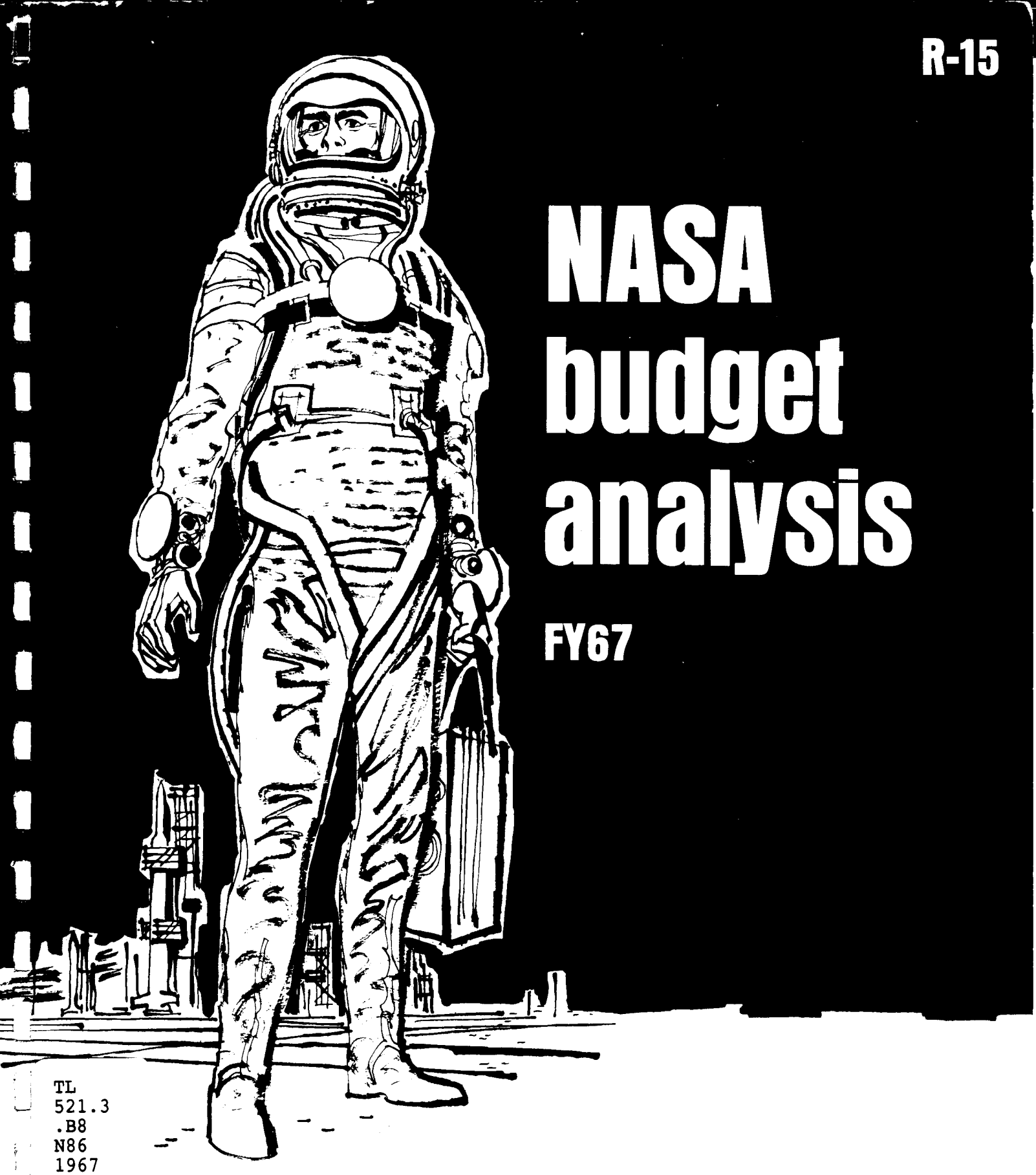
R-15



NASA budget analysis

FY67

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NASA FY 1967 BUDGET ANALYSIS C O N T E N T S

I N T R O D U C T I O N

For the first time in its eight year history, NASA's spending in the fiscal year which begins July 1, will decline. The total appropriation being asked for the agency is $5,012 billion -- down nearly $163 million from the previous year.

While the new budget should still permit an expedition to the moon before the end of 1969, there is little funding cushion for unexpected problems. What the new budget means is that some of the long-range planning for manned space exploration after the first lunar landing will have to be pared.

In his Budget Message, President Johnson said the current decrease in appropriations for the space agency was possible because the nation's large space project were progressing from the expensive developmental phase into operational status and that no new projects of equivalent cost would be started.

At a budget briefing, however, a space agency official called the budget "stringent" and said NASA cuts reflected the war in Vietnam and the nation's commitment to health and antipoverty programs at home. NASA originially had asked for $5.58 billion in new obligational authority but that was cut to $4.8 billion by the Budget Bureau. The present $5.012 billion is a compromise.

Apollo and Apollo Applications will receive $200 million less than NASA requested. Space sciences programs took a whopping cut of $122 million; NASA's basic research programs were cut about $10 million.

Spending for the two-man Gemini project drops sharply, as flights are to be completed this year. Expenditures for the massive Apollo lunar landing program, rising sharply in recent years, will level off.

NASA has stretched out the Apollo Applications program to enable Apollo to remain in orbit about the earth for a month or more, or to carry added supplies to the noon for extended exploration. This has slowed development of a costly new unmanned spacecraft known as Voyager, designed to land life-detection devices on Mars. Voyager was to have been ready by 1971, now, it is not scheduled to fly until 1973 at the earliest. NASA also cut off development work on an advanced liquid fueled engine, known as the M-1, which had already been slowed this year as an economy measure. The Advanced Orbiting Solar Observatory Program was cancelled.

The industrial community, under contracts with the NASA, will continue to carry forward the prime design, development and fabrication effort of the NASA program. Specific elements of the activity will continue to be pursued within NASA installations, other government agencies, universities and research contractors which have the necessary level of expertise in special areas of engineering and science. The major elements of the program fall within the following categories:

MANNED SPACE FLIGHT: The attainment of a capability for manned space operations and exploration through the Gemini and Apollo development efforts, and studies of advanced missions which would exploit and extend this capability to the best national interest.

SPACE SCIENCE: An unmanned space flight program directed toward the study of the earth, moon, sun, planets, stars and interplanetary space through the use of sounding rockets, earth orbiting spacecraft, lunar spacecraft and interplanetary probes.

APPLICATIONS: A program directed toward adapting spacecraft, instrumentation and data gathering technology to support beneficial space applications such as operational meteorological and communications systems.

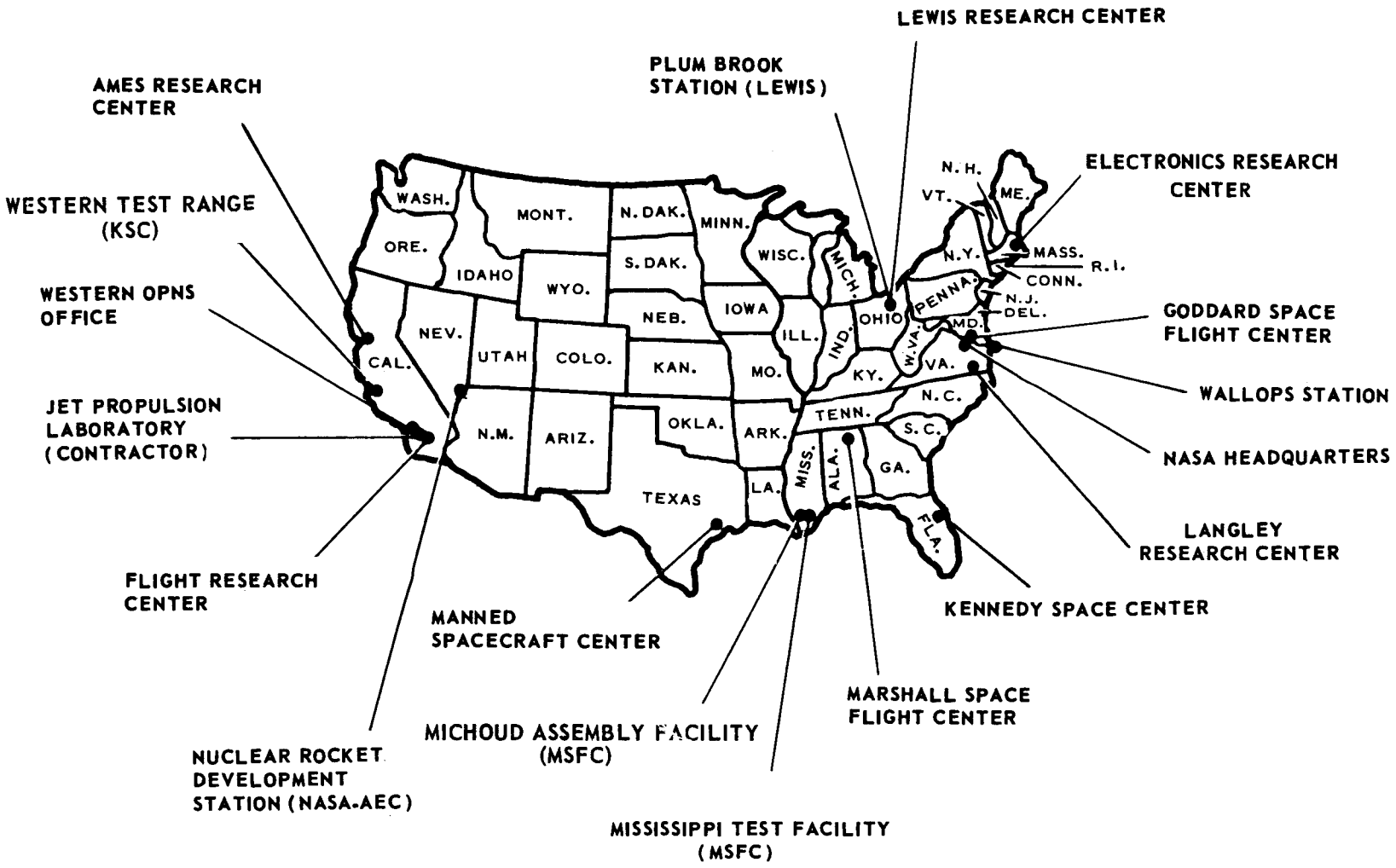
ADVANCED RESEARCH AND TECHNOLOGY: An effort required to provide the fundamental knowledge and the technological base for the future aeronautics and space programs.

Detailed reasons and justifications for expenditures of $4,246,600 for R&D; and summary reasons for expending $101,500,000 and $663,900,000 for Administrative operations are contained in the following pages of this analysis.

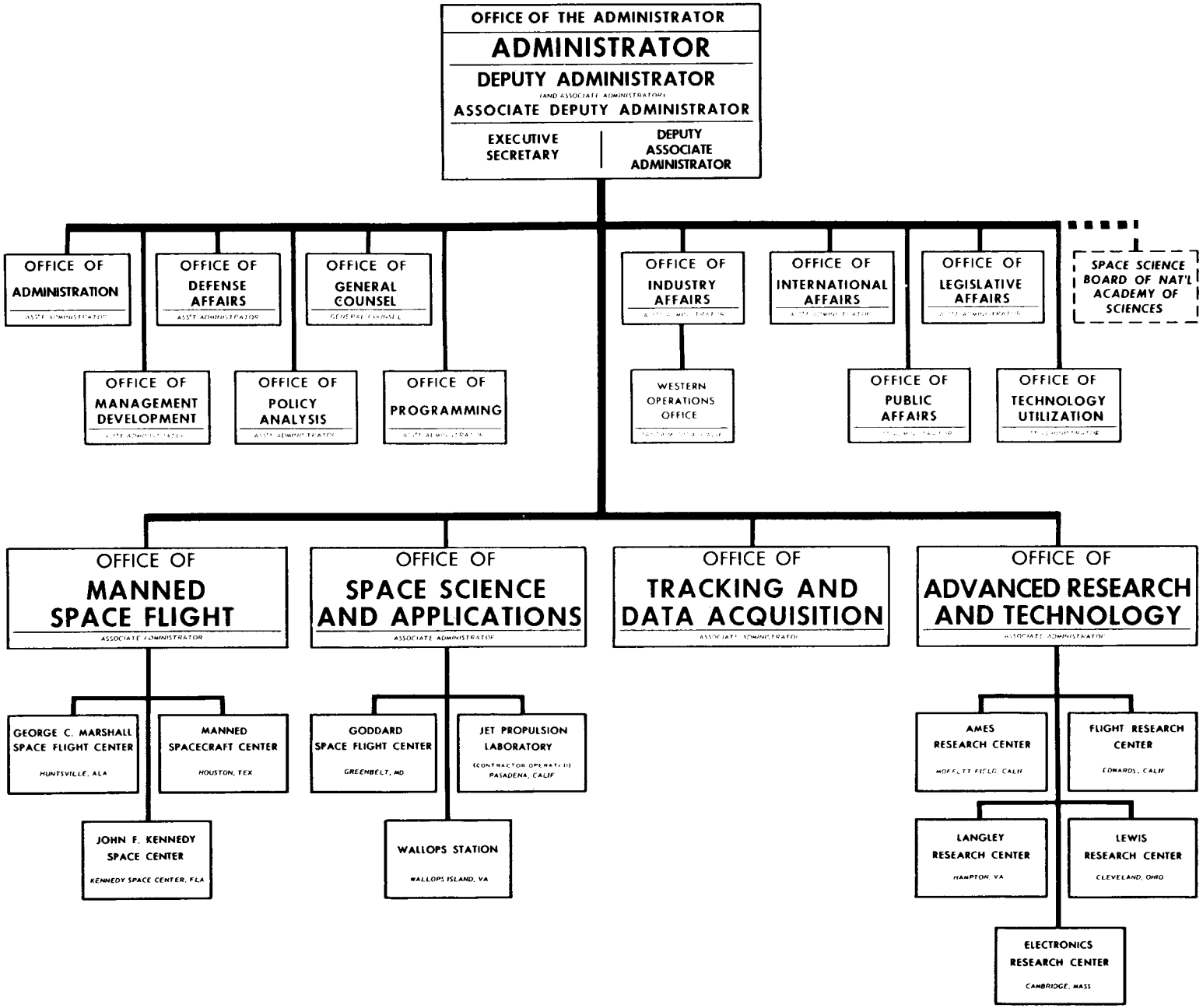
NASA FY 1967 BUDGET ANALYSIS
Summary of Appropriations
(in thousands of dollars)

