NEWS

Space Division
North American Rockwell

Public Relations Department
12214 Lakewood Boulevard
Downey, California 90241

NAUTICAL MILES	STATUTE MILES	FT PER SEC	STATUTE MPH
66	75.9528	66	44.9988

APOLLO MILEAGE AND SPEED CONVERTER

Space Division
North American Rockwell

Public Relations Department
12214 Lakewood Boulevard
Downey, California 90241
(213)923-8111 ext 6467, 6460, and 6468

THE MOON

Diameter	2,160 miles (about 1/4 that of Earth)
Circumference	6,790 miles (about 1/4 that of Earth)
Distance From Earth	238,857 miles mean (221,463 minimum to 252,710 maximum)
Surface Temperature	250°F (sun at zenith) -280°F (night)
Surface Gravity	1/6 that of Earth
Mass	1/100th that of Earth
Volume	1/50th that of Earth
Lunar Day and Night	14 Earth days each
Mean Velocity in Orbit	2,287 miles per hour
Escape Velocity	1.48 miles per second
Month (period of rotation around Earth)	27 days, 7 hours, 43 minutes

The Apollo spacecraft's command and service modules and the Saturn V second stage are produced for NASA by North American Rockwell's Space Division.

APOLLO 11
SPACECRAFT WEIGHTS

(CSM 107 & LM 5)

Command module (including propellants & fluids)	12,253 lb
Service module (including propellants & fluids)	51,156
Spacecraft lunar module adapter (SLA)	4,049
Lunar module LM-5	33,277
Launch escape system	8,910
Total spacecraft weight at launch	109,645 lb
Spacecraft weight injected into earth orbit	100,735 lb (spacecraft with launch escape system jettisoned)
Command module weight at splashdown (normal mission)	10,971 lb (with parachutes disconnected)

APOLLO 11
SPACECRAFT WEIGHT BREAKDOWN

Command module (less RCS propellants)	12,007 lb
Reaction control system propellants	246
Service module (empty)	8,324
Service propulsion system propellants	40,803
Reaction control system propellants	1,341
Cryogenics (hydrogen & oxygen)	688
Total weight of spacecraft command and service modules	63,409

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SATURN V SECOND STAGE (S-II-6) FACT SHEET

The Saturn V launch vehicle's second stage to be used in Apollo 11's manned lunar landing mission is the sixth in a series of S-II stages.

S-II-6 STATISTICAL SUMMARY

Height	81 feet 6 inches
Diameter	33 feet
Weight (pounds)*	
Dry	79,918
Liftoff (ground)	1,069,274
Burnout	94,140
Propellant Loading (total)	979,243
LH_2	158,221
LOX	821,022
Power	

Engines (five J-2s) built by Rocketdyne, a division of North American Rockwell)

Thrust (pounds)	230,000 per engine at 5.5 to 1 oxygen/hydrogen mixture ratio
Ullage motors (4)	Thrust (pounds) 22,700 per motor
Burntine	6 minutes, 29 seconds
Velocity	
S-IC/S-II-6 separation	9,064 feet per second (air speed, includes the earth's rotation)
S-II-6/S-IVB separation	22,757 feet per second
Altitude	
S-IC/S-II-6 separation	219,984 feet
S-II-6/S-IVB separation	609,982

SEQUENCE OF S-II-6 APOLLO II MISSION EVENTS

Normal flight time (minutes: seconds)

2:40.8	S-II LH_2 recirculation stop
2:41.3	S-II ullage motor trigger
2:41.6	S-IC/S-II separation
2:43.2	S-II engine start
3:11.9	S-IC/S-II aft interstage separation
4:21.1	S-II LOX step pressurization
7:39.8	S-II center engine cutoff
7:40.6	S-II LH_2 step pressurization
9:11.4	S-II outboard engines cutoff
9:12.2	S-II/S-IVB separation
20:16	S-II Atlantic splashdown (2,300 nautical miles downrange)

*Weights, times, velocities, altitudes estimates

APOLLO 11 MISSION HIGHLIGHTS

Event	GET hr:min:sec	PDT	CDT	EDT
Wednesday, July 16, 1969				
Liftoff	00:00:00	6:32am	8:32am	9:32am
S-IC staging	00:02:41	6:34:41	8:35	9:35
S-II staging	00:09:10	6:41:10	8:41	9:41
Earth orbit insertion	00:11:53	6:43:43	8:43	9:43
Translunar injection	02:44:26	9:16:26	11:16	12:16pm
CSM/S-IVB separation	03:14:46	9:46:46	11:47	12:47
CSM/LM docking	03:25:00	9:57:00	11:57	12:57
LM ejection	04:09:45	10:41:45	12:41pm	1:41
Evasive maneuver	04:39:45	11:11:45	1:11	2:11
MCC 1	11:50:00	6:22pm	8:22	9:22
Begin crew rest (9 hr)	13:30:00	8:02	10:02	11:02
Thursday, July 17				
End rest period	22:30:00	5:02am	7:02am	8:02am
MCC 2	26:50:26	9:22	11:22	12:22pm
Begin crew rest (10 hr)	37:00:00	7:32pm	9:32pm	10:32
Friday, July 18				
End rest period	47:00:00	5:32am	7:32am	8:32am
MCC 3	53:54:00	12:26pm	2:26pm	3:26pm
LMP IVT to LM	56:15:00	2:47	4:47	5:47
CDR IVT to LM	56:20:00	2:52	4:52	5:52
LMP IVT to CSM	57:45:00	4:17	6:17	7:17
CDR IVT to CSM	57:50:00	4:22	6:22	7:22
Begin crew rest (9 hr)	60:00:00	6:32	8:32	9:32
Saturday, July 19				
End rest period	67:00:00	3:32am	5:32am	6:32am
MCC 4	70:54:28	5:26	7:26	8:26
LOI 1	75:54:28	10:26	12:26pm	1:26pm
LOI 2	80:09:30	2:42pm	4:42	5:42
LMP IVT to LM	81:50:00	4:22	6:22	7:22
Begin rev 4	82:10:00	4:42	6:42	7:42
LMP IVT to CSM	83:45:00	6:17	8:17	9:17
Begin rev 5	84:08:00	6:40	8:40	9:40
Begin crew rest (8 hr)	85:00:00	7:32	9:32	10:32
Begin rev 6	86:07:00	8:39	10:39	11:39
Begin rev 7	88:06:00	10:38	12:38am	1:38am
Sunday, July 20				
Begin rev 8	90:02:00	12:34am	2:34am	3:34am
Begin rev 9	92:01:00	2:33	4:33	5:33
Crew rest ends	93:37:00	4:09	6:09	7:09
Begin rev 10	93:59:00	4:31	6:31	7:31
LMP IVT to LM	95:50:00	6:22	8:22	9:22
Begin rev 11	95:57:00	6:29	8:29	9:29
CDR IVT to LM	96:51:00	7:23	9:23	10:23
Begin rev 12	97:55:00	8:27	10:27	11:27
Deploy LM gear	99:05:00	9:37	11:37	12:37pm
Begin rev 13	99:51:00	10:23	12:23pm	1:23
CSM/LM undock	100:15:00	10:47	12:47	1:47
CSM sep maneuver	100:39:50	11:12	1:12	2:12
Descent orbit insertion	101:38:48	12:11pm	2:11	3:11
Begin rev 14 (CSM)	101:51:00	12:23	2:23	3:23
Begin PDI (LM)	102:35:11	1:07	3:07	4:07
Lunar touchdown	102:47:03	1:19	3:19	4:19
Begin rev 15	103:48:00	2:20	4:20	5:20
Go/No-go lunar stay	104:22:00	2:54	4:54	5:54
CDR/LMP eat (40 min)	104:51:00	3:23	5:23	6:23
CMP eats (1 hr)	105:21:00	3:53	5:53	6:53
CMP rests (4 hr)	105:30:00	4:02	6:02	7:02

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APOLLO II MISSION HIGHLIGHTS (CONT)

