20	161	B&W	photo	SM (DNY)
87	20	229	B&W	photo	CM (DNY)
88	20	230	B&W	photos	CSM c/0 (DNY)
89	20	232	B&W	photo	CSM test
90	20	233	B&W	photo	Apollo s/c in VAB
91	20	238	B&W	photo	Apollo 7 CM test (DNY)
92	20	239	B&W	photo	CM test (DNY)
93	20	240	B&W	photos	CM tests (DNY)
94	20	241	B&W	photo	welding (DNY)
95	20	246	B&W	photo	CM hatch ass'y (DNY)
96	20	250	B&W	photo	CM & SM ass'y (DNY)
97	20	248	B&W	photo	egg crate (DNY)
98	20	252	B&W	photo	CM move (DNY)
99	21	95	B&W	photos	CM assembly (DNY)
100	21	134	B&W	photos	CM & SM full scale models
101	21	139	B&W	photos	CM mockup review (DNY)
102	22	226	B&W	photos	CM assembly (DNY)

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