Appropriation	P.L. 88-507 Fiscal Year 1965	P.L. 89-128 Fiscal Year 1966	Fiscal Year 1967
Research and Development.....	$4,363,594	$4,531,000	$4,246,600
Construction of Facilities....	262,880	60,000	101,500
Administrative Operations.....	623,526	584,000	663,900
TOTAL.....	$5,250,000	$5,175,000	$5,012,000

NASA INSTALLATIONS



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



SUMMARY OF APPROPRIATIONS (ADJUSTED)

(Thousands of Dollars)

	Total	Research and Development	Construction of Facilities	Administrative Operations
FISCAL YEAR 1965				
Independent Offices Appropriation Act, 1965 (78 Stat. 657-8)	$5,250,000	$4,363,594	$262,880	$623,526
NASA Appropriation Transfers (78 Stat. 658)	---	-3,545	3,545	---
Transfer to "Operating expenses, Public Buildings Service," General Services Administration (78 Stat. 655)	-273	---	---	-273
Appropriation (adjusted)	$5,249,727	$4,360,049	$266,426	$623,253
FISCAL YEAR 1966				
Independent Offices Appropriation Act, 1966 (79 Stat. 533-4)	$5,175,000	$4,531,000	$60,000	$584,000
NASA Appropriation Transfers (79 Stat. 534)	---	-27,896	---	27,896
Transfer to "Operating expenses, Public Buildings Service," General Services Administration (79 Stat. 531	-76	---	---	-76
Appropriation (adjusted)	$5,174,924	$4,503,104	$60,000	$611,820
FISCAL YEAR 1967				
Appropriation request	$5,012,000	$4,246,600	$101,500	$663,900

HOW THE BUDGET PLAN IS APPROPRIATED IN NASA ACTIVITIES

(Thousands of Dollars)

Title of Appropriation	Total	Manned Flight	Science in Space	Space Applications	Space Tech.	Aircraft Tech.	Supporting Activities
Fiscal Year 1965	$5,166,339	$3,452,371	$692,656	$83,187	$498,564	$82,163	$357,398
Research and development..	4,270,695	2,949,019	612,663	70,467	299,320	35,240	303,986
Construction of facilities	261,107	199,770	8,343	---	21,291	3,729	27,974
Administrative operations.	634,537	303,582	71,650	12,720	177,953	43,194	25,438
Fiscal Year 1966	$5,183,051	$3,518,408	$727,045	$95,059	$431,433	$87,016	$324,090
Research and development..	4,511,644	3,203,996	652,155	83,682	248,500	41,496	281,815
Construction of facilities	59,587	21,401	7,084	---	13,435	682	16,985
Administrative operations.	611,820	293,011	67,806	11,377	169,498	44,838	25,290
Fiscal Year 1967	$5,012,000	$3,387,468	$605,280	$100,643	$450,656	$103,688	$364,265
Research and development..	4,246,600	3,022,800	529,700	88,100	247,900	33,000	325,100
Construction of facilities	101,500	54,378	6,322	---	11,089	21,011	8,700
Administrative operations.	663,900	310,290	69,258	12,543	191,667	49,677	30,465

SUMMARY OF R&D BUDGET PLAN BY PROGRAM IN COGNIZANT HEADQUARTERS OFFICE
(in thousands of dollars)

OFFICE/PROGRAM	FY-1965	FY-1966	FY-1967
MANNED SPACE FLIGHT.....	$2,949,019	$3,203,996	$3,022,800
Gemini.....	308,400	226,611	40,600
Apollo.....	2,614,619	2,967,385	2,974,200
Advanced Missions.....	26,000	10,000	8,000
SPACE SCIENCE AND APPLICATIONS..	$732,362	$783,237	$661,400
Physics and Astronomy.....	139,082	143,500	131,400
Lunar and Planetary Exploration.	206,027	251,337	197,900
Sustaining University Program...	46,000	46,000	41,000
Launch Vehicle Development.....	96,500	55,300	33,700
Launch Vehicle Procurement (unmanned flight programs).....	151,487	178,700	152,000
Bioscience.....	28,501	36,700	35,400
Meteorological Satellites.....	30,991	38,900	43,600
Communication and Applications Technology Satellites.....	30,774	32,800	26,400
ADVANCED RESEARCH AND TECHNOLOGY	$331,328	$288,596	$278,300
Basic Research.....	21,231	22,000	23,000
Space Vehicle Systems.....	44,193	35,000	36,000
Electronics Systems.....	25,622	32,300	36,800
Human Factor Systems.....	13,320	14,900	17,000
Space Power and Electric Propulsion Systems.....	58,220	45,200	42,500
Nuclear Rockets.....	57,000	58,000	53,000
Chemical Propulsion.....	76,502	39,700	37,000
Aeronautics.....	35,240	41,496	33,000
TRACKING AND DATA ACQUISITION...	$253,236	$231,065	$279,300
TECHNOLOGY UTILIZATION.....	$4,750	$4,750	$4,800
TOTAL BUDGET PLAN.....	$4,270,695	$4,511,644	$4,246,600

HOW THE R&D BUDGET PLAN IS DISTRIBUTED TO NASA INSTALLATIONS

(In thousands of dollars)

PROGRAM OFFICE	TOTAL	J. F. KENNEDY SPACE CENTER, NASA	MANNED SPACECRAFT CENTER	MARSHALL SPACE FLIGHT CENTER	GODDARD SPACE FLIGHT CENTER	PACIFIC LAUNCH OPERATIONS OFFICE	WALLOPS STATION	AMES RESEARCH CENTER	ELECTRONICS RESEARCH CENTER	FLIGHT RESEARCH CENTER	LANGLEY RESEARCH CENTER	LEWIS RESEARCH CENTER	SPACE NUCLEAR PROPULSION OFFICE	HEAD QUARTERS	WESTERN OPERATIONS OFFICE
Office of Manned Space Flight															
1965	2,949,019	56,110	1,418,648	1,435,989	389	-	-	39	-	-	2,400	1,160	-	33,367	917
1966	3,203,996	121,109	1,479,182	1,574,635	425	-	-	230	-	-	700	-	-	25,215	2,500
1967	3,022,800	164,505	1,363,400	1,466,295	500	-	-	250	-	-	-	-	-	25,350	2,500
Office of Space Science and Applications															
1965	732,362	2,674	2,608	1,462	186,868	99	1,150	34,683	275	10	67,388	199,083	-	107,230	128,832
1966	783,237	3,327	14,400	10,607	195,404	-	2,830	37,948	650	5	68,217	179,843	-	106,597	163,409
1967	661,400	4,019	15,200	495	189,193	-	3,640	31,463	750	15	35,960	147,371	-	93,146	140,148
Office of Advanced Research and Technology															
1965	331,328	-	1,512	28,911	8,517	-	-	19,391	2,333	7,638	34,953	122,084	45,760	31,648	28,581
1966	288,596	250	2,355	17,264	9,678	-	-	18,775	6,554	14,919	40,749	69,431	50,218	37,765	20,638
1967	278,300	250	3,370	17,496	9,701	-	-	21,455	12,400	7,925	41,127	61,603	48,500	31,833	22,640
Office of Tracking and Data Acquisition															
1965	253,236	-	-	2,000	179,252	-	5,100	-	-	1,900	2,200	-	-	7,015	55,769
1966	231,065	-	-	1,500	155,950	-	5,835	-	-	1,880	2,000	-	-	10,400	53,500
1967	279,300	-	-	1,500	199,600	-	6,400	-	-	2,100	2,100	-	-	12,000	55,600
Office of Technology Utilization and Policy Planning															
1965	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
1966	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
1967	4,800	-	-	-	-	-	-	-	-	-	-	-	-	4,800	-
Total Budget Plan															
1965	4,270,695	58,784	1,422,768	1,468,362	375,026	99	6,250	54,113	2,608	9,548	106,941	322,327	45,760	184,010	214,099
1966	4,511,644	124,686	1,495,937	1,604,006	361,457	-	8,665	56,953	7,204	16,804	111,666	249,274	50,218	184,727	240,047
1967	4,246,600	168,774	1,381,970	1,485,786	398,994	-	10,040	53,168	13,150	10,040	79,187	208,974	48,500	167,129	220,888

HOW THE R&D BUDGET PLAN IS DISTRIBUTED TO NASA INSTALLATIONS
(In thousands of dollars)

PROGRAM		TOTAL	J. F. KENNEDY SPACE CENTER, NASA	MANNED SPACECRAFT CENTER	MARSHALL SPACE FLIGHT CENTER	GODDARD SPACE FLIGHT CENTER	PACIFIC LAUNCH OPERATIONS OFFICE	WALLOPS STATION	AMES RESEARCH CENTER	ELECTRONICS RESEARCH CENTER	FLIGHT RESEARCH CENTER	LANGLEY RESEARCH CENTER	LEWIS RESEARCH CENTER	SPACE NUCLEAR PROPULSION OFFICE	HEADQUARTERS	WESTERN OPERATIONS OFFICE[1/]
OFFICE OF MANNED SPACE FLIGHT, TOTAL	1965	2,949,019	56,110	1,418,648	1,435,989	389	-	-	39	-	-	2,400	1,160	-	33,367	917
	1966	3,203,996	121,109	1,479,182	1,574,635	425	-	-	230	-	-	700	-	-	25,215	2,500
	1967	3,022,800	164,505	1,363,400	1,466,295	500	-	-	250	-	-	-	-	-	25,350	2,500
Gemini	1965	308,400	-	308,050	-	-	-	-	-	-	-	-	-	-	350	-
	1966	226,611	-	226,211	-	-	-	-	-	-	-	-	-	-	400	-
	1967	40,600	-	40,300	-	-	-	-	-	-	-	-	-	-	300	-
Apollo	1965	2,614,619	55,610	1,100,973	1,430,516	389	-	-	39	-	-	1,200	1,160	-	24,087	645
	1966	2,967,385	120,509	1,249,371	1,569,135	425	-	-	230	-	-	700	-	-	24,515	2,500
	1967	2,974,200	163,905	1,320,500	1,461,795	500	-	-	250	-	-	-	-	-	24,750	2,500
Advanced mission studies	1965	26,000	500	9,625	5,473	-	-	-	-	-	-	1,200	-	-	8,930	272
	1966	10,000	600	3,600	5,500	-	-	-	-	-	-	-	-	-	300	-
	1967	8,000	600	2,600	4,500	-	-	-	-	-	-	-	-	-	300	-
OFFICE OF SPACE SCIENCE AND APPLICATIONS, TOTAL	1965	732,362	2,674	2,608	1,462	186,868	99	1,150	34,683	275	10	67,388	199,083	-	107,230	128,832
	1966	783,237	3,327	14,400	10,607	195,404	-	2,830	37,948	650	5	68,217	179,843	-	106,597	163,409
	1967	661,400	4,019	15,200	495	189,193	-	3,640	31,463	750	15	35,960	147,371	-	93,146	140,148
Physics and astronomy	1965	139,082	-	-	755	110,244	-	1,090	1,557	-	10	2,226	-	-	22,866	334
	1966	143,500	-	-	62	108,498	-	2,550	2,586	-	5	2,272	-	-	27,075	452
	1967	131,400	-	-	25	100,961	-	3,400	2,563	-	15	1,100	-	-	22,836	500
Lunar and planetary exploration	1965	206,027	-	2,608	435	1,267	-	-	15,734	-	-	50,050	97	-	9,256	126,580
	1966	251,337	-	14,400	375	1,164	-	-	12,763	-	-	53,115	-	-	12,913	156,607
	1967	197,900	-	15,200	300	1,200	-	-	7,000	-	-	23,200	-	-	14,300	136,700
Sustaining university program	1965	46,000	-	-	-	-	-	-	-	-	-	-	11	-	45,986	3
	1966	46,000	-	-	-	-	-	-	-	-	-	-	-	-	46,000	-
	1967	41,000	-	-	-	-	-	-	-	-	-	-	-	-	41,000	-
Launch vehicle development	1965	96,500	1,321	-	152	1,557	-	-	-	100	-	735	91,302	-	1,333	-
	1966	55,300	820	-	10,000	250	-	-	-	200	-	570	42,820	-	640	-
	1967	33,700	700	-	-	-	-	-	-	250	-	600	31,550	-	600	-
Launch vehicle procurement	1965	154,487	1,353	-	-	19,496	99	-	-	-	-	13,737	107,673	-	12,129	-
	1966	178,700	2,507	-	-	18,580	-	-	-	-	-	11,600	137,023	-	5,625	3,365
	1967	152,000	3,319	-	-	22,205	-	-	-	-	-	10,400	115,821	-	-	255
Bioscience	1965	28,501	-	-	-	385	-	60	17,392	-	-	-	-	-	9,145	1,519
	1966	36,700	-	-	-	420	-	100	22,599	-	-	30	-	-	11,214	2,337
	1967	35,400	-	-	-	420	-	100	21,900	-	-	30	-	-	10,450	2,500
Meteorological satellites	1965	30,991	-	-	120	29,505	-	-	-	175	-	425	-	-	766	-
	1966	38,900	-	-	170	35,400	-	180	-	450	-	630	-	-	2,070	-
	1967	43,600	-	-	170	39,300	-	140	-	500	-	630	-	-	2,860	-
Communication and applications technology satellites	1965	30,774	-	-	-	24,414	-	-	-	-	-	215	-	-	5,749	396
	1966	32,800	-	-	-	31,092	-	-	-	-	-	-	-	-	1,060	648
	1967	26,400	-	-	-	25,107	-	-	-	-	-	-	-	-	1,100	193

HOW THE R&D BUDGET PLAN IS DISTRIBUTED TO NASA INSTALLATIONS

(In thousands of dollars)