Event	GET	PDT	CDT	EDT
	hr:min:sec			
	Monday, July 21, 1969			
Begin rev 16 (CSM)	105:46:00	4:18	6:18	7:18
CSM plane change	107:05:33	5:38	7:38	8:38
CMP rest (4 hr)	107:36:00	6:08	8:08	9:08
Begin rev 17 (CSM)	107:45:00	6:17	8:17	9:17
CDR/LMP rest ends	109:30:00	8:02	10:02	11:02
Begin rev 18 (CSM)	109:44:00	8:16	10:16	11:16
CDR/LMP start EVA	110:33:00	9:05	11:05	12:05am
CMP rest ends	111:20:00	9:52	11:52	12:52
Begin rev 19 (CSM)	111:42:00	10:14pm	12:14am	1:14am
CDR - emerges LM	112:40:00	11:12	1:12	2:12
LMP - emerges LM	113:06:00	11:38	1:38	2:38
CDR deploys TV	113:12:00	11:44	1:44	2:44
LMP deploys SWC	113:19:00	11:51	1:51	2:51
CDR bulk sample	113:24:00	11:56	1:56	2:56
CDR/LMP inspect LM	113:38:00	12:10am	2:10am	3:10am
Begin rev 20	113:39:00	12:11	2:11	3:11
CDR/LMP deploy EASEP	114:00:00	12:32	2:32	3:32
CDR/LMP collect samples	114:08:00	12:40	2:40	3:40
LMP ends EVA	115:00:00	1:32	3:32	4:32
CDR ends EVA	115:10:00	1:42	3:42	4:42
Begin rev 21	115:37:00	2:09	4:09	5:09
Jettison equip from LM	116:17:00	2:49	4:49	5:49
CMP begins rest	116:20:00	2:52	4:52	5:52
CDR/LMP eat (rp min)	116:41:00	3:13	5:13	6:13
Begin rev 22	117:36:00	4:08	6:08	7:08
Begin rev 23	119:35:00	6:07	8:07	9:07
CMP rest ends	121:10:00	7:42	9:42	10:42
CMP eats (1 hr)	121:10:00	7:42	9:42	10:42
Begin rev 24	121:32:00	8:04	10:04	11:04
CDR/LMP eat (30 min)	122:35:00	9:07	11:07	12:07pm
Begin rev 25	123:31:00	10:03	12:03pm	1:03pm
LM lunar liftoff	124:23:21	10:55	12:55	1:55
LM orbit insertion	124:30:44	11:03	1:03	2:03
CSI (LM RCS)	125:21:19	11:53	1:53	2:53
Begin rev 26	125:30:00	12:02pm	2:02	3:02
Plane change (LM RCS)	125:50:28	12:22	2:22	3:22
CDH (LM RCS)	126:19:37	12:52	2:52	3:52
TPI (LM RCS)	126:58:08	1:30	3:30	4:30
MCC 1 (LM RCS)	127:13:08	1:45	3:45	4:45
Begin rev 27	127:27:00	1:59	3:59	4:59
MCC 2 (LM RCS)	127:28:08	2:00	4:00	5:00
5 LM RCS braking burns	127:36:57	2:09	4:09	5:09
	Thru			
	127:43:35	2:16	4:16	5:16
Docking	128:00:00	2:32	4:32	5:32
Begin rev 28	129:27:00	3:59	5:59	6:59
CDR IVT to CSM	130:06:00	4:38	6:38	7:38
LMP IVT to CSM	130:45:00	5:17	7:17	8:17
Begin rev 29	131:27:00	5:59	7:59	8:59
LM jettison	131:53:05	6:25	8:25	9:25
Eat period (1 hr)	132:21:00	6:53	8:53	9:53
Begin rev 30	133:24:00	7:56	9:56	10:56
Begin rev 31	135:18:00	9:50	11:50	12:50am
Transearth injection	135:24:34	9:57	11:57	12:57
	Tuesday, July 22			
All begin rest (10 hr)	137:00:00	11:32pm	1:32am	2:32am
End rest period	147:00:00	9:32am	11:32	1:32pm
MCC 5	150:27:00	12:59pm	2:59pm	3:59
All begin rest (10 hr)	160:00:00	10:32	12:32am	1:32am
	Wednesday, July 23			
End rest period	170:00:00	8:32am	10:32am	11:32am
MCC 6	172:05:00	10:37	12:37pm	1:37pm
Begin rest period	182:00:00	8:32pm	10:32	11:32
	Thursday, July 24			
End rest period	189:00:00	3:32am	5:32am	6:32am
MCC 7	192:05:27	6:37	8:37	9:37
CM/SM separation	194:50:00	9:22	11:22	12:22pm
Entry interface (400K)	195:05:04	9:37	11:37	12:37
Enter S-Band blackout	195:03:45	9:36	11:36	12:36
Exit S-Band blackout	195:06:51	9:39	11:39	12:39
Drogue deployment	195:11:39	9:44	11:44	12:44
Main chute deployment	195:12:27	9:45	11:45	12:45
Touchdown	195:19:06	9:51	11:51	12:51

KSC	Houston	Downey	DAY 1	2	3	4	5	6	7	8	9
9:32a	8:32a	6:32a	0	24	48	72	96	120	144	168	192
11:32a	10:32a	8:32a	2	26	50	74	98	122	146	170	194
1:32p	12:32p	10:32a	4	28	52	76	100	124	148	172	196
3:32p	2:32p	12:32p	6	30	54	78	102	126	150	174	
5:32p	4:32p	2:32p	8	32	56	80	104	128	152	176	
7:32p	6:32p	4:32p	10	34	58	82	106	130	154	178	
9:32p	8:32p	6:32p	12	36	60	84	108	132	156	180	
11:32p	10:32p	8:32p	14	38	62	86	110	134	158	182	
1:32a	12:32a	10:32p	16	40	64	88	112	136	160	184	
3:32a	2:32a	12:32a	18	42	66	90	114	138	162	186	
5:32a	4:32a	2:32a	20	44	68	92	116	140	164	188	
7:32a	6:32a	4:32a	22	46	70	94	118	142	166	190	
9:32a	8:32a	6:32a	24	48	72	96	120	144	168	192	

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

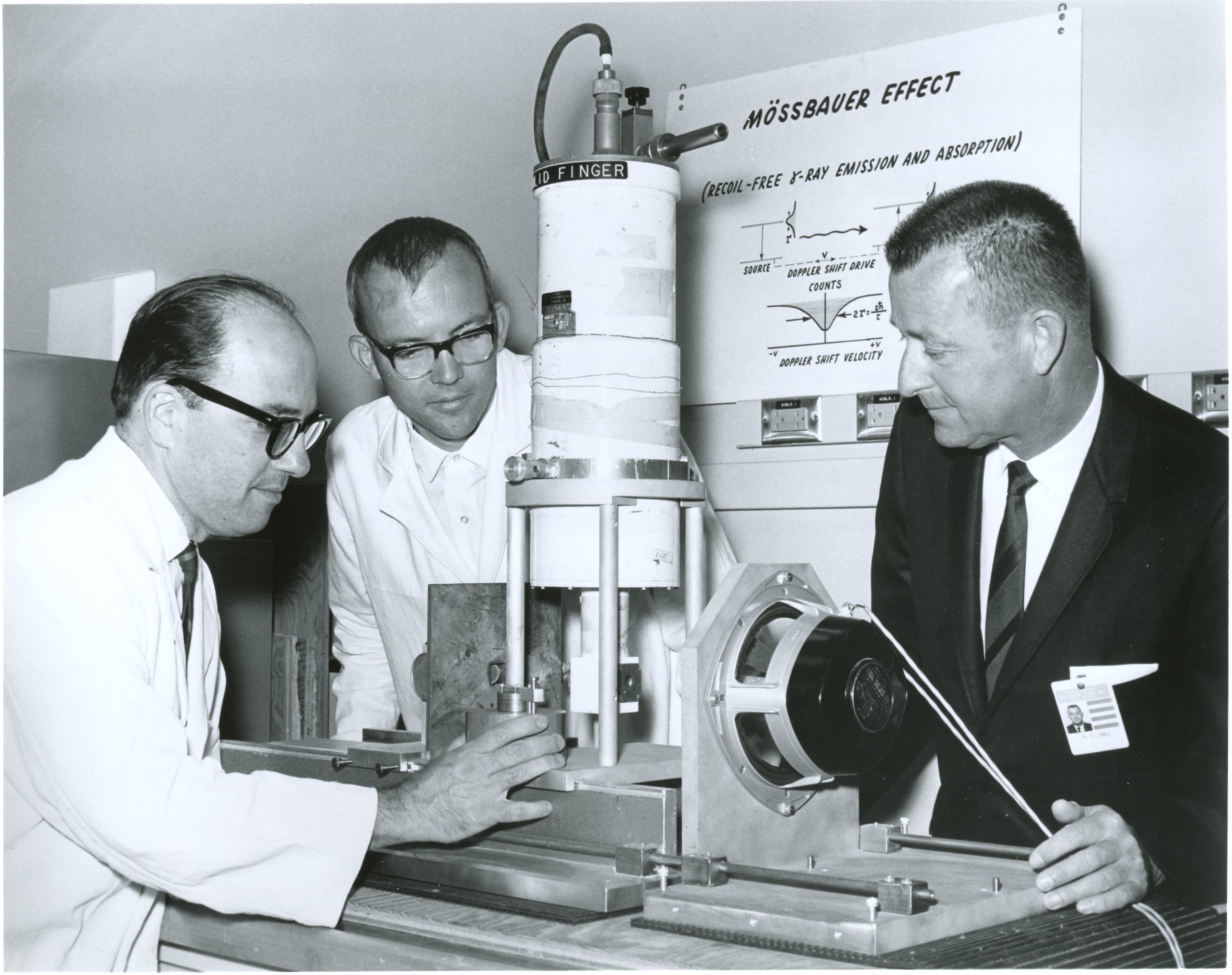
FOR IMMEDIATE RELEASE

GATHERING LUNAR SOIL--Apollo 11 Spacecraft Commander Neil Armstrong scoops lunar soil sample into pouch held by Lunar Module Pilot Edwin Aldrin in this illustration by North American Rockwell's Space Division. About 50 pounds of rock and soil are to be brought back to earth. Space Division, which produces the Apollo command and service modules (seen orbiting moon), is among principal investigators selected by NASA to help analyze lunar soil which will be returned to earth in command module.