PROGRAM		TOTAL	J. K. KENNEDY SPACE CENTER, NASA	MANNED SPACECRAFT CENTER	MARSHALL SPACE FLIGHT CENTER	GODDARD SPACE FLIGHT CENTER	PACIFIC LAUNCH OPERATIONS OFFICE	WALLOPS STATION	AMES RESEARCH CENTER	ELECTRONICS RESEARCH CENTER	FLIGHT RESEARCH CENTER	LANGLEY RESEARCH CENTER	LEWIS RESEARCH CENTER	SPACE NUCLEAR PROPULSION OFFICE	HEAD-QUARTERS	WESTERN OPERATIONS OFFICE[1/]
OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY, TOTAL	1965	331,328	-	1,512	28,911	8,517	-	-	19,391	2,333	7,638	34,953	122,084	45,760	31,648	28,581
	1966	288,596	250	2,355	17,264	9,678	-	-	18,775	6,554	14,919	40,749	69,431	50,218	37,765	20,638
	1967	278,300	250	3,370	17,496	9,701	-	-	21,455	12,400	7,925	41,127	61,603	48,500	31,833	22,640
Basic research	1965	21,231	-	-	916	257	-	-	1,966	95	3	1,901	2,234	-	7,503	6,356
	1966	22,000	-	-	815	117	-	-	1,910	595	30	2,119	2,731	-	8,627	5,056
	1967	23,000	-	-	850	120	-	-	2,100	1,000	30	2,200	2,800	-	8,500	5,400
Space vehicle systems	1965	44,193	-	629	16,444	1,231	-	-	3,354	-	1,825	10,594	2,408	-	3,474	4,234
	1966	35,000	-	435	4,201	1,751	-	-	3,076	250	1,010	11,466	3,087	-	6,006	3,718
	1967	36,000	-	670	3,096	2,081	-	-	3,475	250	1,010	14,282	3,223	-	3,713	4,200
Electronics systems	1965	25,622	-	465	3,685	2,967	-	-	3,480	2,178	1,038	6,660	400	-	2,022	2,727
	1966	32,300	-	525	4,003	2,975	-	-	3,718	5,110	698	7,260	539	-	3,906	3,566
	1967	36,800	-	450	4,200	2,960	-	-	4,100	10,000	660	7,420	540	-	3,180	3,290
Human factor systems	1965	13,320	-	365	355	-	-	-	4,233	60	1,750	4,053	232	-	2,172	100
	1966	14,900	-	795	310	25	-	-	5,224	359	1,500	4,246	125	-	2,216	100
	1967	17,000	-	1,100	300	-	-	-	5,830	700	1,250	5,000	-	-	2,820	-
Space power and electric propulsion systems	1965	58,220	-	53	2,415	3,512	-	-	191	-	-	1,324	43,517	-	1,351	5,857
	1966	45,200	-	100	2,010	4,260	-	-	110	50	-	846	28,768	-	4,565	4,491
	1967	42,500	-	650	1,650	3,990	-	-	50	300	-	700	26,065	-	3,045	6,050
Nuclear rockets	1965	57,000	-	-	1,375	-	-	-	-	-	-	-	9,846	45,760	13	6
	1966	58,000	-	-	1,125	-	-	-	-	-	-	-	6,599	50,218	58	-
	1967	53,000	-	-	900	-	-	-	-	-	-	-	3,550	48,500	50	-
Chemical propulsion	1965	76,502	-	-	3,721	550	-	-	-	-	-	1,369	49,588	-	11,973	9,301
	1966	39,700	250	500	4,800	550	-	-	540	-	-	2,877	15,205	-	11,271	3,707
	1967	37,000	250	500	6,500	550	-	-	500	-	-	2,900	12,800	-	9,300	3,700
Aeronautics	1965	35,240	-	-	-	-	-	-	6,167	-	3,022	9,052	13,859	-	3,140	-
	1966	41,496	-	-	-	-	-	-	4,197	190	11,681	11,935	12,377	-	1,116	-
	1967	33,000	-	-	-	-	-	-	5,400	150	4,975	8,625	12,625	-	1,225	-
OFFICE OF TRACKING AND DATA ACQUISITION	1965	253,236	-	-	2,000	179,252	-	5,100	-	-	1,900	2,200	-	-	7,015	55,769
	1966	231,065	-	-	1,500	155,950	-	5,835	-	-	1,880	2,000	-	-	10,400	53,500
	1967	279,300	-	-	1,500	199,600	-	6,400	-	-	2,100	2,100	-	-	12,000	55,600
Tracking and data acquisition	1965	253,236	-	-	2,000	179,252	-	5,100	-	-	1,900	2,200	-	-	7,015	55,769
	1966	231,065	-	-	1,500	155,950	-	5,835	-	-	1,880	2,000	-	-	10,400	53,500
	1967	279,300	-	-	1,500	199,600	-	6,400	-	-	2,100	2,100	-	-	12,000	55,600
OFFICE OF TECHNOLOGY UTILIZATION AND POLICY PLANNING	1965	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
	1966	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
	1967	4,800	-	-	-	-	-	-	-	-	-	-	-	-	4,800	-
Technology utilization	1965	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
	1966	4,750	-	-	-	-	-	-	-	-	-	-	-	-	4,750	-
	1967	4,800	-	-	-	-	-	-	-	-	-	-	-	-	4,800	-
TOTAL BUDGET PLAN	1965	4,270,695	58,784	1,422,768	1,468,362	375,026	99	6,250	54,113	2,608	9,548	106,941	322,327	45,760	184,010	214,099
	1966	4,511,644	124,686	1,495,937	1,604,006	361,457	-	8,665	56,953	7,204	16,804	111,666	249,274	50,218	184,727	240,047
	1967	4,246,600	168,774	1,381,970	1,485,786	398,994	-	10,040	53,168	13,150	10,040	79,187	208,974	48,500	167,129	220,888

1/Amount for Western Operations Office includes funds for the Jet Propulsion Laboratory

HOW TOTAL BUDGET PLAN IS DISTRIBUTED TO NASA INSTALLATIONS

(In million of dollars)

	Research and Development			Construction of Facilities			Administrative Operations			Total		
	1965	1966	1967	1965	1966	1967	1965	1966	1967	1965	1966	1967
John F. Kennedy Space Center, NASA....	58.8	124.7	168.8	88.6	7.8	37.9	52.4	79.7	98.1	199.8	212.2	304.8
Manned Spacecraft Center.....	1422.8	1495.9	1382.0	23.9	4.2	13.8	91.0	87.6	98.2	1537.7	1587.7	1494.0
Marshall Space Flight Center.....	1468.4	1604.0	1485.8	12.5	2.3	.6	137.8	128.3	131.9	1618.7	1734.6	1618.3
Michoud Plant.....	-	-	-	6.4	.3	.7	-	-	-	6.4	.3	.7
Mississippi Test Facility.....	-	-	-	58.9	1.9	1.7	-	-	-	58.9	1.9	1.7
Goddard Space Flight Center.....	375.0	361.5	399.0	2.3	2.4	.7	92.6	64.0	71.7	469.9	427.9	471.4
Pacific Launch Operations Office.....	.1	-	-	-	-	-	.9	-	-	1.0	-	-
Wallops Station.....	6.3	8.7	10.0	1.7	1.0	.2	10.9	9.5	10.2	18.9	19.2	20.4
Jet Propulsion Laboratory.....	206.3	234.1	218.1	3.6	-	.3	17.7	.7	.8	227.6	234.8	219.2
Ames Research Center.....	54.1	56.9	53.2	5.7	2.7	-	31.8	32.9	33.5	91.6	92.5	86.7
Electronics Research Center.....	2.6	7.2	13.1	10.0	5.0	10.0	3.2	6.2	15.1	15.8	18.4	38.2
Flight Research Center.....	9.5	16.8	10.0	-	-	-	10.5	9.3	9.6	20.0	26.1	19.6
Langley Research Center.....	106.9	111.7	79.2	3.6	8.3	6.1	59.0	63.0	62.6	169.5	183.0	147.9
Lewis Research Center.....	322.3	249.3	209.0	.8	.9	16.0	68.5	67.2	66.3	391.6	317.4	291.3
Space Nuclear Propulsion Office.....	45.8	50.2	48.5	-	-	-	1.7	1.8	1.8	47.5	52.0	50.3
NASA Headquarters.....	184.0	184.7	167.1	-	-	-	51.5	56.3	58.7	235.5	241.0	225.8
Western Operations Office.....	7.8	5.9	2.8	-	-	-	5.0	5.3	5.4	12.8	11.2	8.2
Various Locations.....	-	-	-	33.1	20.2	6.5	-	-	-	33.1	20.2	6.5
Facility Planning and Design.....	-	-	-	10.0	2.6	7.0	-	-	-	10.0	2.6	7.0
Total Budget Plan.....	4270.7	4511.6	4246.6	261.1	59.6	101.5	634.5	611.8	663.9	5166.3	5183.0	5012.0

SUMMARY OF CONSTRUCTION OF FACILITIES BUDGET PLAN BY LOCATION

(in thousands of dollars)

Location	FY-1965	FY-1966	FY-1967
Ames Research Center.....	$5,668	$2,749	----
Electronics Research Center...	10,000	5,000	$10,000
Goddard Space Flight Center...	2,314	2,400	710
Jet Propulsion Laboratory.....	3,582	---	350
John F. Kennedy Space Center, NASA.....	88,618	7,782	37,876
Langley Research Center.....	3,640	8,250	6,100
Lewis Research Center.....	770	867	16,000
Manned Spacecraft Center.....	23,907	4,180	13,800
Marshall Space Flight Center..	12,454	2,309	581
Michoud Assembly Facility.....	6,450	285	700
Mississippi Test Facility.....	58,891	1,910	1,700
Various Locations.....	33,114	20,183	6,478
Wallops Station.....	1,699	1,048	205
Facility Planning and Design..	10,000	2,624	7,000
TOTAL PLAN.....	$261,107	$59,587	$101,500

ADMINISTRATIVE OPERATIONS

SUMMARY OF OBLIGATIONS BY INSTALLATION
(thousands of dollars)

	FY-1965	FY-1966	FY-1967
MANNED SPACE FLIGHT			
John F. Kennedy Space Center, NASA	$52,416	$79,723	$98,108
Manned Spacecraft Center.....	91,036	87,550	98,212
Marshall Space Flight Center....	137,787	128,260	131,934
SPACE SCIENCE AND APPLICATIONS..			
Goddard Space Flight Center.....	92,570	64,040	71,687
Pacific Launch Operations Office	844	---	---
Wallops Station.....	10,931	9,446	10,166
ADVANCED RESEARCH AND TECHNOLOGY			
Ames Research Center.....	31,807	32,923	33,475
Electronics Research Center.....	3,201	6,233	15,143
Flight Research Center.....	10,523	9,335	9,641
Langley Research Center.....	58,998	63,006	62,587
Lewis Research Center.....	68,546	67,207	66,284
Space Nuclear Propulsion Office.	1,669	1,824	1,847
SUPPORTING ACTIVITIES			
NASA Headquarters.....	51,516	56,286	58,667
Western Operations Office.....	22,693	5,987	6,149
TOTAL.....	$634,537	$611,820	$663,900

R&D NASA OFFICE OF MANNED FLIGHT

GEMINI PROGRAM

Gemini funding is tapering off in FY 1967 for a very good reason: most of its program objectives have been accomplished. The project was conceived to develop an operational capability in manned space flight, and through this, to conduct specific experiments and tests which support the Apollo moon venture, DOD programs and scientific investigations in space. As calendar year 1966 rolled around, only docking and post-docking maneuvers remained to be accomplished after seven previous flights had demonstrated long-duration flights of 14 days, rendezvous, extravehicular activity (outside the capsule), and controlled reentry.

Gemini effort in FY 1967 therefore will be devoted primarily to final hardware deliveries and operational activities of Gemini 8 through 11, which are scheduled to be launched in calendar year 1966. Gemini 12 is scheduled to be launched in the following calendar year.

	(thousands of dollars)		
FUNDS REQUIRED:	1965	1966	1967
Spacecraft.....	$165,300	$107,211	$19,100
Launch Vehicles.....	115,400	88,600	8,500
Support.....	27,700	30,800	13,000
TOTAL.....	$308,400	$226,611	$40,600

WHY FUNDS REQUIRED:

The FY 1967 budget request supports delivery and checkout of the last two McDonnell Aircraft Corporation spacecraft, engineering support for

launches to be conducted in FY 1967, and preparation and publication of final flight and program summary reports.

Launch Vehicles

Three separate vehicles are required for the Gemini program: the Gemini Launch Vehicle (GLV), the Atlas Standard Launch Vehicle (Atlas SLV-III), and the Gemini Agena Target Vehicle (GATV). The GLV, which places the spacecraft in orbit, is a Titan II intercontinental ballistic missile modified for manned flight.

The Atlas SLV-III and the GATV are also military vehicles adapted to meet the unique requirements of Gemini.

The Space Systems Division of the Air Force Systems Command, acting similarly to a NASA prime contractor, is procuring these vehicles. The FY 1967 estimate provides for the incremental funding required by the Air Force for delivery of the last two GLV, the last two SLV-III, and the last GATV, plus operational support of the vehicles to be launched during the fiscal year.

Support

Gemini support provides for crew operations, flight operations, and spacecraft and launch vehicle support for the remaining Gemini manned missions.

Crew operations involve three types of effort: simulation equipment and support, astronaut training, and specialized in-flight devices. Flight operations include the planning, support, and actual flight from lift-off to recovery. Spacecraft and launch vehicle support include funding for such items

as the life support systems, extravehicular activity equipment, and the experiments to be performed on the various flights.

APOLLO PROGRAM

During FY 1967 the Apollo program will see intensive ground and flight qualification testing to achieve a national commitment set by President Kennedy in 1961. The goal is worth repeating: to achieve a broad national capability for manned space exploration to enable this country to reach and maintain a position of leadership in space activities. A specific objective in acquiring this ability is to land men on the moon and return them safely to earth within this decade. The Apollo program is not only designed to meet this specific objective, but also should create a broad base of operational ability in manned space flight and the associated skills and technology; a valuable complex of development, manufacturing, test and operational facilities; and an experienced government and industrial team.

To do all this, the Apollo program requires the development of a highly reliable spacecraft, capable of supporting three men in space up to two weeks, docking in space, landing on and return from the moon, and safely re-entering the earth's atmosphere. Three large launch vehicles are in the program: Saturn I, which completed its flight series in July, 1965; the Saturn IB; and the Saturn V. The Saturn IB and V are being developed and qualified for manned space flight.

FUNDS REQUIRED:	(thousands of dollars) 1965	1966	1967
Spacecraft	$1,009,898	$1,170,600	$1,200,600
Saturn I	40,265	800	--
Saturn IB	262,690	274,185	216,400
Saturn V	964,924	1,177,320	1,191,000
Engine Development	166,300	134,095	111,000
Mission Support	170,542	210,385	255,200
TOTAL	$2,614,619	$2,967,385	$2,974,200

WHY FUNDS REQUIRED:

Spacecraft:

Development ground testing of boilerplate Apollo command and service modules (CSM) will be completed by the end of FY 1966. Ground testing of Block I CSM is underway and major emphasis will be placed on ground and flight qualification during FY 1967 Five Block I flight-CSM are in various stages of assembly, systems installation, and checkout in preparation for shipment to the John F. Kennedy Space Center (KSC). These Block I CSM will be used for early unmanned and manned earth-orbital flights on the Saturn IB and Saturn V. Block II CSM will have opgraded subsystems to provide the capability for lunar missions. During FY 1967, an intensive ground test program will qualify Block II CSM will be delivered to KSC for pre-flight checkout and 10 more Block II CSM will be going through assembly, systems installation, and in-factory checkout.

FY 1967 activity on the lunar excursion module (LEM) will include completion of the major portion of ground development and qualification testing.

Test articles will undergo structural, thermal-vacuum, and propulsion testing at the Manned Spacecraft Center, the White Sands Test Facility, and the Arnold Engineering Development Center. Ground qualification testing of key LEM systems, including electric power, reaction control, communications, propulsion, landing gear, and environmental control, will end. The first flight LEM will be completed, delivered to KSC, and tested on a Saturn IB in FY 1967. Ten additional flight LEMs will be in manufacture and checkout, and two of these LEMs will be delivered to KSC in preparation for flight.

Saturn I and IB

The Saturn I project completed its flight series in July 1965. No funds are requested in FY 1967. Saturn IB launches will begin with unmanned development flights early in calendar year 1966. In calendar year 1967 four launches are scheduled, including long-duration manned missions. During FY 1967, four vehicles will be delivered to the Kennedy Space Center. Fabrication, assembly and checkout of the last four Saturn IB vehicles will proceed during the fiscal year.

Saturn V

During calendar year 1967 the first launch of a Saturn V vehicle will occur. FY 1967 development effort will be concentrated on the ground testing that will culminate in the first flight qualification test. Dynamic testing of the entire vehicle will continue at the Marshall Space Flight Center.

FY 1967 also represents the peak year, to date, for production and delivery of Saturn V vehicles. The first three flight vehicles will be delivered during the fiscal year and an additional seven vehicles will be in fabrication, assembly, of checkout by the end of FY 1967.

Engine Development

H-1 development effort will consist, primarily, of the field and test support required to provide quick response analysis and problem solving associated with the flight evaluations of engine performance on Saturn IB vehicles. Qualification testing of the F-1 engine and the up-rated J-2 engine will include the test and field activity required to support the flight programs of the Saturn IB and Saturn V. No RL-10 activity is scheduled for FY-67. Space flight use of the RL-10 engine was limited to the Saturn I which has completed its flight program.

Mission Support

In FY 1967, support effort will continue for the over-all launch, flight, crew and recovery operations; program-wide systems engineering; supporting development required for the successful accomplishment of manned space flights; and for the maintenance of hardware production capability for Apollo applications, project definition and payload development.

ADVANCED MISSIONS PROGRAM

Three years ago NASA established this program to examine advanced manned space flight concepts, and if funding can be used as a criteria in judgment, there is decreasing emphasis in going much beyond Apollo. The program received $26 million in FY 1965, $10 million in FY 1966, and is down two million to $8 million requested in FY 1967.

Studies, however, include analysis of present hardware systems for growth potential; development of requirements for future systems; guiding research and technological activities; providing technical information and cost data upon which future program decisions can be based; and starting the definition, preliminary design and specification of probable future missions.

WHY FUNDS REQUIRED

The FY 1967 requirements for manned earth orbital studies support preliminary systems definition of space station concepts, based on several examined during FY 1966. Systems under review include a long-term station not requiring resupply, using the present family of subsystems and launched with a Saturn V, and a future space station capable of supporting planetary flight. Preliminary systems definition will also be conducted on a ferry/logistic system for use with these concepts. Particular attention will be given to the description and definition of experiment modules which can be used in conjunction with the various space station concepts and which can

be operated by the crew of the space station. In addition, efforts will continue on the selection and description of possible experiments for advanced missions and the constraints of these experiments on the space station and the logistic system will be assessed. The ultimate growth capability of such a space station into a planetary mission module will be considered, as well as the earth orbital requirements for a new and larger spacecraft with inherently greater experimental man-hour capabilities.

The FY 1967 funding for manned lunar mission studies provides for the definition of an extended lunar exploration plan and related conceptual designs. The results of comparative evaluations of shelter and mobility concepts, as well as various modes of payload delivery to the moon will be combined with the recommendations of the scientific community to formulate a comprehensive lunar exploration plan. This work will provide the basis for decision concerning the start of program definition for an advanced lunar exploration system.

Manned planetary mission studies have established the feasibility of a number of mission modes and system concepts for Mars and Venus fly-bys, as well as Mars landing missions. The FY 1967 requirements cover more detailed analysis of systems feasibility, systems concepts, and technological requirements. Studies will focus on manned planetary spacecraft concepts that can be applied to the broadest range of missions and launch dates. Objectives, schedules, and costs, will be studied to identify the

most promising concepts for detailed engineering design.

Launch vehicle studies to support earth orbital, lunar, and planetary manned missions will aslo be conducted during FY 1967. These studies will stress preparation for systems definition of improved Saturn vehicles, as well as reusable transport concepts. The related requirements for operational and support facilities will also be studied.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

PHYSICS AND ASTRONOMY PROGRAMS

The objective of this program is to increase our knowledge of the space environment of the earth, the sun and its relationship to the earth and the interplanetary medium, and the fundamental physical nature of the universe. To achieve this objective, research programs have been undertaken to intensively study the upper atmosphere, the ionosphere, the earth's magnetosphere, the region beyond the boundaries of the magnetosphere, solar radiation and the solar wind and their interactions with these regions, cosmic rays from beyond the solar system, radiation from stars and other celestial bodies in areas of the electromagnetic spectrum which cannot be observed from the earth's surface, and the geodetic figure of the earth.

Knowledge gained in this program has demonstrated support for other national programs such as meteorology, communications, manned space flight, and cartography. However, the program is primarily intended to be a basic

research program dedicated to the expansion of human knowledge. As such it is integrated with the programs of educational and scientific research institutions throughout the United States and in many foreign countries. Substantial efforts are made to insure that the results of the research are made generally available on a basis that will make the knowledge most useful to facilitate future advancements in technology, scientific research, and education.

FUNDS REQUIRED:

	(thousands of dollars)		
	1965	1966	1967
Supporting Research and Technology/Advanced Studies.....	$21,057	$23,800	$22,900
Solar Observatories.....	16,597	24,500	11,900
Astronomical Observatories....	32,644	24,600	29,200
Geophysical Observatories.....	30,352	28,600	23,400
Explorers.....	21,565	21,400	23,000
Sounding Rockets.....	16,867	18,500	19,000
Data Analysis.....	---	2,100	2,000
TOTAL.....	$139,082	$143,500	$131,400

WHY FUNDS REQUIRED:

Supporting Research and Technology

This program seeks to provide a sound theoretical base for flight programs; starts development of instrumentation for future experiments; provides laboratory data to evaluate flight data; conducts ground-based balloon and aircraft observations for correlation with flight program results; and provides scientific experiments and scientific support for the manned space flight program.

Advanced Studies

Advanced studies establish concepts, characteristics, and the feasibility of future unmanned earth-orbital and interplanetary missions. Studies include small modular scientific satellites of the Explorer class, other specialized Explorers, galactic probes, and small interplanetary probes.

Orbiting Solar Observatories (OSA)

This program provides a thorough investigation of the sun and its changing activities. Satellites will systematically and uniformly study the rapid changes as well as the long term changes in solar radiation during a solar cycle and probe into the underlying causes of these changes by analyzing regions of activity. The OSO's operated during the period of minimum solar activity with the flights of OSO-I and II in 1962 and 1965, respectively. Continuous program effort will be pursued with OSO into the period of maximum solar activity.

Astronomical Observatories

The Orbiting Astronomical Observatory (OAO) is designed to provide a precisely stabilized observatory above the atmosphere so that fundamental information about the universe can be obtained. Astronomical observations of electromagnetic radiation will be made in the ultraviolet and X-ray regions of the spectrum which do not penetrate the earth's atmosphere, and high resolution observations in the visible regions of the spectrum. The first OAO will be ready to fly early in 1966, and will

carry a variety of ultraviolet, X-ray and gamma ray telescopes. Spacecraft and experiment development for three additional OAO's is in progress. FY 1966 funds will provide launch, operational and data analysis support for OAO-A, refurbishment of the prototype spacecraft for the OAO-A_2 mission, development of spacecraft for OAO-B and C missions, and experiment development for OAO-B, A_2 and C. Fiscal year 1967 funds will support launching, orbital operations, and data analysis for the OAO-B mission, for a continuation of effort on OAO-A_2 and C, and for the initiation of hardware development for the OAO-D spacecraft and experiments.

Geophysical Observatories

The objective of the Orbiting Geophysical Observatory (OGO) program is to develop a standard earth-orbiting observatory capable of carrying large numbers of experiments in a variety of orbits to simultaneously investigate the geophysical phenomena and interrelationships of solar activity, the interplanetary and galactic medium, the terrestrial magnetosphere, and the atmosphere. The first two spacecraft in this series, OGO-I and II, have been launched. OGO-I has operated for over a year in an eccentric orbit and has obtained scientific data from almost all of its 20 experiments despite a failure to attain earth-orientation caused by improper boom deployment. OGO-II was launched into polar orbit late in 1965 and is returning data although it is no longer stabilized due to early depletion of the gas supply. Two more missions are planned for launching into eccentric orbits

and two more missions are planned for launching into polar orbit.

Fiscal year 1966 funds provided for the launch of OGO-II (C), for analysis of data from OGO-I and II, for the completion and launch of OGO-B, for continuation of development of OGO-D and E spacecraft and experiments, and to start experimental development for OGO-F. Fiscal year 1967 funds will provide the completion and launch of OGO-D, the completion of OGO-E, and refurbishment of the prototype spacecraft for the OGO-F mission. Funds will also support data analysis for the first four OGO missions, and experiment development for OGO-E and F.

Explorers

These spacecraft, most of which are launched by Scout and Delta vehicles, are specifically designed for particular scientific investigations, and are flown in orbits particularly suitable for these investigations.

These spacecraft are developed by NASA installations, industry, universities, and cooperating foreign countries. Many smaller organizations have been able to gain competence and experience by perticipating in the development of these small Explorer spacecraft.

In FY 1966, increased emphasis was given to Astronomy Explorers with major funding of the Radio Astronomy Explorers and start of the X-ray Astronomy Explorer. A Scout launch vehicle was also provided for a Solar Explorer developed by the Naval Research Laboratory. Development of Geophysical and

Interplanetary Explorers is being continued at a reduced level of effort, and the Geodetic Satellite program is being continued at a level effort.

The FY 1967 program will see reduction of the level of effort for Geophysical and Enterplanetary Explorers, providing only for continuation of launches of Interplanetary and Energetic Particles Explorers and the international cooperative program in the 1968-1969 time period. The program for Astronomy Explorers will provide observations into the 1968-1969 time period with emphasis on X-ray and radio observations of the sun. Geodetic investigations will be continued using the satellites in the currently approved program.

Sounding Rockets

Sounding rockets have proven to be the only effective way of making scientifically valuable studies of the upper atmosphere at altitudes above 20 miles and below perigee altitudes of earth satellites. These rockets are relatively small and inexpensive vehicles capable of carrying wide varieties of instrumentation for the study of the atmosphere, ionosphere, energetic particles, and studies in astronomy and solar physics. Sounding rocket flights have been extremely useful for developing instrumentation for later use on satellites. The usefulness of sounding rockets for astronomical observations, particularly observations of the sun and stars in the X-ray and ultraviolet regions of the spectrum, has been greatly enhanced by the development of attitude control systems.

The small cost increase in the sounding rocket program in FY 1966 and FY 1967 is largely due to the development and increased use of improved attitude control systems; and to an increased use of the larger, more expensive vehicles to carry stabilized payloads, as well as heavier payloads, with several instruments for a number of simultaneous measurements.

Data Analysis

This project enables NASA to meet its obligation to make the scientific information gained from space explorations available to the world scientific community. Data accumulated from NASA's orbiting ovservatories, Explorers, sounding rockets, and space probes is being reduced and placed in storage at the National Space Science Data Center located at the Goddard Space Flight Center. Here it is catalogued and distributed to interested researchers. Fiscal year 1966 and FY 1967 funds provide for the operation of the Data Center and for the support of research tests using the data stored there.

LUNAR AND PLANETARY PROGRAM

Through these program efforts NASA is aiming for the scientific exploration of our solar system using manned and unmanned spacecraft and earth-based research. While the exploration of the moon, Venus and Mars and the interplanetary space between are immediate objectives, eventually the outer planets and their moons, comets, asteroids and far out interplanetary space will be explored. From such investigations it is hoped that the world will

be better able to understand the origin, history and mechanisms of development of our solar system and that life may be found elsewhere.

There are three lunar flight programs. The first of these, the Ranger program, has been completed and provided a much better understanding of the nature of the surface of the moon from high resolution photographs. The Surveyor program will soft land on the moon a series of unmanned spacecraft to make observations. The Surveyor will determine the suitability of its landed site for later manned missions. The Lunar Orbiter program will complement the information obtained by Ranger and work with Surveyor in conducting scientific investigations and locating and certifying suitable landing sites for Apollo. Lunar Orbiter will photograph all regions of the moon and will be a useful tool in continuing lunar exploration. Scientific instruments and techniques are being developed for lunar investigations capitalizing on man's capabilities and the payload return capabilities of the Apollo program.

The Planetary and Interplanetary program has yielded a wealth of scientific information on the planets and interplanetary environment from the Mariner II encouter with Venus, the Mariner IV flyby of Mars and the Pioneer VI launch into solar orbit. Additional Mariner and Pioneer launches are planned during FY 1966-1969 to measure inteplanetary phenomena and continue exploration of the inner planets. Mariner launches to Venus in 1967 and Mars in 1969 will use the Mariner IV design, and pave the way for the detailed

exploration of these planets by the Voyager program now planned to be available for the 1973 Mars and subsequent opportunities.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology/Advanced studies ...	$24,140	$38,600	$40,100
Ranger	11,037	1,000	---
Surveyor	81,814	111,637	90,400
Lunar orbiter	49,500	52,400	24,600
Mariner	17,368	18,000	26,100
Voyager	7,168	17,000	10,000
Pioneer	15,000	12,700	6,700
Total	$206,027	$251,337	$197,900

WHY FUNDS REQUIRED:

Supporting Research and Technology/Advanced Studies

This provides support to flight missions as well as the necessary feasibility studies and other advanced work required to establish future missions. The Lunar and Planetary Science program develops new concepts and ideas for scientific investigation of the moon and planets to the stage where they can be proposed as flight experiments for future missions. Ground based observations provide scientific data for the design and calibration of and comparison with flight experiments. Examples are spectroscopic observations of Mars and radio wave observations of Venus. The Advanced Technical Development program develops equipment which must survive both a rigorous sterilization and long

long exposure in a deep space environment. Development of landing technology to ensure safe planetary landings of Voyager type spacecraft is receiving particular emphasis. Planning for the future in Lunar and Planetary program will require continued study of advanced missions. Current year studies indicate the potential of trajectories which swing-by one planet enroute to a different, target planet, in terms of the reduction of trip time and energy required to the target planet. Mission trajectories to Mars, Venus, and Mercury as well as Jupiter and the outer planets were included. Spacecraft conceptual design studies have been largely confined to Mars and Venus missions during FY 1965 and FY 1966, but a minimal effort has been maintained on flights to Jupiter and to comets and asteroids. The Manned Lunar Science program plans scientific investigations and develops equipment for manned lunar missions. Major scientific objectives of early manned missions to the moon are the observation of natural phenomena, collection of representative samples and emplacement of monitoring equipment. The Lunar Mapping program supports both the manned and unmanned flight programs.