# # # #

DBA072169
A-254

Phone: Earl Blount, Dave Alter
(213) 923-8111, Ext. 6467, 8
or
Bill Levering
(213) 647-5440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LUNAR SAMPLE PREPARATIONS -- A. C. Jones (right) of North American Rockwell's Space Division, and two scientists check on Mossbauer effect spectrometer that will be used to analyze moon dust when it is returned by the Apollo II astronauts. Jones (right) is program manager and principal administrator for the Space Division in the lunar sample experiment. Dr. Milton Blander (left) and Dr. Robert M. Housley (center), North American Science Center, will help with the analysis.

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DBA072169
A-255

PHONE: Earl Blount, Dave Alter
(213) 923-8111, Ext. 6467,8

or

Bill Levering
(213) 647-5440

FOR IMMEDIATE RELEASE

S-27

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

DOWNEY, Calif. —Apollo spacecraft command modules containing 7,999,930 perfectly working parts have traveled more than 9 million miles through space.

The flight record amassed by Apollos 7, 8, 9, and 10 includes two trips to the moon and back, 41 lunar orbits and 318 earth orbits—roughly 9,470,000 miles—in a total of 840 hours or 35 days, said William B. Bergen, President of North American Rockwell's Space Division.

The Space Division builds the Apollo command and service modules and the S-II second stage of the Saturn V launch vehicle under contract to NASA.

Each command module has nearly two million functional parts, exclusive of wiring and structural components. On the manned flights to date, approximately 70 parts have malfunctioned; none has been of a critical nature which jeopardized either the safety of the crew or the success of the mission. On the contrary, all missions have achieved or bettered their objectives.

Bergen noted that the Space Division has been working on the Apollo program for eight years under a NASA contract with a total value of $3.4 billion, and with a peak employment of 34,000 persons. Half of the contract money has gone to 9,000 suppliers and subcontractors across the country.

- more -

Now Apollo 11 will take two million more parts to the moon and back. The lunar landing mission will log nearly 750,000 miles, including 28 lunar orbits, in slightly more than 195 hours.

Astronauts Neil Armstrong, Michael Collins, and Edwin Aldrin are scheduled to lift off in Apollo 11 the morning of Wednesday, July 16, atop a Saturn V at Cape Kennedy.

According to NASA's flight plan, the mission will proceed as follows:

The Space Division-built S-II second stage will boost the spacecraft and third stage to near earth-orbital altitude. On either the second or third orbits, a third-stage burn will start Apollo 11 on its 73-hour journey to the moon at a speed of about 24,000 miles per hour.

Shortly thereafter, the astronauts will separate the command and service modules from the third stage, turn around, dock with the lunar module nestled in the third stage, and pull it away. The combined command, service, and lunar modules will then perform an evasive maneuver away from the third stage.

Up to four midcourse corrections may be made in the translunar trajectory, depending upon the degree of correction required.

During the translunar coast, flight commander Armstrong and lunar module pilot Aldrin will transfer briefly to the lunar module to check it out.

While enroute to the moon, the spacecraft's velocity will decrease gradually to about 1,300 miles per hour because of the earth's gravity pull, then will increase again as the moon begins exerting its gravitational influence.

- more -

Apollo 11 is scheduled to arrive at the moon about midday Saturday, July 19. Two burns by the service propulsion engine will put the spacecraft into a circular orbit approximately 69 miles above the lunar surface.

Early Sunday morning, July 20, Armstrong and Aldrin will again transfer to the lunar module. About four hours later, they will separate the lunar module from the command module and prepare to take it down to the moon, while command module pilot Collins stays in circular orbit.

The descent firing will occur at about midday. Touchdown on the lunar surface is planned for precisely 1:17 p.m. PDT.

After a rest and checkout period of about 10 hours, Armstrong will exit the lunar module and descend a nine-step ladder to the surface. Aldrin will monitor Armstrong's activities and operate cameras and television for about 25 minutes, then he too will step down to the surface.

For the next two hours, the astronauts will explore, photograph, and televise their surroundings, collect surface and subsurface samples, examine the lunar module, and deploy scientific equipment, some of which will remain on the moon to continue sending data to earth.

Then the astronauts will return to the lunar module and, after a rest period of about nine hours, will lift off in the ascent stage, leaving the descent stage on the surface. At this time it will be late Monday morning, July 21.

Rendezvous and docking with the command module will take a little under four hours. Armstrong and Aldrin will rejoin Collins in the command module, the lunar module ascent stage will be jettisoned to remain in lunar orbit, and early Monday evening the astronauts will head for home.

- more -

The return trip will last about 60 hours—until late Thursday morning, July 24. Shortly before entry into the earth's atmosphere, the command module will separate from the service module and turn so that it enters blunt end forward.

At entry speed of about 24,700 miles per hour, the command module's blunt aft heat shield will endure temperatures reaching 4,200 degrees Fahrenheit, but inside the cabin it will be a comfortable 75 degrees or so.

Slowed gently by its parachutes, Apollo 11 will end its epic space voyage with splashdown at about midday Thursday in the Pacific Ocean.

# # # #

DBA071669

Phone: Earl Blount, Dave Alter
(213) 923-8111, Ext. 6467, 8

or

W. C. Levering
(213) 647-5440

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

FOR IMMEDIATE RELEASE

S-26

DOWNEY, Calif.--The company that produced the spacecraft and Saturn V second stage for the Apollo 11 moon landing mission has been selected to test and analyze a lunar soil sample for the National Aeronautics and Space Administration (NASA).

A small amount of lunar dust--about two grams (70 thousandths of an ounce) will be consigned by NASA to the Space Division of North American Rockwell, said Albert C. Jones, program manager and principal administrator responsible for the lunar sample experiment. Two grams of lunar dust are expected to be less than a thimble full, or equal to about 1/4 teaspoon of salt.

The lunar sample will be flown to Space Division in Downey, Calif., after the soil has been quarantined at Houston for at least 21 days.

Then the pinch of priceless and historic dust will be transported to a specially-prepared laboratory at North American Rockwell's Science Center in Thousand Oaks, Calif., where a new type of spectrometer will seek to unveil the sample's origins and type--is it volcanic ash, meteorite material, cosmic dust, a mixture, or what? The spectrometer will analyze and measure energy which the sample absorbs.

Principal science investigator for the lunar sample test is Dr. Arthur H. Muir Jr., NR physicist, whose scientific team will concentrate on iron content and its distribution in the sample. Distribution of iron may help determine whether the material is volcanic or meteoritic.

Tha laboratory will utilize Mossbauer Effect Spectroscopy to do nondestructive test analysis, said Dr. R. M. Housley, scientist and co-investigator. It permits analysis of grains that cannot be identified by conventional means because of small

-moresize or amorphous (glassy) nature. The technique works like this:

Radioactive material is placed in the spectrometer and emits gamma rays. The rays are transmitted through the lunar sample. Then, a spectrum is produced on a small screen and tells the scientists the characteristics of the material. For instance, the position of the lines of the spectrum can identify the mineral.

The method is named for a German scientist, Professor Rudolf Mossbauer, whose discovery in 1958 netted him the Nobel prize.

# # #

DBA061669

Phone: Earl Blount, Dave Alter
(213) 923-8111, Ext. 6467,8

or

Bill Levering
(213) 647-5440

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

DOWNEY, Calif.--North American Rockwell's Space Division has contracts with the National Aeronautics and Space Administration totaling $4.8 billion for the design and fabrication of the Apollo command and service modules and the second stage (S-II) of the Saturn V launch vehicle.

The more than four billion dollar total includes $3.4 billion for the Apollo and $1.4 billion for the S-II stage. The Apollo spacecraft program contract extends through February, 1971, and the S-II program contract through July, 1971.

In addition, the division is under letter contract to NASA to modify four Apollo command and service modules for planned use in extended Earth Orbital missions in the Apollo Applications Program (AAP), which is scheduled to follow the lunar landing flights. The definitized contract is being negotiated.

Under the direction of NASA's Manned Spacecraft Center, the Space Division's Apollo contract is for the development and fabrication of 45 manned or test spacecraft command and service modules, 30 boilerplate (engineering test) vehicles, and 23 full-scale mockups. Also included are the production of accompanying spacecraft/lunar module adapters, two miscellaneous spacecraft/LM adapters, five test fixtures, four Apollo mission simulators, three evaluators, five trainers, and tracking and ground support equipment.

The Saturn S-II contract, under the direction of NASA's Marshall Space Flight Center, calls for the development and fabrication of 15 S-II flight stages, three test stages, a "battleship"--or systems--test vehicle, three cryogenic structural test articles, and associated ground support and test equipment.

A number of the early Apollo boilerplate and test spacecraft were used in ground tests and various unmanned flights to qualify spacecraft systems and for spacecraft/launch vehicle compatibility checks. Status of the flight spacecraft, including those already used in Apollo missions and those scheduled for future manned missions, is as follows: (Note--Spacecraft (SC) numbers shown are used for manufacturing, identification prior to delivery to NASA.)

SC-017--Used in unmanned Apollo 4 mission, first Apollo launched aboard Saturn V. Now used by NASA for display purposes, the command module is at the Smithsonian Institution.

SC-020--Flown in Apollo 6 mission, second unmanned test of Apollo on the Saturn V. Command module used as a NASA display article.

SC-101--Payload for Apollo 7, first manned Apollo flight. On loan to Air Force for display purposes.

SC-102--Ground test article. Command module used in docking tests with lunar module at Grumman Aircraft Engineering Corp. Service module initially utilized in service propulsion system static firing tests at NASA's Kennedy Space Center. Both are now in storage at Downey.

SC-103--Used in Apollo 8 moon orbit mission. Command module featured U.S. display at Paris Air Show, now on extensive tour in Europe. On its return to to the U.S. it will go to the Smithsonian Institution.

SC-104--Payload for Earth-orbiting Apollo 9 mission. Command module will be used for display purposes by NASA's Manned Spacecraft Center.

SC-105--Command and service modules (ground test only) used in manned acoustic-vibration tests at NASA's Manned Spacecraft Center.

SC-106--Flown in Apollo 10 mission to moon, command module is nearing completion of post-flight testing at Space Division's Downey, Calif., facility.

SC-107--Spacecraft for Apollo 11 mission.

SC-108--At Kennedy Space Center being prepared for Apollo 12, scheduled for later this year.

SC-109--At Kennedy Space Center being prepared for Apollo 13.

SC-110--Has completed pre-delivery systems checkout at Downey. Now on stand-by for tests in support of Apollo 11.

SC-111--At Downey, undergoing final pre-delivery systems checkout.

SC-112--At Downey, in final systems installation prior to start of systems checkout.

SC-113--At Downey, beginning final systems installation.

SC-114--At Downey, in initial systems installation.

SC-115--At Downey, in initial systems installation.

SC-115A--At Downey, at start of initial systems installation.

Apollo SC-116, 117, 118, and 119, all earmarked for use in the Apollo Applications Program, are at Downey in the initial phase of manufacturing structural assembly.

Space Division has already built for NASA all test and development hardware, and has delivered eight S-II flight stages and associated supporting equipment. Status of the flight stages, including those that have been used in Apollo missions and those under construction, is as follows: (Note-S-II-numbers are used for identification prior to delivery to NASA.)

S-II-1--Apollo 4.

S-II-2--Apollo 6.

S-II-3--Apollo 8.

S-II-4--Apollo 9.

S-II-5--Apollo 10.

S-II-6--On the pad at Kennedy Space Center in Apollo 11 launch vehicle.

S-II-7--At Kennedy Space Center, stacked in the launch vehicle for the Apollo 12 mission.

S-II-8--At Kennedy Space Center, being prepared for Apollo 13 flight.

S-II-9--Undergoing post-acceptance static firing checkout at NASA's Mississippi Test Facility.

S-II-10--At Mississippi Test Facility being readied for static-firing acceptance test.

S-II-11--At Space Division's Seal Beach, Calif., facility in final phase of systems installation.

S-II-12--At Seal Beach, approximately midway through systems installation.

S-II-13--At Seal Beach, being prepared for systems installation.

S-II-14--At Seal Beach, in vertical assembly.

S-II-15--At Seal Beach, major components being prepared for assembly.

# # # #

MISSIONS

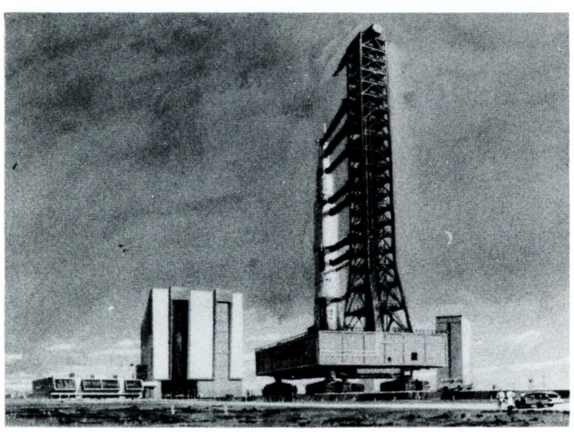
Apollo missions fall into three categories: earth- and lunar-orbital, lunar landing, and the Apollo Applications Program (AAP). Scheduled missions in the first category have been completed. Post-Apollo missions are described in a separate section of this book.

EARTH AND LUNAR-ORBIT MISSIONS

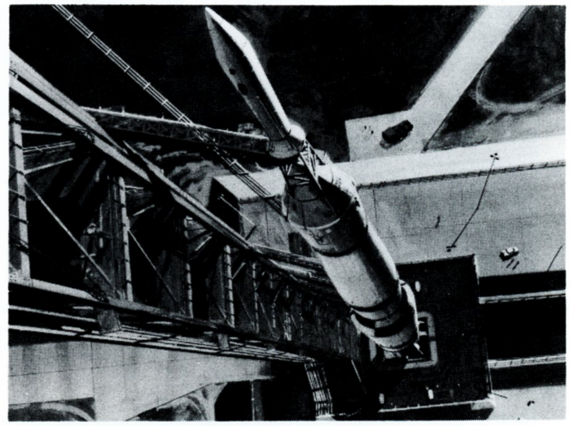
NASA's schedule of Apollo development missions has progressed logically toward accomplishing a lunar landing. The flight test program comprised unmanned flights, manned earth-orbital flights, and manned lunar-orbital flights.

All flight tests of the Apollo command, service, and lunar modules have been successful. First CSM tests were aimed primarily at the operation of its subsystems and of man-rating the subsystems (certifying for manned space flight). Particularly important were tests of the heat shield and command module structure, which survived such rigorous conditions as the 4,200-degree heat during atmospheric entry from a lunar mission. The spacecraft's compatibility with the Saturn launch vehicles has been demonstrated.

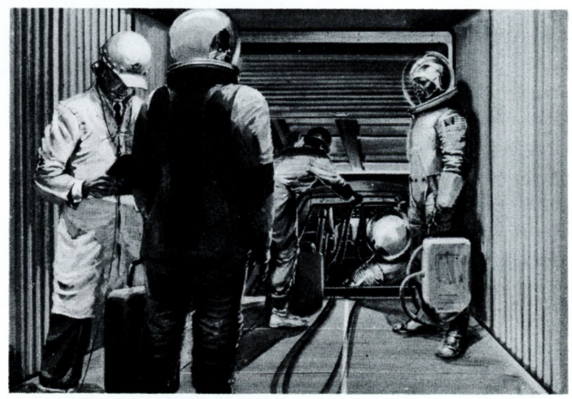
Primary objective of the manned missions was to determine the proficiency of the crew in the complex tasks required during the lunar missions and to test the operation of the Manned Space Flight Network, the communications link used during lunar missions. Crew tasks evaluated were those required for navigation, transposition and docking, rendezvous and docking, major propulsion maneuvers, entry, and recovery.



P-12
Mobile launcher carries space vehicle to launching pad



P-13
Apollo and Saturn are checked out before launch



P-14
Three astronauts enter the command module

The first manned mission (Apollo 7, October 11-22, 1968) tested the adequacy and performance of all CSM subsystems, including the life support and environmental control subsystems. Only the command and service modules were launched. The Saturn IB was the launch vehicle.

The success of Apollo 7 cleared the way for the pioneer U.S. manned flight to the moon. Apollo 8 (December 21-27, 1968), consisting of the command and service modules and a 3-man crew, was launched into earth orbit by a Saturn V, then boosted by the Saturn's third stage toward the moon, where it completed ten orbits before returning to earth.

Having proved the operability of the CSM and crew in deep space, NASA conducted the first manned test of the lunar module (Apollo 9, March 3-13, 1969). Transposition and docking, intravehicular transfer, separation, rendezvous and docking, and extravehicular activity were completed successfully in earth orbit.

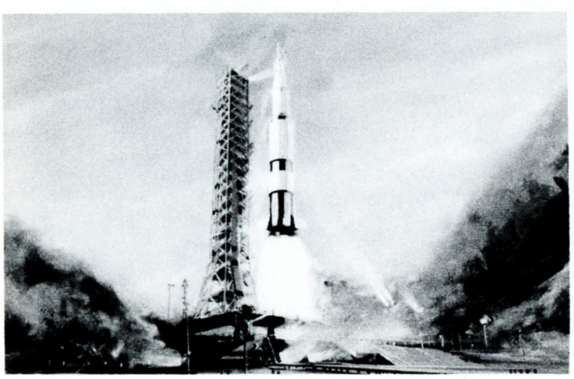
Apollo 10 (May 18-26, 1969) carried the CSM and LM to the moon together for the first time, for 31 orbits. In maneuvers simulating a landing and liftoff, two of the three crewmen flew to within 50,000 feet of the lunar surface.

LUNAR LANDING MISSION

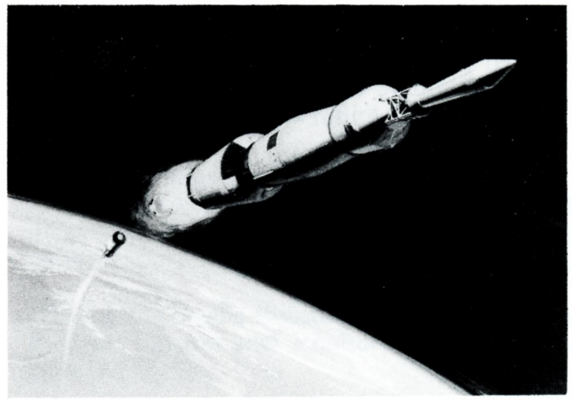
For planning purposes, the lunar landing mission is divided into operational phases, described here.