Surveyor

The Surveyor system will soft land unmanned spacecraft on the moon to make measurements to improve our understanding of the nature of that body. A successful landing should yield important information on landing technology and the surface characteristics (roughness, bearing strength, dust coverage) which affect the landing and data on the immediate area as a possible site for

later manned landings. Because the Surveyor design concepts are basically the same as those being used on Apollo, the landing of Surveyor on the moon should demonstrate the feasibility of later manned landings. Surveyor has many elements in common with the Apollo Lunar Excursion Module, such as the radar altimeter, radar doppler velocity sensors, closed-loop terminal guidance system, variable-thrust rocket engines, leg-type landing gear, S-band communications and tracking to lunar distances. Surveyor represents a considerable advance in spacecraft technology over earlier systems. During 1965, major problems were corrected and the first descent test conducted successfully. To obtain lunar surface data at the earliest possible time to support the first Apollo missions, the effort was reduced on the 2500 pound spacecraft in order to concentrate on the 2200 pound spacecraft, which will be used on the first seven flights. Two lunar missions are planned for 1966 and the remaining eight flights of the current series are planned to be completed by the end of 1968. Fiscal year 1967 funds will provide for the launch and mission operations of spacecraft two through four, assembly and test of spacecraft five through seven and first hardware procurement for the final three spacecraft in the currently planned ten flight series.

Lunar Orbiter

The Lunar Orbiter is the low-altitude lunar reconnaissance satellite member of the Surveyor-Orbiter team which will conduct unmanned scientific investigations of the moon prior to the Apollo period. The Oribter will pro-

vide both high resolution photographs (comparable to Ranger pictures immediately preceding impact) and broad area coverage of the surface. The combination will yield stereo coverage and permit topographic mapping of the moon, and correlated with data from landed Surveyors, will go far toward reducing uncertainties of subsequent lunar landings. Analysis of orbital data from Lunar Orbiter missions should disclose much about the nature of the moon's shape, its mass distribution and internal structure. Development and testing of the Lunar Orbiter prototypes will be completed and first flight spacecraft will be launched during the current year. Fiscal year 1967 funds will cover three more launches and post-launch operations and prepare for the final mission of this five flight program.

Mariner

The objectives of the Mariner program are to conduct flight missions in the vicinity of Mars and Venus to obtain information about their surfaces and atmospheres, and to measure magnetic fields, energetic particle and micrometeoroid flux in interplanetary space and close to the planets. The Mariner II flyby of Venus on December 14, 1962, and Mariner IV's encounter with Mars on July 14, 1965, produced the first direct measurements of other planets from space. With the delay in starting Voyager flights, additional Mariner flights have been introduced. The spare spacecraft from the Mariner IV program will be refitted to be launched by Atlas-Agena for a flyby of the planet Venus in 1967. Development of a spacecraft based on the Mariner IV design is also

underway for two flights to Mars in 1969 to be launched on Atlas-Centaur. Fiscal year 1967 funding will support continued development of the Venus 1967 and Mars 1969 missions as well as an attempt to reestablish telemetry communications with the Mariner IV spacecraft when it returns to the vicinity of the earth in early 1967.

Voyager

Voyager is developing the capability for detailed study of the near planets. The primary goal of these missions is to obtain detailed information on atmospheric, surface, and body characteristics, with special emphasis on the possible existence and nature of life on the planets. Voyager flights should also further our knowledge of the interplanetary medium between earth and the planets by conducting scientific and engineering measurements while in transit. Although the system is being developed to explore the planet Mars, it should provide a basic capability which can be generally applied to the exploration of the near planets by automated spacecraft.

To meet these objectives, the spacecraft must be capable of orbiting the planet and landing a scientific payload on the surface. Presently this spacecraft is conceived to consist of three modules; a bus-orbiter module, a retropropulsion module, and an entry capsule module. Definition studies have indicated the desirability of launching two of the Voyager spacecraft on a single Saturn V launch vehicle to take advantage of this vehicle's weight lifting capacity and planned reliability. Currently efforts are underway to further

define the mission, the spacecraft system and the capsule system design. The Voyager effort will be continued at the system definition level through FY 1967, resulting in possible first flights for the 1973 Mars opportunity. The funding requested for FY 1967 will be used to continue the overall mission studies, the capsule design studies, and supporting activities leading to detailed system design and breadboard testing planned to be initiated in FY 1968.

Pioneer

Pioneer will investigate the interplanetary environment and the propagation of solar and galactic phenomena through this medium, by launching spacecraft during a period of increasing solar activity over the next several years. Pioneer data will be correlated with similar measurements made near earth to provide simultaneous observations at widely separated points in space. Pioneer VI was successfully launched in December 1965 into solar orbit. Four additional Pioneer missions are scheduled to alternate between missions approaching as close as 0.8 A.U. and going out as far as 1.2 A.U. from the sun (1 A.U. is equal to the mean earth to sun distance, 92,900,000 miles). Because Pioneer experiments largely measure charged particle fluxes and magnetic fields, great care has been taken in the design and construction of the Pioneer spacecraft to make it magnetically clean. The residual spacecraft magnetic field for Pioneer VI was less than one hundred-thousandth of the earth's field, an order of magnitude better than any previous spacecraft. Funding requested

Research Facilities

The NASA Research Facilities program is directed at providing campus facilities at those universities already heavily committed to the space program. Facilities acquisition funded under this program through FY 1966 will provide approximately one and one half million (1,500,000) square feet of laboratory space at a cost of $47 million. These facilities will be located throughout the country, and will vary from highly specialized technical facilities to general purpose laboratories depending upon the individual university's need and potential.

FY 1967 funds will provide for construction of an additional two hundred thousand (200,000) square feet of laboratory space at a cost of $7 million.

Research

For the continued growth of special purpose research programs in FY 1967, approximately 71 projects will be supported at a cost of $12 million. Sixty five of these grants will be for the continuation of projects supported in FY 1965, and the remainder will be to universities participating in this program for the first time.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

LAUNCH VEHICLE DEVELOPMENT PROGRAM

Goal of the Launch Vehicle Development program is to assure a timely,

economical availability of launch vehicles to meet unmanned mission requirements. Mission requirements show a need for improved vehicle performance. As mission requirements exceed present vehicle capability, there must be systems improvements, configuration changes, improved operating techniques, new stages, new launch vehicles or combinations thereof. Scout and Delta development programs were completed in FY 1963. The Centaur development program is expected to be completed in FY 1967.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology/advanced studies	$7,100	$4,000	$ 4,000
Centaur development	89,400	51,300	29,700
Total	$96,500	$55,300	$33,700

WHY FUNDS REQUIRED:

Supporting Research and Technology/Advanced Studies

The purpose of Advanced Studies is to define future vehicle requirements and to establish the methods by which needed performance increases can best be developed. The Supporting Research and Technology efforts are directed toward developing the new technology and techniques shown to be needed by the Advanced Studies.

The FY 1966 and FY 1967 studies and technology efforts have been focusing on high-energy mission requirements for a small energetic (kick) stage as an addition to existing launch vehicles. Other efforts on solid propellant

performance prediction, operational hazards and overall vehicle performance requirements will be continued in FY 1967.

Centaur Development

The Atlas/Centaur is under development as a high-energy upper stage, burning liquid hydrogen and liquid oxygen that will provide the required capability for NASA's unmanned lunar missions. The Centaur program has provided technology for the handling, storage, and use of liquid hydrogen in the space environment. Another feature of the Centaur vehicle is its utilization of an all-inertial guidance system through the complete mission profile.

Funding for FY 1967 is for completion of the developmental effort on the Centaur vehicle and improvement effort on the RL-10-A3 engines, formerly funded by the Office of Manned Space Flight.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

LAUNCH VEHICLE PROCUREMENT PROGRAM

This means what it says: buying launch vehicles for the unmanned NASA spacecraft program. The rockets are Scout, Delta, Thor-Agena, Atlas-Agena and Centaur.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Scout	$13,287	$11,700	$10,400
Delta	32,374	27,900	22,900
Agena	55,040	71,100	54,700
Centaur	44,814	64,000	64,000
Atlas	8,972	4,000	---
Total	$154,487	$178,700	$152,000

WHY FUNDS REQUIRED:

Scout Procurement

. Purpose of Scout is to provide a reliable, relatively inexpensive vehicle for general space research. It is the smallest of the basic NASA family of launch vehicles and carries small-sized payloads for orbital, probe and re-entry missions. The FY 1967 funds for Scout procurement will be used for new buys of Scouts and launch services. Funds will be applied to continue procurement of first, second, third, and fourth stage motors to meet calendar year 1967 launch requirements. Funding is also provided for other support requirements, such as adaptation of the Scout vehicles to satisfy spacecraft and mission requirements.

Delta Procurement

Delta is used for a variety of medium-size satellites and small space probes. Included in the FY 1967 request are funds to continue procurement of Thor boosters, Delta second stages and third stages to meet launch schedule requirements for the Delta vehicle. Fiscal year 1967 funds will also provide for launch service requirements and other supporting services.

Agena Procurement

In combination with Thor and Atlas boosters, the Agena second stage is employed extensively by NASA. The restartable Agena stage provides considerable latitude in mission capability among the various earth orbital and lunar or planetary missions. Funds requested for FY 1967 will buy the basic Agena

stages, Atlas and Thor boosters, and the adaptation of the Agena stages for mission peculiarities. The necessary Atlas, Thor and Agena launch support, i.e., launch services, propellants, supporting services, etc., will also be provided.

Centaur Procurement

The Centaur vehicle is used on unmanned lunar, planetary, scientific, and applications missions which exceed the capability of the Atlas-Agena vehicle. The present procurement of operational Centaur vehicles is programmed to meet the requirements of the Surveyor unmanned lunar surface exploration project. There are two operational Centaur-Surveyor launches planned for calendar year 1966. Funds requested for FY 1967 are to continue Centaur procurement in support of the Surveyor program and to complete procurement of Atlas-Centaur vehicles for the first seven Surveyor missions; provide launch services and other supporting services for calendar year 1967; and provide for initiation of procurement of additional Atlas boosters, RL-10-A3 engine sets, and Centaur stages.

Atlas Procurement

This project consists of procurement of Atlas launch vehicles for unmanned missions. Two vehicles were bought for the Space Vehicles Systems program, (Project FIRE). Funds in FY 1966 and 1967 are for the SLV-3X, Atlas improvement program. This effort was started late in FY 1965 to provide greater payload capabilities for all missions utilizing the Atlas booster.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

BIOSCIENCE PROGRAM

This program has two fundamental objectives; the search for extraterrestrial life with primary emphasis directed to Mars and the development of a basic understanding of the effects of the space environment on terrestrial organisms by means of ground-based experiments and the Biosatellite project. A supporting program of basic and applied research is being conducted. Accomplishment of these objectives should increase our understanding of the nature and origin of life, including the possibility that life exists on Mars, provide for the testing of biological hypotheses in the areas of genetics, developmental biology, environmental physiology, and general metabolism, furnish data pertaining to biological requirements for prolonged manned space flight, and result in the development of various new procedures and devices which may have medical and other applications to human beings.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology	$12,501	$15,100	$14,700
Biosatellite	16,000	21,600	20,700
Total	$28,501	$36,700	$35,400

WHY FUNDS REQUIRED:

Supporting Research and Technology

The search for extraterrestrial life is one of the primary objectives of

the Bioscience program. This effort includes ground-based studies to provide an experiment system capable of determining the physical and chemical characteristics of Mars and search in various ways for the existence of life, and a planetary quarantine effort intended to assure, with a high degree of probability, that terrestrial organisms will not contaminate Mars.

The Exobiology effort supports this objective in various ways, for example, by analyzing fossil remains in ancient terrestrial rocks, in quest of data pertaining to the history of terrestrial life. In addition, studies on proteins and their amino acids, and the fact that 18 amino acids are constituents of our contemporary biota, and about half of these remain stable for millions of years, suggest that gas chromatography, mass spectrometry, and the application of classical chemical techniques may be employed in the biological exploration of the Moon and Mars.

Investigations in the planetary quarantine area indicate that heat is the most feasible agent for use in spacecraft sterilization. It will be necessary to develop parts capable of withstanding the heat required, minimize the number of biological organisms on the spacecraft when it undergoes sterilization, and protect the sterile spacecraft from recontamination during launch.

Environmental, Physical, and Behavioral Biology support basic and applied research, and some technological development in support of the Bioscience objectives. Environmental Biology is concerned with the biological effects of the space environment on living organisms, including man. It is investigating

the effects of weightlessness on the cardiovascular and nervous systems, and on general metabolism, and the environmental extremes which various organisms can endure and still survive. Physical Biology supports research in comparative physiology, bioinstrumentation, and molecular biology. Nutritional studies have shown that men can live on chemically-defined liquid diets for at least six months without apparent ill effects. In biological telemetry and electron microscopy, the development of a multi-channel sensing implantable device, and superconducting lenses, should further research efforts in various biological areas. Behavioral Biology is studying the effects of zero gravity and other conditions of the space environment on the behavior of organisms, including brain-behavior relationships of importance to organisms in environmental adaptation.

The Bioscience program for manned missions is assisting in the development of flight experiments for Gemini and Apollo earth-orbiting missions. Several experiments have already been flown yielding information on the effects of radiation and weightlessness on white blood cells. An effort is also underway to define experiments, and mission and spacecraft requirements for future manned missions.

Biosatellite

The Biosatellite program will investigate the effects on biological systems of such unique aspects of the space environment as weightlessness, the effects of combined weightlessness and radiation, and the removal of living systems from the direct influence of the Earth's periodicity.

The three-day flights will consist of general biology and radiation experiments intended to explore the effects of weightlessness, and weightlessness combined with radiation, on animal cells and insects. The 30-day flights will investigate the effects of weightlessness on general metabolic behavior and performance of a primate, as well as its effects on the primate's cardiovascular and nervous systems. The 21-day flights consist of general biology experiments, investigation of gross body composition and function and circadian rhythms in mammals.