EARTH ASCENT

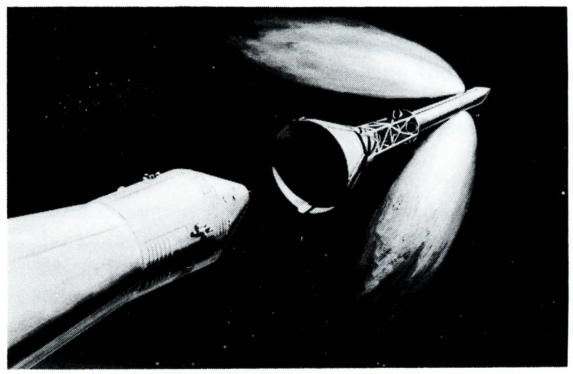
At liftoff, the Saturn V's first stage, developing over 7-1/2 million pounds of thrust from its five F-1 engines, lifts the 6.4 million-pound space vehicle off the pad and boosts it on its way. The first stage burns for about 2-1/2 minutes and reaches a velocity of about 5400 miles per hour and an altitude of about 40 miles. After the F-1 engines cut off, retrorockets on the first stage fire to achieve separation from the second stage. Four seconds later, the second stage's five J-2 engines ignite to boost the third stage and spacecraft to an altitude of approximately 114 statute miles. During its approximately 6 minutes of firing, the second stage increases velocity to about 15,000 miles per hour. When its engines cut off, the second stage is jettisoned.



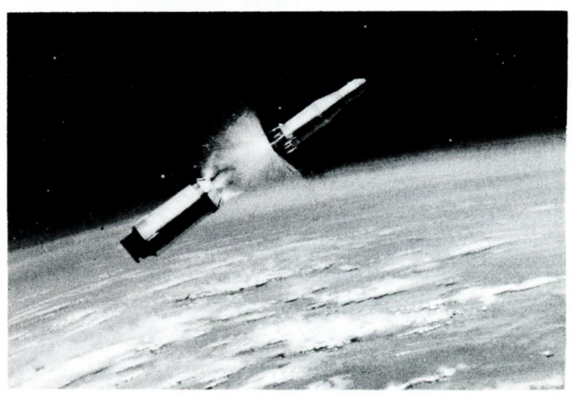
P-15 *First stage lifts huge space vehicle off pad*



P-16 *Second stage ignites after first stage falls away*



P-17 *Launch escape assembly is jettisoned*



P-18 *Third stage ignites as second stage falls away*

The third stage's single J-2 engine ignites at separation and burns for about 2 minutes to increase speed to about 16,500 miles an hour and put it and the Apollo spacecraft into a near-circular earth orbit at about 115 statute miles.

During ascent, the crew monitors the launch vehicle displays to be prepared for an abort, if necessary; relays information about boost and the spacecraft to the ground; and monitors critical subsystem displays.

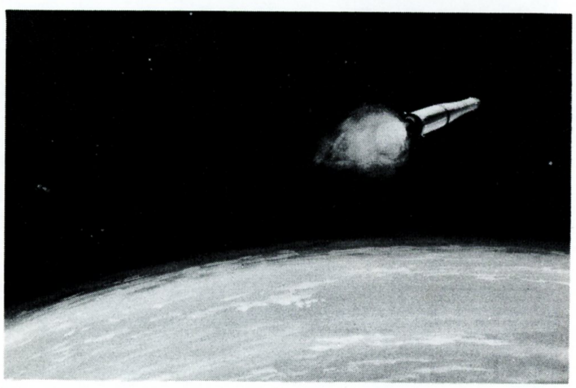
EARTH PARKING ORBIT

The spacecraft is inserted into an earth parking orbit to permit checkout of subsystems before it is committed to lunar flight, and to allow for more than one opportunity for translunar injection (instead of a single one in a direct launch).

The mission allows the spacecraft, with the third stage attached, to orbit the earth up to three times (for 4-1/2 hours) before injection into translunar flight. Because injection is desirable as soon as possible after checkout, the translunar injection maneuver probably will be performed during the second orbit. To inject the spacecraft into translunar flight, the crew reignites the third-stage engine.

TRANSLUNAR INJECTION

The translunar injection parameters are computed with the guidance system in the Saturn V's third-stage instrumentation unit. Thus, the third stage is commanded to fire at the proper moment and for the precise length of time necessary to put the spacecraft into a trajectory toward the moon.



P-19

Third stage fires again for translunar injection

This trajectory is nominally one that provides a "free return" to earth; that is, if for any reason the spacecraft is not inserted into an orbit around the moon, the spacecraft will return to earth.

The third-stage engine burns for about 5-1/2 minutes and cuts off at an altitude of about 190 miles and at a velocity of about 24,300 statute miles an hour.

During the engine thrusting, the crewmen remain in their couches and monitor the main display console.

INITIAL TRANSLUNAR COAST

The manned space flight network tracks the spacecraft for about 10 minutes after third-stage engine cutoff to determine whether to proceed with transposition and docking. During the same period, the third stage maneuvers the spacecraft to the attitude programmed for the transposition, docking, and LM-withdrawal maneuvers.

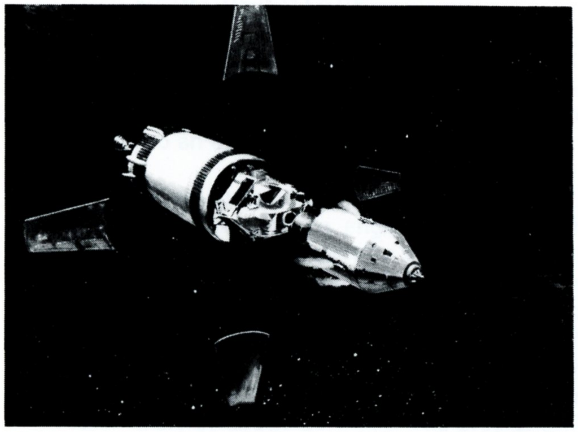
The crewmen position their couches to see out of the docking windows. The commander begins the transposition and docking maneuver by firing the service module reaction control engines. A signal is sent almost simultaneously to deploy and jettison the SLA panels, separate the CSM from the SLA, and deploy the CSM's high-gain antenna. The lunar module remains attached to the adapter.

The commander stops the CSM 50 to 75 feet away from the third stage, turns 180 degrees with a pitch maneuver so the docking windows are facing the LM, rolls the CSM for proper alignment with the LM, closes with the LM, and docks.

After the CSM and LM have docked, the pressure between the CM and the LM is equalized and the CM forward hatch is removed. A check is made to determine that all docking latches are engaged, the CSM-LM electrical umbilicals are connected, and the CM forward hatch is reinstalled. The LM's four connections to the SLA are severed by small explosive charges, and the spacecraft is separated from the SLA and third stage by spring thrusters.

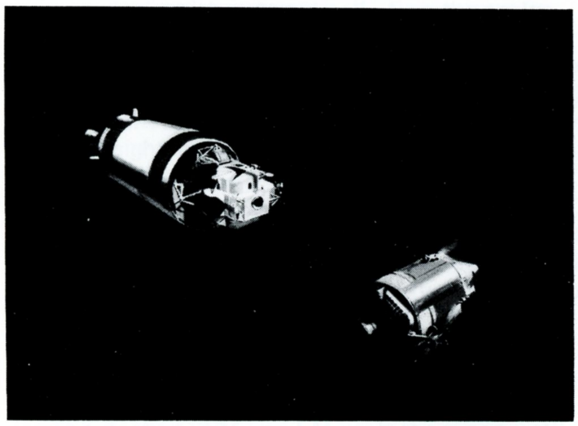
TRANSLUNAR COAST

Now the long journey to the moon begins. It has been three to six hours since liftoff from Kennedy Space Center, depending on the number of earth



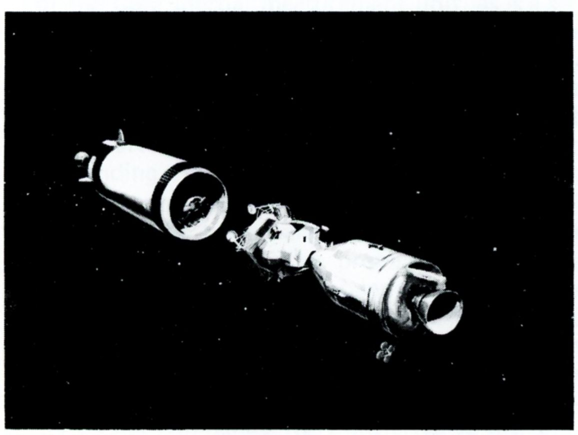
P-20

SLA panels jettison and the CSM pulls away



P-21

Commander turns CSM around for docking maneuver



P-22

After docking, spring thrusters separate two craft

parking orbits, and the crew settles down for the 73-hour flight.

In this phase of the flight, the spacecraft is coasting. At the time of injection into the trans-lunar trajectory, the spacecraft is traveling almost 24,300 miles per hour with respect to the earth. It begins slowing almost immediately because of the pull of earth's gravity. The speed drops until the spacecraft enters the moon's sphere of influence where it again increases due to the moon's gravitational pull.