R&D OFFICE OF SPACE SCIENCE & APPLICATIONS

METEOROLOGICAL SATELLITE PROGRAM

Aims of this program are: (1) development of a satellite for, (a) global and local readout of cloud cover day and night, (b) global quantitative measurement of temperature, wind, moisture, and other meteorological factors as a function of height under continuous and variable time scales; (2) develop and implement for the Department of Commerce, Environment Science Services Administration (ESSA), the TIROS Operational Satellite (TOS) System; (3) develop a meteorological sounding system to explore and study the atmospheric region 20 to 60 miles above the earth; (4) develop new and improved techniques and equipment; and (5) explore the use of manned spacecraft for Meteorology.

Objectives (1) and (2) are accomplished by the TIROS/TOS Improvements, Meteorological Flight Experiments, and Nimbus projects; objective (3) by

Meteorological Soundings project, and objectives (4) and (5) by Supporting Research and Technology and Advanced Studies.

Ten TIROS spacecraft, including TIROS X funded by ESSA, have been successfully launched since April 1960 to test spacecraft systems and sensors and provide operational meteorological data for use by ESSA. One Nimbus spacecraft has been launched and three additional flights are planned to provide cloud cover and vertical atmospheric measurement data. Approximately 50 large research rockets and 100 small developmental sounding rockets are launched per year to explore the region 20 to 60 miles above the earth and obtain meteorological data from this region. The investigation of scientific techniques; design and development of advanced hardware for meteorological application; study of data acquisition techniques; and feasibility studies on future spacecraft designs and capability including manned experiments are conducted in Supporting Research and Technology and Advanced Studies.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology/ Advanced studies	$ 7,311	$ 8,300	$ 9,100
TIROS/TOS improvements	4,100	3,700	2,600
Meteorological flight experiments	1,200	3,900	5,500
Nimbus	16,000	20,000	23,400
Meteorological soundings	2,380	3,000	3,000
Total	$30,991	$38,900	$43,600

WHY FUNDS REQUIRED:

Supporting Research and Technology/Advanced Studies

NASA wants to: (1) develop and evaluate components for potential meteorological satellite system application; (2) design and develop satellite sensors for the detection and controlled acquisition of meteorological data directly from the atmosphere and from other sources; (3) investigate scientific techniques and tools for the systematic observation, analysis and subsequent interpretation of meteorological atmospheric phenomena, and (4) better satellite performance and information retrieval techniques through advanced system analyses. Results are applicable both to research and development goals of NASA and to the operational systems of the Environmental Science Services Administration (ESSA). In FY 1967, funds are required to continue atmospheric research into newly-measurable phenomena and expanded observation techniques. Efforts continue in the design of improved control subsystems and data processing loops to achieve greater efficiency, capacity, and life in future meteorological satellites. Sensors and instrumentation systems for advanced cameras and infrared detectors will be developed.

Advanced Studies will be conducted for the development of advanced unmanned systems. Advanced component developments will be investigated to determine reliable design interfaces for long life and low power operations in future satellites.

Applications for manned space missions include the study and development of advanced meteorological sensors and other equipment from manned orbital spacecraft. Several investigations of this type have taken place on manned Gemini flights. Studies of experiments for Apollo manned orbital missions were initiated in FY 1965 and FY 1966 to select experiments to take full advantage of manned space flight missions and capabilities. Fiscal Year 1967 funds will be used to continued this effort.

TIROS/TOS Improvements

The objectives of the TIROS/TOS Improvements project are to provide research and development toward advanced meteorological satellite systems and to provide continuing development support for the ESSA funded TIROS Operational System (TOS). During 1965, the ninth and tenth TIROS satellites were successfully launched. TIROS IX demonstrated the capability of a cartwheel configured spacecraft to provide daylight cloud cover pictures on a global basis daily. This configuration is the basic design being used in the TOS system. TIROS X, the first ESSA funded spacecraft, was launched in July 1965 to ensure cloud picture coverage during the 1965 hurricane season. Efforts are being continued to develop flight hardware for improvements to the TOS system, to improve reliability and extend subsystem and component life and to meet operational data requirements. FY 1967 funds are asked to continue funding TOS Improvement subsystems aimed primarily at developing the automatic picture transmission (APT) with recorder for the TOS spacecraft, increasing the life and reliability of vidicons and advancing the technology for night sensors.

Meteorological Flight Experiments

This conducts meteorological research and development on non-meteorological satellites and space vehicles. The first experiments are for the advancement of technology leading to a capability for continuous viewing of the visible disc of the earth with its cloud and radiation data, and for nearly continuous detail viewing of shortlived meteorological phenomena such as thunderstorms, tornadoes and other individual cloud cells. Also, weather data dissemination experiments (WEFAX) will be conducted to demonstrate the meteorological usefulness of transmitting weather information via synchronous satellites to local users on a regional and world-wide basis. FY 1967 funds are asked to complete procurement of high and low resolution cameras for Applications Technology Satellites, ATS-S; the Image Dissector or equivalent spin scan camera, and Omega Position Location Experiment (OPLE) spacecraft hardware for ATS-C; to initiate the camera and WEFAX hardware development, operations and data evaluation of the ATS meteorological experiments data.

Nimbus

The objectives of Nimbus are: (1) to develop a spacecraft with adequate power supply and stabilization to test a number of meteorological sensors, (2) to develop a variety of meteorological sensors to obtain day and night cloud cover, and atmospheric data such as pressure, temperature, wind and water vapor at various altitudes over the globe, and (3) to test these sensors and associated data acquisition and handling techniques prior to recommending their use on the operational systems of ESSA.

The successful launch of Nimbus I on August 28, 1964 proved the basic spacecraft configuration and the usefulness of the meteorological sensors tested. A failure in the solar array drive reduced power which caused termination of useful data after approximately one month of operation. The next spacecraft (Nimbus C) is scheduled for launch in 1966. A new experiment, a Medium Resolution Infrared Radiometer (MRIR) will be flown, in addition to improved versions of the sensors tested on Nimbus I. The MRIR experiment should permit a full global study of the earth's heat balance, and represents, NASA says, one of the most significant meteorological experiments so far undertaken.

Nimbus C will provide to ESSA, in nearly real-time, High Resolution Infrared Radiometer (HRIR) data for operational purposes; and start experimentation with nighttime direct local readout of HRIR data through APT ground stations. The current Nimbus program includes the development of two additional spacecraft (Nimbus B and D) scheduled for launch in 1967 and 1969 respectively. Significant spacecraft and meteorological sensor advances are being developed for testing on these flights such as: (1) a 50-watt radioisotope thermoelectric generator (RTG) which will demonstrate the feasibility of RTG long life power supplies for meteorological satellites; (2) new experiments for determining the temperature profile and the water vapor content of the atmosphere such as spectrometers developed by NASA and ESSA; (3) a sensor to measure the solar flux in the ultraviolet spectral region to determine its

influence on the upper layers of the atmosphere; and (4) initial experimentation in collecting, recording, and relaying data from a number of sensors placed on and above the earth's surface to record atmospheric and meteorological data.

FY 1967 funds are asked for ground operations and support for Nimbus C; and to complete the development of the more advanced Nimbus B experiments as well as to continue the development of the spacecraft; and to start the development of the Nimbus D spacecraft and its advanced experiments.

Meteorological Soundings

Three areas of effort are in this project: (1) large research rockets; (2) small developmental sounding rockets; and (3) field experiment support. The objective of the large research rockets is to develop and improve sensors and techniques for measuring the characteristics of the atmosphere in the region 40 to 60 miles above the earth. The objective of the small developmental sounding rockets is to develop a reliable, inexpensive, self-sufficient system, including the rocket vehicle, sensors and data acquisition which will provide routine measurements of the basic atmospheric parameters in the region 20 to 40 miles above the earth. Field experiment support provides for conducting sounding rocket experiments in cooperation with other countries, on a cost-sharing basis. FY 1967 funds are asked to launch approximately 50 large research rockets of the Nike/Cajun class, 100 small developmental sounding

rockets of the Arcas/Hasp class, for development and improvement of the sounding rocket system, initiation of design and development efforts on an advanced system, and for the continuation, extension and development of field experiment support jointly with countries in South America, Europe, and Asia.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

COMMUNICATIONS AND APPLICATIONS TECHNOLOGY SATELLITES PROGRAM

Previously these had been separate programs but NASA has now combined them into one. Objectives are: (1) to assure that technology required for establishment of future communication, navigation, and other applications satellite systems is developed; (2) to study requirements and technically assess the applicability of satellites to the future needs of communication, navigation, and other promising applications systems; and (3) to fulfill NASA's responsibilities under the Communications Satellite Act of 1962.

Serving as relay stations at altitudes that are within line-of-sight of distant points on the earth's surface, communications satellites offer microwave communication over long distances, not presently attained by high frequency radio. They have the potential of providing all types of telecommunication services on a world-wide basis. Studies are underway to determine the need for an improved world-wide navigation system, traffic control, search and rescue, and communication systems for aircraft and ships. Five

Applications Technology Satellites scheduled for launch in the 1966-1969 period may test and evaluate advanced subsystems applicable to communications, meteorology, navigation, and other purposes; test and evaluate satellite structures and stabilization systems peculiar to communications, navigation and other satellite endeavors; and offer the potential for determining the radiation levels and the long-term effects of this environment on spacecraft components at different altitudes, particularly the synchronous altitude where little environmental data exists. The Echo, Relay and Syncom projects are completed except for continuing data reduction and analysis.

FUNDS REQUIRED:

	(Thousands of Dollars) 1965	1966	1967
Supporting research and technology/advanced studies	$ 2,124	$4,500	$4,600
Echo II	325	---	---
Relay	462	200	---
Syncom	168	100	---
Early gravity gradient test satellite	5,000	---	---
Applications technology satellites ..	22,695	28,000	21,800
Total	$30,774	$32,800	$26,400

WHY FUNDS REQUIRED:

Supporting Research and Technology/Advanced Studies

The Supporting Research and Technology (SR&T) is concentrated in four areas; (1) Communication and Navigation, (2) Applications Technology, (3) Advanced Missions, and (4) Data Analysis. The SR&T effort will identify

and solve critical technical problems, advance the state-of-the-art, provide the basis for advanced satellite projects and provide data analysis on life-time data on Echo II, Relay and Syncom.

Echo II

The Echo project consisted of design, development, launch and evaluation of a large inflatable passive communication satellite. Other than a low level effort in experiments on Echo II, the project has been completed. No FY 1966 funds are required. FY 1967 funds are required for continued data analysis.

Relay

Project Relay consisted of the design, development, launch and evaluation of two intermediate altitude active communications satellites. This project demonstrated the capability to economically and reliably perform narrowband and wideband communication between widely separated ground stations for long periods of time. Except for continued communications and radiation experiments data reduction and analysis, the project is completed.

Syncom

Project Syncom consisted of the design, development, launch, and evaluation of synchronous altitude active communication satellites. This project demonstrated the capability of performing communications experiments including telegraph, digital data, and TV demonstrations reliably, economically, and for long periods of time. The project was completed following the launch

of Syncom III in August 1964 and subsequent successful demonstrations. Effort is continuing in communications experiments data reduction and analysis for which FY 1967 funds will be used.

Early Gravity Gradient Test Satellite

Earlier, work on this project consisted of the design, development and flight testing of a gravity gradient stabilization system in support of the Defense Communications Satellite program. The NASA and the DOD entered into an agreement whereby the Air Force Space Systems Command will be responsible for the procurement of flight hardware and will flight test the gravity gradient system as an integral part of the initial Defense Communications Satellite flights. NASA will continue to monitor this effort and provide technical assistance to the Air Force. FY 1965 funds of $5,000,000 are available to the Air Force to cover costs of the spacecraft. No FY 1966 or FY 1967 funds are required by NASA.

Applications Technology Satellites

This project consists of the design, development, launch, and evaluation of a basic spacecraft capable of performing communications, meteorological, gravity gradient stabilization, scientific and other technological experiments. The project includes five launches: one being a gravity gradient stabilized satellite in a 6,500 mile circular orbit; two launches of spin stabilized satellites; and two launches of gravity gradient stabilized satellites into synchronous orbit. All five satellites will carry meteoro-

logical, communications, scientific and other technological experiments; in addition, the 6,500 mile orbit, and two synchronous satellites will carry gravity gradient experiments. FY 1967 funds will provide for the first launch (spin stabilized, synchronous orbit) and preparation for the second launch (6,500 mile orbit) and continued development and testing of the remaining three spacecraft and experiments. Operations and initial date analysis for the first flight will also be provided for with FY 1967 funds.

R&D OFFICE OF SPACE SCIENCE AND APPLICATIONS

BASIC RESEARCH PROGRAM

In this program NASA initiates and administers fundamental research in the physical and mathematical sciences for development of future aeronautical and space vehicles. The Basic Research Program is concentrated in the NASA Research Centers, supplemented by a contract program with universities, non-profit institutions, industry and other Government agencies. Basic research covers a wide spectrum, from extremely fundamental studies of the nature and behavior of matter to more applied studies such as the prevention of catastrophic stress-corrosion failure of titanium tanks when filled with nitrogen tetroxide. The broad objective of this program is the increase and dissemination of knowledge in areas considered vital to the future of NASA.

FUNDS REQUIRED:

	(Thousands of Dollars) 1965	1966	1967
Supporting research and technology	$21,231	$22,000	$23,000
Total	$21,231	$22,000	$23,000

WHY FUNDS REQUIRED:

The Basic Research Program concentrates on four major disciplines related to NASA's current and future missions: Fluid Physics, Electrophysics, Materials and Applied Mathematics. The following examples show how existing and planned research contributes to the NASA program.

Liquids relating to magnetic fields may lead to unique space power systems and provide a means for studying and controlling fluids in "zero-gravity" situations. Nuclear magnetic resonance techniques have been used to detect hydrogen nuclei in soil and rock samples; such knowledge could indicate the presence of trace amounts of water in samples from the moon and planets. New materials investigations may lead to lighter-weight structural materials, chemically stable and radiation resistant coatings, and high temperature and high strength materials for propulsion systems.

R&D OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

SPACE VEHICLE SYSTEMS PROGRAM

This program wants to identify and solve design problems in space vehicle launch and ascent through the atmosphere, flight through space,

entry into the atmosphere of the earth and other planets, and landing. Research is conducted on a broad front in spacecraft and launch vehicle aerothermodynamics and structures and in technological disciplines of importance to space flight which include high energy radiation, meteoroids, vacuum, thermal radiation and temperature control, and the control of fluids in the weightless state. The program is directed toward providing the advanced technology base for future space vehicles and missions, and at the same time provide support for existing vehicle development programs in the solution of immediate design problems.