Shortly after the coast period begins, the spacecraft is oriented for navigation sightings of stars and earth landmarks. The spacecraft is then put into a slow roll (about 2 revolutions an hour) to provide uniform solar heating. This thermal control rolling is stopped for inertial measurement unit alignment and for course corrections.

If tracking from the ground indicates a course correction is needed during the translunar coast, the correction is made with the service propulsion engine when a large change is indicated or with the SM reaction control engines when the change required is small.

The crew has a number of subsystem duties. Electrical power and environmental control subsystem status checks are conducted. The service propulsion and SM reaction control subsystems are checked. Hydrogen and oxygen purges of the fuel cells are conducted, the lithium hydroxide canisters exchanged, and communication with the ground is maintained.

The three astronauts eat in shifts but sleep at the same time. The ground monitors the spacecraft performance continuously and can awaken the crew. Biomedical data is sent to the ground continuously.

P-23

Engine retro-fires to put spacecraft in lunar orbit

LUNAR ORBIT INSERTION

Insertion of the spacecraft into lunar orbit is essentially a braking maneuver in which the spacecraft is transferred from the ellipse of the lunar approach to an orbit around the moon.

The insertion maneuver involves the longest firing of the service propulsion engine and results in a reduction in the craft's velocity with respect to the moon from about 5600 to 3600 miles per hour. The insertion may be a two-stage firing of the service propulsion engine, the first to put the CSM in an elliptical orbit of approximately 70-by-195 statute miles and the second to put the CSM in a circular orbit of about 69 miles. The precise timing of the firing and the exact length of the burn or burns are determined by the Mission Control Center in Houston and are programmed into the CM computer, which automatically fires the engine.

During the firing the spacecraft is out of communication with the ground since it will be passing behind the moon. Communications, which require line-of-sight to earth, are lost for about 45 minutes on each 2-hour lunar orbit.

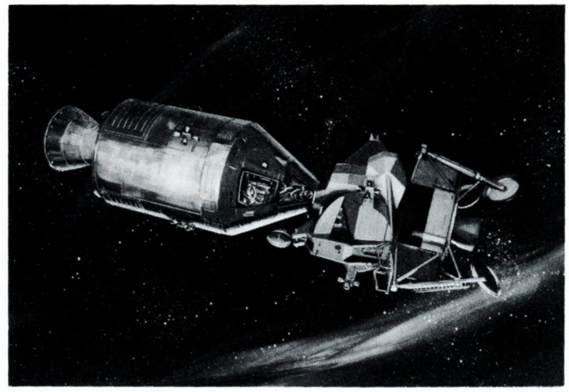
During the maneuver, the crew monitors the display of the velocity change required, the digital event timer, the flight director attitude indicators, and subsystem status displays.

LUNAR ORBIT COAST

The docked CSM and LM orbit the moon until the LM is checked out for descent to the lunar surface. During this time coarse and fine alignments are made of the CSM inertial measurement unit, as is a series of sightings of landmarks on the lunar surface. These operations, each involving changes in spacecraft attitude, are compared with tracking data from the manned space flight network to determine the spacecraft's precise location in orbit with respect to the landing site on the moon.

The CM-LM tunnel and the LM are pressurized, and the CM hatch, the probe, and drogue are removed. The LM hatch is opened to clear the way into the LM. First to transfer to the LM is the LM pilot, who activates the LM's environmental control, electrical power and communications subsystems.

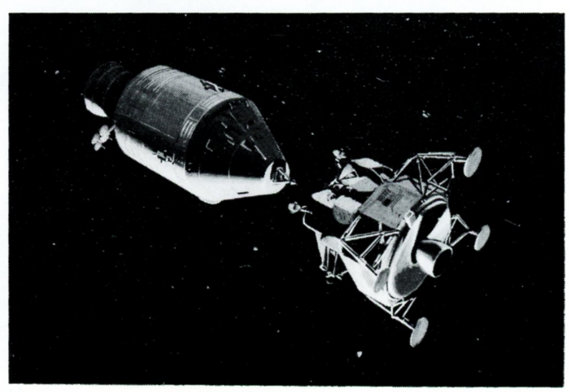
After the commander has transferred to the LM, he and the LM pilot perform a lengthy series of checks of the LM subsystems. While they do this, the CM pilot is performing another series of alignments and landmark sightings. The CM controls the attitude of the spacecraft during the lunar orbits and during the coarse alignments of the LM inertial measurement unit. (The fine aligning of the LM inertial measurement unit is done after the CSM and LM have separated.)



P-24

Two crewmen transfer to LM to prepare for separation

The probe and drogue are installed, the 12 docking latches are unlatched, the LM hatch is closed, the CM hatch is installed, the LM landing gear is deployed, and guidance computations are made in the final minutes before separation. Then the CM pilot activates the probe extend/release switch which undocks the LM from the CSM. The LM reaction control system moves the LM away from the CSM a short distance and is oriented so the CM pilot can inspect the LM landing gear. The LM's reaction control system then fires again to separate further the LM and CSM.



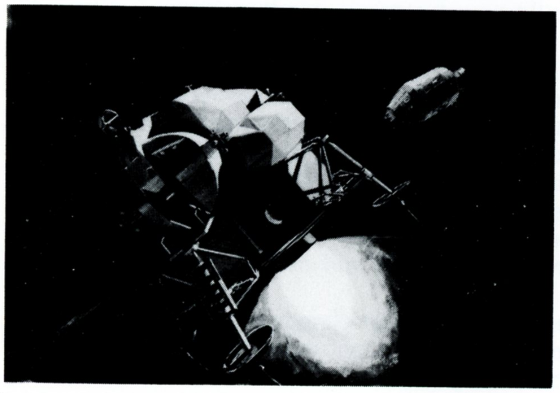
P-25

LM with two men separates from CSM

CSM LUNAR ORBIT

The CSM remains in the 69-mile lunar orbit for about 28 hours, until the LM returns from its moon landing. The CM pilot has many duties during this time and is particularly busy during two periods: LM descent to the moon and LM ascent to rendezvous and docking. His principal jobs during these periods are to monitor the performance of the LM (requiring changes in CSM attitude to keep it in sight), communicate with the LM and with earth, and activate or operate equipment to aid in both the landing and the rendezvous and docking procedures. The CM pilot will have a period to sleep while the LM is on the lunar surface.

After separation, the CSM and LM pass behind the moon, and communications with earth are cut off. During this period, the LM telemeters its data to the CSM, where it is stored and relayed to earth after the CSM emerges from behind the moon.



P-26

LM descends and CSM stays in orbit

P-27

LM's descent engine fires as craft comes in for landing

LM DESCENT

The descent to the moon takes an hour of complex maneuvering that taxes the skills of the astronauts and the capabilities of the lunar module.

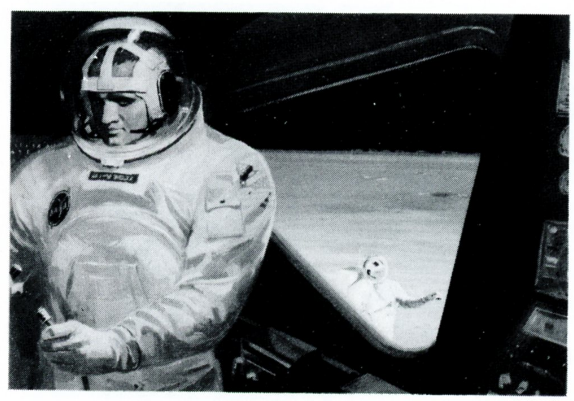
Briefly, the descent will follow this course. The LM fires its descent engine to put it into an elliptical orbit that reaches from about 69 miles to within 50,000 feet of the moon's surface. Near the 50,000 foot altitude at a preselected surface range from the landing site, the engine is fired again in a braking maneuver to reduce the module's speed.

The LM's two-man crew is busy with position and velocity checks, subsystem checks, landing radar test, attitude maneuvering, and preparation of the LM computer or the braking maneuver.

The final approach begins at approximately 7000 feet altitude with a maneuver to bring the landing site into the view of the LM crew. The firing is controlled automatically until the craft reaches an altitude of about 500 feet. When the commander takes over, the LM is pitched at an angle which permits the crewmen to assess the landing site. At about 150 feet altitude, the LM is re-oriented and descends vertically to the surface at about 3 feet per second. The commander shuts off the descent engine as soon as the landing gear touches the moon.

LUNAR STAY

It will be about 10 hours after landing before the first American sets foot on the moon. Upon landing, the commander and LM pilot first spend



P-28

One astronaut checks LM, other stays inside at first

P-29

Two astronauts set up scientific equipment on moon

about two hours checking out the LM ascent stage. Any remaining propellant for the descent engine is vented and the inertial measurement unit is aligned and placed in standby operation. After a 5-1/2-hour resting and eating period, the crewmen devote 2 hours to preparing the extravehicular mobility units for use.

Finally, they depressurize the LM cabin, open the hatch, and the commander descends a 9-step ladder to the moon. He remains alone on the lunar surface for about 40 minutes, familiarizing himself with the environment and gathering preliminary samples of surface material, while his companion inside the LM records his activity on film and on television.

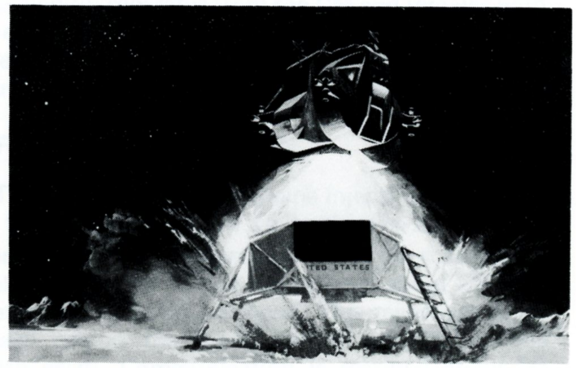
The LM pilot then descends to the surface, and for the next 2 hours the astronauts explore, photograph, and televise their surroundings, collect surface and subsurface geological samples, inspect the LM to determine the effects of touchdown on the vehicle, and set up a scientific station that will continue to send data to earth after they leave.

Although busy, the astronauts move with care; there is none of the popularly conceived bounding about in the moon's one-sixth gravity environment.

Once back in the LM, the crewmen rest, eat, and check out the ascent stage system. These activities take about 7 hours. Then, 21-1/2 hours after touchdown, the LM lifts off to rejoin the CSM.

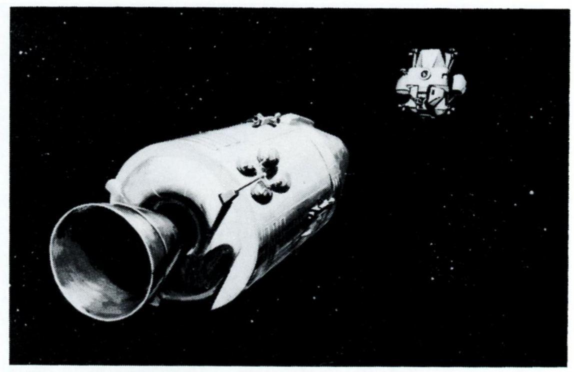
LM ASCENT

Ascent of the LM from the moon and rendezvous and docking with the orbiting CSM takes 3-1/2 hours.



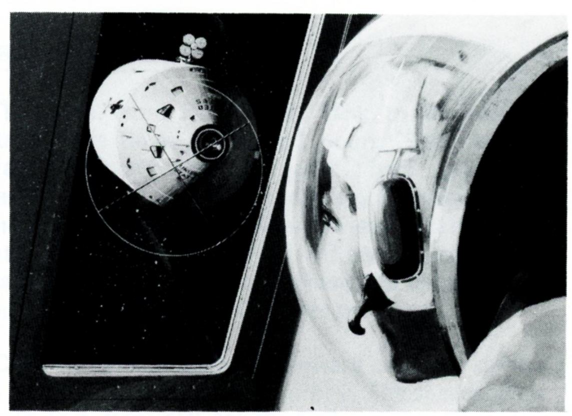
P-30

Astronaut fires ascent stage engine to leave moon



P-31

LM's ascent stage in rendezvous with orbiting CSM



P-32

CSM maneuvers for docking with LM

When the ascent engine ignites, the ascent stage of the LM separates from the descent stage, using the latter as a launching platform. The engine boosts the ascent stage off the moon into an elliptical orbit of about 10-1/2 by 52 miles.

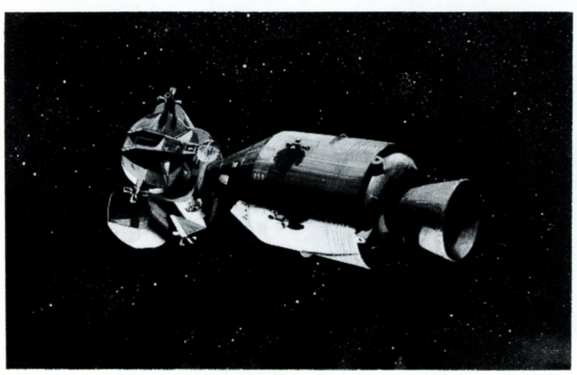
The next maneuver places the LM in a circular orbit which has a constant altitude distance from that of the CSM. When the LM's orbit is in the proper phase with the CSM orbit, the LM reaction control engines are fired to raise the LM orbit to that of the CSM, about 69 miles. During these maneuvers the CM pilot tracks the LM.

The LM takes about 30 minutes to intercept the CSM, during which course corrections are made with the reaction control engines. The firings are controlled by the LM computer on the basis of data supplied by the ground. The LM closes on the CSM through a series of short reaction control engine firings. Final docking maneuvers are performed by the CM pilot with the CSM reaction control engines.

LUNAR ORBIT COAST

After docking, the spacecraft coasts in lunar orbit while the crew transfers equipment and samples into the CSM, returns to the CSM, jettisons the LM ascent stage, and prepares for transearth injection.

The LM crew opens the LM hatch after the CSM and LM pressures have been equalized and the CM pilot removes the CM tunnel hatch. The drogue and probe are removed and stowed in the LM. Lunar samples, film, and equipment to be returned to earth are transferred from the LM to the CM; equipment in the CM that is no longer needed is put



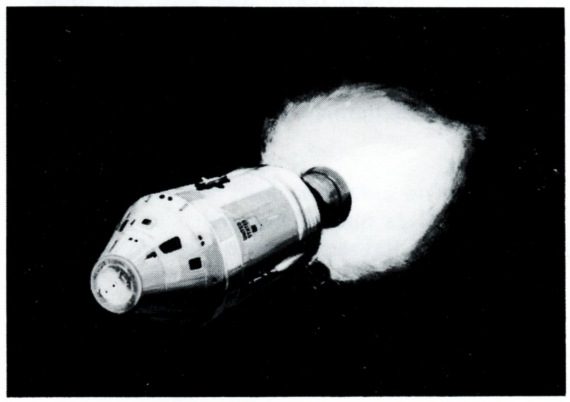
P-33 *Astronauts return to CM, prepare to jettison LM*

into the LM and the LM hatch is closed, the CM hatch is replaced, and the seal checked.

The LM is jettisoned by firing small charges around the CM docking ring. The entire docking mechanism separates from the CM and remains with the LM ascent stage. The SM reaction control engines are fired in a short burst to assure separation and to put the CSM into the lead in the orbit.

TRANSEARTH INJECTION

The service propulsion engine injects the CSM into a trajectory for return to earth. The engine fires for about 2-1/2 minutes to increase the spacecraft's velocity relative to the moon from about 3600 to nearly 5500 miles per hour. This maneuver takes place behind the moon, out of communications with earth. Communication is regained about 20 minutes after the engine has cut off.

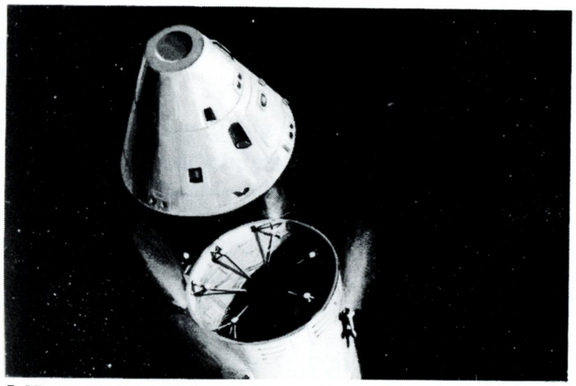


P-34 *After jettisoning LM, the CSM heads for earth*

TRANSEARTH COAST

The trip from lunar orbit back to the earth's atmosphere takes about 60 hours. The spacecraft's velocity on the coast back gradually decreases because of the moon's gravitational pull and then increases again when the spacecraft comes into the earth's sphere of influence. When the spacecraft enters the atmosphere, its velocity has increased to about 25,000 miles per hour.

Crew duties during the homeward coast are similar to those of the outbound journey. The spacecraft is again in a slow roll for thermal control. Crewmen make any necessary course corrections, maneuver



P-35
Shortly before entry, the CM separates from SM

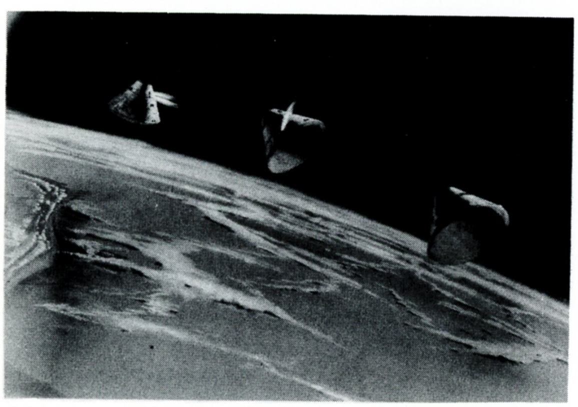
the spacecraft for inertial measurement unit alignments and regularly check subsystems.

About three and a half hours before entry, the CSM is rotated and held in an attitude that puts the forward heat shield of the CM in shadow. This cooling of the shield lasts for about an hour and a half, after which the attitude must be changed for the final course correction.