FUNDS REQUIRED:

	(Thousands of Dollars) 1965	1966	1967
Supporting research and technology	$25,707	$26,000	$28,700
Project FIRE	1,811	500	---
Lifting body flight and landing tests	1,400	1,000	1,000
Scout reentry project	400	3,000	4,800
Project Pegasus (Saturn-launched meteoroid experiment)	13,690	2,500	---
Small space vehicle flight experiments	1,010	2,000	1,500
Scout-launched meteoroid experiments	175	---	---
Total	$44,193	$35,000	$36,000

WHY FUNDS REQUIRED:

Supporting Research and Technology

The requested funds will carry out research and advanced technology

program in aerothermodynamics, structures, and space environmental factors and develop space vehicle design criteria in these and other areas. Emphasis will be in the technologies of atmosphere entry and spacecraft terminal descent and landing especially, advanced controlled entry vehicles for manned space flight applications and refurbishable ablative heat shields for such vehicles; vehicle concepts, heating, and heat protected structures for atmosphere entry at planetary flight speeds of 50,000 feet per second and greater; advanced controlled terminal descent techniques and systems for semi-ballistic manned entry vehicles; and parachute and decelerator technology for terminal descent in the atmosphere of Mars. Research also will be conducted on aerothermodynamic and structural problems of importance to current launch vehicles. Special attention will be given to the difficult problems involved in recovery and reuse of launch vehicle stages. In space environmental factors, emphasis will be on the problem of further defining the meteoroid environment, on which major progress was made during the past year with the successful launchings of the large Pegasus meteoroid detection satellites. Research will be continued and augmented in high energy radiation effects and shielding and the behavior of fluids in the weightless state.

The Space Vehicle Systems program is carried out in-house at all major NASA Centers, with the primary effort conducted at the Langley, Ames, Lewis and Flight Research Centers, and is supplemented by research conducted by contract with industry and educational institutions.

Lifting Body Flight and Landing Tests

Fiscal Year 1967 funds are asked to conduct an extensive flight test program at Flight Research Center on the M-2 and HL-10 vehicles, a program in which both NASA and USAF test pilots will participate. The program will investigate the terminal approach and landing phase of flight of unconventional wingless vehicles typical of a class of lifting configurations having improved maneuvering capabilities in atmosphere entry flight. The two test vehicles were constructed by the Northrop Corporation to NASA specifications. The M-2 has been delivered and is nearing flight readiness; the HL-10 is nearing delivery and will reach flight readiness in the spring of 1966. The test program will be conducted by carrying the vehicles aloft by a B-52 aircraft and releasing them to gliding flight at 40,000 feet and Mach 0.8.

Scout Reentry Project

The funds requested are needed for anchor point flight experiments launched by Scout vehicles. This is a continuing program whose objective is to support the advancement of atmosphere entry technology, with particular emphasis on the technologies of aerothermodynamics and heat protective structures. These experiments are conducted with the aim of correlating, verifying, and extending research results obtained in laboratory facilities.

The flight experiments will (1) determine the performance of an advanced ablative heat shield material of interest to ballistic entry vehicle

applications; (2) investigate performance and characteristics of ablative heat shields for application to refurbishable heat protection systems for lifting reentry configurations; (3) measure heating rates associated with turbulent boundary layers at high Mach numbers and high Reynolds numbers; and (4) develop, in an intermediate step, the flight techniques, systems, and instruments required for later 50,000 feet per second entry flight tests.

Small Space Vehicle Flight Experiments

Fiscal Year 1967 funds are requested for selected flight experiments using small rocket launch vehicles to verify results obtained in ground-based facilities, and to investigate problems which can only be studied under actual flight conditions. Flight experiments will be conducted in this program to determine the deployment, loading, and descent characteristics of advanced parachutes, for application to the problem of terminal descent and landing of instrumented payloads in the thin atmosphere of Mars. The experiments will be launched by Nike rockets to altitudes near 100,000 feet to simulate conditions expected in the Martian atmosphere.

Funds are requested for ablation materials performance experiments at intermediate speeds between those obtained in the Scout-launched experiments and those achievable in ground-based facilities. These flights will incorporate research on techniques and instrumentation aids for payload recovery, an essential feature of future heat shield materials flight experiments which will permit post-flight examination and analysis of specimens.

R&D OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

ELECTRONICS SYSTEMS PROGRAM

Laboratory research is conducted, under this program, both in-house and under contract in problems of guidance, control, communications, tracking, instrumentation, data processing and electronic components.

Guidance research has the objective of employing new concepts having the potential of substantially reducing the quantity of moving parts or of otherwise decreasing complexity, size, weight and power requirements. Inertial, optical, and electromagnetic means are employed to exploit these concepts. In control systems research, automatic and manual flight control and space or aeronautical vehicle attitude control technology improvements are sought. Emphasis is placed on establishing new concepts and verifying them on flight control simulators, leading eventually to experimental and operational flight on real vehicles.

The ability to communicate over interplanetary distances and to accomplish deep space tracking functions is limited. Research is performed to provide a firm technological base for the evolution of future system configurations. Investigations in the microwave, millimeter and sub-millimeter, and optical frequency domains are conducted to develop the basic concepts and components required to improve system capabilities.

In the area of instrumentation and data processing, the technology applied to the processing of Mariner IV pictures to reduce noise and improve

contrast leads to a host of new technological requirements for future missions. Included are needs for on-board data storage of millions of bits of information and pre-transmission processing to relieve the requirement for greater spacecraft transmitter power and bandwidth.

Component technology research involves the basic element of all electronic systems and subsystems. Efforts are centered on the development of new and improved space-qualified components and methods for achieving increased reliability in future system applications.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology	$23,222	$30,000	$34,000
Flight projects	2,400	2,300	2,800
Total	$25,622	$32,300	$36,800

WHY FUNDS REQUIRED:

Supporting Research and Technology

FY 1967 funds are asked to continue and increase support of guidance technology based on the promising aspects of the laser gyroscope, new concepts in horizon scanning and laser radar. Manual control of launch vehicles for recoverable booster programs, and potential applications of new components to such low fuel and weight attitude control systems as the control moment gyro need support. Work leading to use of the laser in deep space communications and new microwave tubes for improvement of present systems in the same

area requires increased support. Increased emphasis in FY 1967 will be placed on statistical and optical data processing so that future missions can transmit more meaningful data from space in less bandwidth. Unique applications of computers on the ground are required, especially in the area of better communications between computer and man. Adaption of microelectronic technology to space system components is necessary to meet requirements of decreased size, weight and power consumption. FY 1967 funds are necessary to expand this effort and investigate techniques to reduce interconnections between microcircuits and to provide for improved inspection techniques to better understand the physics of failure. Increased emphasis will be placed on reducing the power consumed by electronic circuitry.

Flight Projects

Radio attenuation by plasma sheaths generated in the earth and planetary entry process continue to disrupt vital communication between spacecraft and earth. Earth based simulation of reentry conditions especially for planetary entry and return velocities is inadequate as the state-of-the-art is now understood. Project RAM (Radio Attenuation Measurements) requires funding to permit diagnostic flights and flights in the real environment to test alleviation concepts. Funds are also required to gather more data in the manned space flight program to evaluate the effects of spacecraft windows on the performance of improved space sextants.

Horizon sensors for determining spacecraft attitude are dependent on an accurate knowledge of the earth's radiation characteristics as viewed from space. Current programs (SCANNER) are developing techniques for measuring these characteristics. The Earth Coverage Horizon Measurement project requires funds to provide a statistical description of the earth's horizon radiance profile over a broad range of seasonal and climatic variations.

R&D OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

HUMAN FACTOR SYSTEMS PROGRAM

Four major objectives are being sought in this program: (1) to determine man's reactions to the unique environments of space and aeronautical flight, (2) to define the essential requirements for sustaining and protecting man in these environments, (3) to develop the technology necessary to provide suitable life support and protective systems, and (4) to integrate man's capabilities with those of machines to obtain composite systems of superior performance.

The scope, as well as the success, of future manned space missions will depend upon the effective utilization of man for extended periods of time. This requirement is equally important to the success of future aeronautical systems. Considerations of man's performance capability and psycho-physiological limitations directly affect equipment design and performance specifications. Such considerations are essential when man

is to be integrated as a functional part of a total system. The success of new manned systems requires that Human Factors research stays in step with all other aspects in the development of a new system. The increasing priority of certain lagging Human Factors investigations and technological developments is reflected by the requested funding increases detailed below.

This program is accomplished through a multi-disciplines approach. It includes researchers in nearly every field of medicine, and in biology, psychology, engineering, physics, and electronics. They are located in NASA centers, DOD aerospace medical facilities, universities, and industries located throughout the country.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology	$12,160	$13,000	$15,500
Small biotechnology flight projects	1,160	1,900	1,500
Total	$13,320	$14,900	$17,000

WHY FUNDS REQUIRED:

Supporting Research and Technology

This is an integrated program directed toward the accomplishment of the four major objectives of the overall Human Factors System Program. The program includes effort toward understanding the physiological and psychological reactions of men to the environmental conditions of space travel, including

cardiovascular, metabolic, and nutritional reactions. The research involved covers microbiology, definitions of systems to sustain life in the hostile environment, studies of man-machine interactions, and research toward defining and solving next-generation of man into the operational system of future air and spacecraft.

Small Biotechnology Flight Projects

These projects cover a continuing series of small flight experiments designed either to validate results of laboratory research or to obtain essential information not obtainable from research in the laboratory. Experiments to be performed in FY 1967 include the measurement of physiological processes in humans under conditions of stress encountered in flight and measurements of the adaptability of animals to prolonged orbital flight.

R&D OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

SPACE POWER AND ELECTRIC PROPULSION SYSTEMS PROGRAM

This program provides research and technology to evolve new and improved methods of power generation and electric propulsion for space applications. The program includes work aimed at more efficient and practical use of nuclear, solar and chemical energy for the generation and utilization of electric power in space; as well as the development of the technology of electric thrustors powered by either solar or nuclear power systems.

All space vehicles require electric power for operation of such equipment as communications, telemetry, guidance, stabilization and scientific instruments.

The power level and duration varies widely (watts to megawatts and hours to years) depending on the purpose of the vehicle, but the trend is toward the higher power levels and longer mission durations. This trend results from the availability of larger launch vehicles such as the Saturn and from the desire to undertake more ambitious programs. All power system experience to date has been at relatively low power levels, less than 1 kilowatt, and the vast majority of applications have involved solar cell and battery systems. This experience has shown that current solar cell and battery systems will require major improvements in performance, particularly at the higher power levels, and that advanced systems that are more compact and independent of the sun will be required.

Electric thrustor systems offer promise of significant savings in spacecraft weight, trip time or increased payload. The power required ranges from watts for attitude control systems to megawatts for manned interplanetary propulsion systems. Solar cells appear to be satisfactory power sources for the lower power thrustors. Work is needed on the system aspects of electric thrustors in anticipation of several early applications.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology	$36,770	$38,200	$37,000
Space electric rocket test (SERT)	2,300	3,000	---
SNAP-8 development	19,150	4,000	5,500
Total	$58,220	$45,200	$42,500

WHY FUNDS REQUIRED:

Supporting Research and Technology

All spacecraft utilize electric power for their operation. The space power portion of the space power and electric propulsion program is aimed at providing the technology for making significant and worthwhile improvements in operational systems, i.e. solar cells and batteries, and achieving the potential advantages of advanced systems such as isotope and reactor power plants.

The electric thrustor portion of the program includes the technology necessary for early applications of low thrust systems powered by solar cell power plants, and a longer range effort toward the continued improvement of thrustors over the entire range of applications from small spacecraft position control systems to large nuclear powered manned interplanetary propulsion systems. The program is paced to provide new technology information in a timely and economical manner consistent with possible future mission requirements.

SNAP-8 Development

Development of SNAP-8 power conversion system performance and endurance will be continued toward the 35 KWe, 10,000 hour objective. During FY 1967 it is expected that the endurance testing of the major components will be advanced to the 2500 hour point. Technical support investigations in boiler performance, materials and long life instrumentation initiated in late FY 1966

will be continued in FY 1967. Operation at 35 KWe of the first breadboard power conversion system will be continued in FY 1967, and automatic system startup will be investigated.

R&D OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

NUCLEAR ROCKETS PROGRAM

This program provides the necessary research, design, and engineering data, test hardware, and general technology required to develop nuclear rocket systems with power levels, operating times, restart conditions, and specific impulse values suitable for advanced space missions. Such systems have higher performance that should provide major advantages over chemical systems in terms of payloads, costs, and mission flexibility. They are particularly suitable for many advanced space missions such as lunar base logistic operations, deep space probing with heavy complex spacecraft, and manned exploration of the planets.

The major areas of effort are the research and engineering of the nuclear reactor, the development of certain non-nuclear components, and the integration of the reactor and non-reactor components into a complete experimental engine system.

The experimental ground test engine system is being investigated to provide an essential understanding of the interaction of components in nuclear rocket engines and of the system performance characteristics. Progress in the technology phase, NASA says, warrants the initiation of specific engine development in FY 1967.

FUNDS REQUIRED:

	(Thousands of Dollars) 1965	1966	1967
Supporting research and technology	$20,891	$21,000	$16,900
NERVA	35,370	36,000	33,100
NRDS operations	739	1,000	3,000
Total	$57,000	$58,000	$53,000

WHY FUNDS REQUIRED:

Supporting Research and Technology

The supporting research and technology effort supplies four basic needs (1) general supporting research and technological data for current projects; (2) necessary basic technology for the development of future generations of nuclear rocket engines and vehicles; (3) feasibility analyses of advanced nuclear propulsion concepts; and, (4) studies of the special safety problems of nuclear rockets.

This effort also includes research on the components and systems required for both the reactor and engine of future nuclear rocket propulsion systems. The major problems studied are those associated with developing systems that will operate reliably under the adverse conditions of reactor radiation and temperature extremes inherent in the nuclear rocket engine.

NERVA

The objective of the NERVA technology effort is to develop the technology of nuclear rocket engine systems utilizing graphite solid-core reactors.

Progress in the graphite reactor program has been good. Altitude equivalent performance levels in excess of 750 seconds specific impulse at 55,000 pounds of thrust have been achieved for extended durations. In view of the reactor progress, increased emphasis is being devoted to the engine system phase. This effort includes the development of critical non-nuclear components, such as the nozzle, turbopump and control system, and the integration of these components with the reactor into meaningful nuclear rocket engine systems tests. It is important to gain a thorough understanding of the interactions of the various components during start-up, full power operation, operation at off-design conditions, and during cool-down periods. With this knowledge NASA can develop components and systems leading to the development of operational flight engine systems with a high assurance of success.

NRDS Operations

The mission of the Nuclear Rocket Development Station in Nevada is to provide a site for ground static testing of reactors, engines, and eventually, vehicle stages for the nuclear rockets program. The funds under this project provide for NASA's share of the base support services necessary in the maintenance and operation of the facilities at the site.

R&D OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

CHEMICAL PROPULSION PROGRAM

The chemical propulsion program is geared at establishing a sound base of technology on which to plan and to develop propulsion equipment for space program

missions. The spectrum of applications includes launch vehicles, upper stages, spacecraft, and auxiliary devices such as personnel mobility devices. The research work covers a broad range of engineering sciences, with the intent to provide a stockpile of technical information from which to draw to meet any future propulsion requirement. The work covers basic studies and experiments such as measurements of chemical and physical properties of propellants, ignition and combustion phenomena, classical and non-equilibrium thermodynamic processes, studies of fluid mechanics, gas dynamics, heat transfer, and solid mechanics. It also includes the examination of new materials, propellants, or processes, and examination and documentation of techniques, procedures, and specifications. This base covers the examination of new concepts and the obtaining of data to establish their feasibility. Future requirements and new problem areas are identified.

The experimental engineering program concentrates engineering effort toward demonstrating the adequacy of our technology to meet attractive mission requirements. This work involves the design, fabrication, and test of functional model propulsion systems and subcomponents to prove that the basic technologies can be integrated to create practical and reliable propulsion machinery.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology ...	$24,762	$33,500	$33,500
M-1 engine project	24,910	2,000	---
Large solid motor project	26,800	4,200	3,500
Small chemical propulsion flight projects	30	---	---
Total	$76,502	$39,700	$37,000

WHY FUNDS REQUIRED:

Supporting Research and Technology

Advanced engine design concepts for improving vehicle performance with chemical propellants are being investigated for launch vehicle and upper stage application; the high energy propellants are being examined for use in spacecraft where high specific impulse offers significant weight savings. A liquid propellant experimental program is concentrating initially on spacecraft propulsion related to applications during the next decade. It includes examination of high performance propulsion systems using hydrogen and fluorine propellants and of space-storable propellants suitable for use after extended duration flight in the space environment. The experimental program also covers work on advanced high performance engine systems that will succeed the discontinued M-1 engine.

The solid propellant motor program includes research on nondestructive testing techniques for inspection and qualification of loaded motors, ignition and instability problems, thrust vector control systems, methods of combustion termination, and improved processing techniques. New requirements under investigation are stop-restart capability, more accurate thrust alignment, and improved predictability of propellant burning rate. An experimental engineering program will develop the technology related to solid motor development to the point of demonstrated applicability to launch vehicles, spacecraft, and auxiliary propulsion use.

Large Solid Motor Project

The first phase of this program will be completed in early calendar year 1966. Program continuation will involve development of the technology of critical subsystems.

Subscale motors of 156" size will be used for testing of such subsystems as thrust vector control, failure warning, and abort implementation. These features will ultimately be integrated into 260" size motor tests.

R&D OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

AERONAUTICS PROGRAM

The Aeronautics program seeks to improve the efficiency, utility, and safety of aircraft. General objectives are: (1) to provide leadership in the generation of advanced aircraft concepts, (2) to seek technological advances needed to develop superior aircraft, and (3) to supply industry with advanced data for the design of new aircraft. The scope of work in aerodynamics, structures, materials, air breathing propulsion, and operational aspects including safety, noise, and pilot and aircraft integration. These are the technical disciplines that provide the data needed for the construction of advanced aircraft. Studies of these problems also point to the most profitable paths for technological advances in the future. For example, the XV-5A fan-in-wing aircraft, the tilt-wing SC-142A V/STOL transport, and the variable sweep concept for the F-111 all appeared several years ago as NASA research concepts having great promise. In the years between the first indication of the value of the concept

and the first flights of the vehicles, NASA aided in the detailed formulation of the concepts and in substantiating the over-all capabilities of practical vehicles based on these concepts.

In addition, NASA has conducted extensive wind tunnel tests, simulator programs, and flight investigations using appropriate testbed aircraft to substantiate predicted performance and operational characteristics of these vehicles and to aid in the solution of problems of a developmental nature. In this regard, advanced technical development in support of military and civil aircraft procurement continues to be conducted. This work is performed in cooperation with government-sponsored contractors at the request of the cognizant government agencies.

Experimental research and development aircraft and engineering test pilot proficiency aircraft considered necessary to carry out and support the aeronautics effort are included under this Fiscal Year program.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Supporting research and technology....	$ 8,163	$10,261	$ 9,000
X-15 research aircraft	1,425	883	900
Supersonic transport	19,953	14,056	14,100
V/STOL aircraft	2,987	2,000	5,000
Hypersonic ramjet experiment	2,712	5,000	2,000
XB-70 flight research program	---	9,296	2,000
Total	$35,240	$41,496	$33,000

WHY FUNDS REQUIRED:

Supporting Research and Technology

This will include studies directed toward improvement of subsonic, supersonic, and hypersonic aircraft. For example, wind tunnel investigations of the aerodynamic interference between engine nacelles and wings at high subsonic speeds; studies of new structural design concepts required to fabricate reliable lightweight structures suitable for long lifetimes under high temperature conditions, for supersonic and hypersonic aircraft; studies of air-breathing propulsion cycles and engine components to increase efficiency and permit the design of efficient lightweight engines for V/STOL aircraft, supersonic transport, and hypersonic aircraft; and studies directed toward improving flight safety and increasing operational flexibility of present and proposed aircraft, especially under adverse or "all-weather" flight conditions will be conducted.

X-15 Research Aircraft

The X-15 research program, conducted in cooperation with the Department of Defense, is providing data on manned, maneuverable hypersonic flight. The X-15 remains the only research capability in the world for studying hypersonic flight in its true environment. Experimental results to date have given basic insight into problems of aerodynamics, structures, propulsion and operations during hypersonic flight. Of major importance, the X-15 results have given and will continue to give confidence and guidance to research in ground based

hypersonic research facilities enabling exploration in depth of many hypersonic flight problems. In six and one-half years of flight test, from June 1959 to December 1965, the X-15 program not only has contributed to the increased confidence of designers of current high-performance aircraft, but has focused attention on the areas which required additional research. The future program will be directed toward these areas, to provide information for the next logical step in our flight research program--manned, maneuverable hypersonic cruise flight.

Supersonic Transport

NASA's research effort and support for the national supersonic transport (SST) program will continue in 1967 at about the same level as in FY 1966, but with a substantial shift in emphasis. The Federal Aviation Agency and its contractors will by then be carrying the major activity in prototype configuration development, structural design, and development of the first-generation engines. The NASA will maintain a major effort on advanced propulsion systems and materials for advanced engines, expand its operational research, carry major responsibility in noise and sonic boom research and make available its unique facilities and technical resources as needed during prototype development.

A large part of the requested funds will be used in the field of propulsion for continuing contract research on engine components and materials started in FY's 1965 and 1966. In FY 1967, however, the contract program will be reduced and at the same time, the in-house effort will be increased to provide research information required for second-generation SST engine development.

V/STOL Aircraft

A major part of the increase in funding in FY 1967 will cover studies of a new VTOL research airplane capable of providing more accurate information on the influence of all-weather landing operation capability on the design of high-performance tactical V/STOL types. A feasibility study will be initiated to determine the characteristics required of such a research airplane, and to identify existing conventional high-performance aircraft which could be modified to provide the vehicle needed. Wind tunnel studies will be undertaken to determine the effectiveness of the modifications proposed. Actual modification of the existing vehicle--which the Air Force has agreed to provide from its inventory--may begin. Related flight studies of the requirements for pilot displays to effect safely such VTOL all-weather landing operation, begun in FY 1966, will continue using the NASA Bell 204B helicopter; a flight investigation of an advanced landing-approach aid for STOL aircraft, recently initiated using a conventional transport airplane, will be extended in FY 1967 to more realistic approach conditions following procurement of a suitable STOL aircraft.

Hypersonic Ramjet Experiment

A feasibility study and design competition is currently in progress between the Garrett Corporation, the General Electric Corporation, and the Marquardt Corporation to determine an optimum configuration for a liquid hydrogen fueled ramjet engine capable of being operated between Mach 3 and 8. In this speed regime both subsonic and supersonic combustion systems can be studied using a convertible combustion arrangement.

Upon completion of the current phase I studies, an evaluation will be undertaken to select one or more of the study phase contractors to continue with detailed design, experimental wind tunnel verification, fabrication, and proof test of the selected concepts. This second phase of the program is expected to require 29 months for completion.

XB-70 Flight Research Program

The use of the USAF XB-70 aircraft as a research tool will be supported jointly by the USAF and the NASA. It will provide the NASA with the ability to validate its basic aerodynamic theories and experimental results obtained in ground facilities to account for, as examples, effects of vehicle size (Reynolds Number) on skin friction and heat transfer, effects of elastic structure deformation on aerodynamics and the effect of heat soak on this deformation, effects of vehicle inertia combined with low damping (high altitude) on vehicle control requirements, effect of vehicle size on sonic boom generation and propagation, inlet control system requirements and many others. All of these problems have been and will continue to be the subject of major research efforts in analysis and ground based facilities. The XB-70 program will provide vital guidance and assessment of the soundness of these programs, assuring that major programs such as the supersonic transport will proceed on a sound basis.

OFFICE OF TRACKING & DATA ACQUISITION

TRACKING & DATA ACQUISITION PROGRAM

The purpose of this program is to provide tracking and data acquisition

support to meet the requirements of flight projects. Support is provided for all NASA projects, and as mutually agreed, for projects of the Department of Defense, other government agencies, universities, private corporations, international organizations, and other countries engaged in mutual research endeavors.

Support is provided for manned and unmanned flights; for spacecraft, launch vehicles, sounding rockets, and research aircraft; for earth orbital and suborbital missions, lunar and planetary missions, and space probes.

Types of support provided include tracking to determine the position and trajectory of vehicles in space, acquisition of data from scientific experiments and on the engineering performance of spacecraft and launch vehicle systems, transmission of commands from ground stations to spacecraft, communication of information between various ground facilities and mission control centers, and processing of the data acquired from the space vehicles.

Tracking and data acquisition support is provided by a world-wide network of ground stations (including Department of Defense stations and instrumented ships), and by general purpose facilities in launch areas. These stations are linked together by a network of ground communications which provides the real-time information necessary for critical decisions. Facilities also are provided to process into meaningful form the large amounts of data which are collected from flight projects.

Tracking and data acquisition facilities are used for support of current

missions. At the same time, they must be augmented to meet the requirements of missions in the immediate future. Concurrently, planning must proceed for projects which are even further in the future, and equipment and techniques must be developed to assure a sound technological approach for the support of the more complex mission requirements of the next generation.

FUNDS REQUIRED:

	(Thousands of Dollars)		
	1965	1966	1967
Operations	$95,254	$129,600	$199,000
Equipment	144,482	87,665	66,500
Supporting research and technology	13,500	13,800	13,800
Total	$253,236	$231,065	$279,300

WHY FUNDS REQUIRED:

Operations

Funds are required for the operation and maintenance of the world-wide tracking and data acquisition facilities. The FY 1967 operation program reflects the support required for the more complex unmanned flight missions and the support for the increasing activity in the manned space flight program. New and augmented facilities, including ships and aircraft, are becoming operational with corresponding increase in communications requirements. Increase in personnel and additional logistic support must be provided to operate and maintain the new facilities and equipment.

Equipment

The tracking and data acquisition support requirements for forthcoming flights establish the equipments that must be procured and the facilities that must be modified. The FY 1967 funds for this purpose reflect a decrease mainly due to prior years' funding of the major portion of the Apollo requirements. Procurements to meet manned space flight requirements will continue in FY 1967, as well as procurement of equipments required for the support of future unmanned missions.

Supporting Research and Technology

Supporting Research and Technology is the activity whereby advanced systems, components and techniques are developed and are then used to implement the various networks to meet the requirements of new flight projects. The program for FY 1967 will emphasize improvements for increasing the reliability and lifetime of existing systems and for determining techniques for efficient utilization of these systems to meet upcoming requirements.

OFFICE OF TECHNOLOGY UTILIZATION

TECHNOLOGY UTILIZATION PROGRAM

The Technology Utilization program provides the widest practicable and appropriate dissemination to industry of information concerning NASA activities and results which appear to have industrial applications potential. Technology Utilization also includes projects to study and evaluate those factors which will improve our understanding of the implications of the space program.

FUNDS REQUIRED:

	(Thousands of Dollars) 1965	1966	1967
Identification	$1,235	$1,220	$1,165
Evaluation	645	680	650
Dissemination	1,970	2,000	2,085
Analysis	900	850	900
Total	$4,750	$4,750	$4,800

WHY FUNDS REQUIRED:

Identification

The Identification effort is carried out by special personnel who search for ideas, innovations, processes and techniques which appear to have potential for non-aerospace application and report them quickly to NASA Headquarters. The Identification effort also includes the identification of incremental advances in technology. Research institutes, universities and private companies identify these incremental advances in technology by reviewing broad areas of space research and developing state-of-the-art summaries called Technology Surveys. This program will be continued at about the same level during FY 1966 and FY 1967.

Evaluation

The technical information reported to Headquarters is forwarded to a group of Research Institutes and evaluated for novelty, technical feasibility and relevance to non-aerospace industry. The product of this evaluation is a flow of new items, processes and techniques having non-aerospace potential. These

products are then made the subject of one of several publications: Tech Briefs, Technology Utilization Notes, or Technology Utilization Handbooks. Although the current emphasis on new technology reporting is expected to increase the rate of documents coming into the system, the funding requested for FY 1967 will permit continuation of this evaluation effort at about the same level as for FY 1966 and FY 1965.

Dissemination

Dissemination activities are focused on exploiting the normal channels of communication that are in existence or which can be developed. Two general techniques of dissemination are employed. The first is by mailing lists consisting of over 8,000 industrial companies and individuals who receive information in some cases on all Technology Utilization publications, and in others only those in their technical areas of interest. The second form of dissemination is through experimental regional dissemination centers. Fiscal Year 1967 funds will be used to support current programs at these Centers with appropriate modifications and improvements; and also provide support for several pilot projects with other agencies. In addition, two new experimental dissemination centers are planned.

Analysis

In recognition of the much broader impact of NASA programs than simply that of a major one in advancing science and technology, support is given to a study program to analyze the impact of the space program on the regional

and local economy, and on industries, private institutions and different types of manpower. The principal aim here is to have researchers assist in characterizing NASA's impact as it has affected their regions and to develop analyses which lead to consideration of improved policies within the constraints of existing legislation.

A recognition of the need to solve critical management problems and possibly to develop wholly new techniques for managing such a large and complex Research and Development enterprise as the NASA led to the support of study areas that include the organization and management of large R&D projects, the diversified roles of the research director, the government-industry contracting system, conditions under which the transfer of new technology takes place in the economy, and top level policy and decision-making in large R&D organizations. During FY 1967 NASA will continue to support a modest program of research on such management areas.

NASA budget analysis FY ..