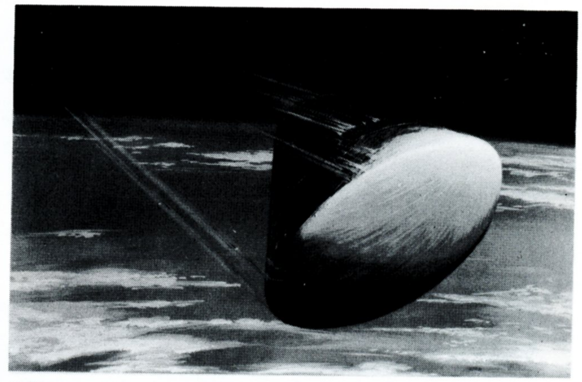
Shortly before entry into the earth's atmosphere, the service module is jettisoned. The CM and SM are separated by small explosive devices in the SM. The SM reaction control engines fire simultaneously to increase separation and assure that the two modules will not collide.

ENTRY

The desired entry conditions include the arrival of the CSM at a particular point above earth at a



P-36
CM is oriented blunt end forward for entry



P-37
Aft heat shield chars to absorb 5,000-degree heat

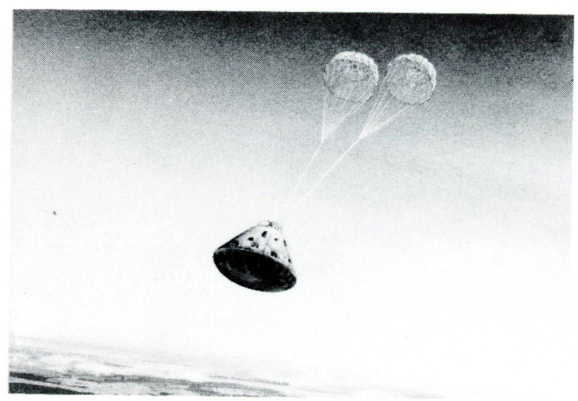
particular time and with a proper flight path angle, neither too steep nor too shallow.

Entry is considered to begin at an altitude of about 400,300 feet, when the CM begins to meet the resistance of the atmosphere. At this point the CM is traveling about 24,700 miles an hour, and the heat generated on its plunge through the atmosphere may reach 4200 degrees Fahrenheit on the blunt aft heat shield.

But despite the heat generated on the outside of the CM, its cabin will remain at 80 degrees. The maximum gravitational forces felt by the astronauts will be a little over 5 G's.

LANDING

The landing is controlled automatically by the earth landing subsystem, although the crew has

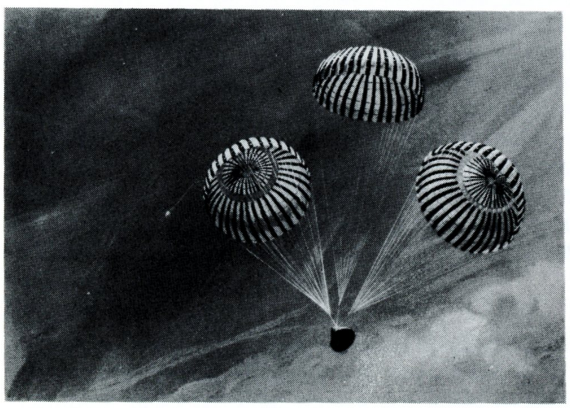


P-38
Drogue chutes open to provide initial slowing

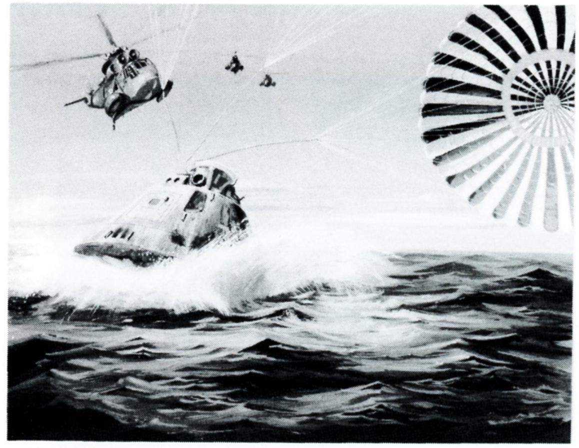
backup controls. At about 23,300 feet, a barometric switch closes to start the subsystem in operation.

The forward heat shield is jettisoned to permit deployment of parachutes, and the drogue parachutes are immediately released. They are deployed reefed (half closed) and open after a few seconds. The drogues orient the CM for main parachute deployment and reduce the CM's speed from an estimated 325 to 125 miles an hour.

At an altitude of about 10,500 feet the drogues are disconnected and the pilot parachutes are deployed. They pull out the main parachutes. The main parachutes are double reefed, which means they open in two stages. They further slow the CM, and final descent and splashdown is made at about 22 miles an hour.



P-39
CM drifts gently to splashdown on main chutes



P-40
Recovery helicopters move in as CM floats in water

As soon as the main parachutes are disreefed, the crewmen start burning the remaining reaction control propellant, activate the VHF recovery beacon, adjust their couches for landing, and purge the propellant lines. Final descent on the main parachutes takes about 5 minutes.

In addition to the recovery beacon deployed by the crew, two VHF antennas are deployed automatically shortly after the main parachutes are deployed. These provide voice communication with the recovery forces. The recovery beacon transmits a continuous signal.

The main parachutes are released by the crew at splashdown and postlanding ventilation is turned on.

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

FOR IMMEDIATE RELEASE

NS-22

DOWNEY, Calif.--Technicians began assembling the spacecraft command module (CM) and service module (SM) for the Apollo 11 lunar landing mission more than three years ago at North American Rockwell's Space Division in Downey, Calif. Here is a biography of the spacecraft, recorded as Serial No. 107:

Began assembly of CM	July 5, 1966
Began assembling crew compartment heat shield	Oct. 1, 1966
Completed closeout weld of Apollo 11's CM crew compartment	Jan. 3, 1967
Began assembly of the SM at Tulsa, Okla.	Jan. 30, 1967
Shipped SM from Tulsa to Downey	Apr. 14, 1967
Shipped crew compartment head shield to AVCO for ablator	Apr. 14, 1967
Started assembly of the spacecraft lunar module adapter (SLA 14)	May 5, 1967
Completed installation of the CM's secondary structure	June 9, 1967
Began assembling launch escape tower	July 15, 1967
AVCO completed ablator installation and returned heat shield to Downey	Oct. 16, 1967
Completed mating SLA panels	Nov. 20, 1967
Installed SM secondary structure	Dec. 8, 1967
Shipped tower to Downey	Apr. 24, 1968
Installed crew compartment heat shield on CM	July 2, 1968
Completed SM final systems installation	Aug. 20, 1968

-more-

Final systems installed in SM	Aug. 20, 1968
Completed individual and combined systems checkout of CSM	Oct. 22, 1968
Completed integrated systems checkout and demate CSM	Dec. 6, 1968
Apollo 11 spacecraft SLA shipped to Kennedy Space Center	Jan. 10, 1969
Shipped CSM and tower to KSC	Jan. 22, 1969
Completed CSM and lunar module (LM) mechanical docking test at KSC	Feb. 13, 1969
Completed manned altitude run with the prime crew	Mar. 18, 1969
Moved CSM, LM and SLA stack to the VAB and mated to booster	Apr. 14, 1969
Moved Apollo 11 space vehicle to Launch Complex 39A	May 20, 1969

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Phone: Earl Blount, Dave Alter
(213) 923-8111, Ext. 6467, 8
or
Bill Levering
(213) 647-5440

NORTH AMERICAN ROCKWELL CORPORATION
Space Division
12214 Lakewood Boulevard
Downey, California 90241

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S-27

DOWNEY, Calif.--Assembly of the second (S-II) stage of the Apollo 11's Saturn V launch vehicle began more than two years ago at the Seal Beach, Calif., facility of North American Rockwell's Space Division.

The stage is 81 1/2-feet tall and 33-feet in diameter. It is powered by five Rocketdyne J-2 engines developing a total of more than one million pounds of thrust.

The S-II's role in the lunar mission begins about 2 1/2 minutes after liftoff, following separation of the first stage. The S-II's engines ignite to power the third stage and spacecraft from about 40 miles altitude to approximately 114 miles. During its about six minute lifetime, the S-II increases the velocity of the vehicle from approximately 5400 miles per hour to about 15,000 miles per hour.

Built at Seal Beach, Calif., the S-II stage is shipped to NASA's Mississippi Test Facility aboard the USNS Point Barrow, a converted AKD (Arctic Kargo Dock) craft. At MTF, the stage is put through an approximately 6 1/2- minute, full-duration static firing acceptance test before being shipped to NASA's Kennedy Space Center for stacking in the Saturn V launch vehicle.

The S-II for the Apollo 11 mission is the sixth flight stage built by Space Division for NASA's Marshall Space Flight Center. The following are highlights of its sequence of assembly.

Start Vertical Assembly	Jan. 18 , 1967
Complete Vertical Assembly	April 19, 1967
Start Systems Installation	June 28, 1967
Start Systems Checkout	Jan. 8, 1968
Systems Checkout Complete	April 3, 1968
Shipped from Seal Beach to MTF	May 25, 1968
MTF Acceptance Static Firing Completed	Oct. 3, 1968
Arrive Kennedy Space Center	Feb. 6, 1969

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AJL070869

Phone: Earl Blount, A. J. Longo
(213) 923-8111, Ext. 6467, 8

or

Bill Levering
(213) 647-5440